"OWO MADE"

UNLOCKING THE POTENTIALS OF AGRICULTURAL VALUE CHAINS FOR SUSTAINABLE ECONOMIC DEVELOPMENT IN NIGERIA

PROCEEDINGS

55TH ANNUAL CONFERENCE

AGRICULTURAL SOCIETY OF NIGERIA (ASN)

DATE AND VENUE

25th – 29th October, 2021
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AGRICULTURAL SOCIETY OF NIGERIA

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The Chairman, Senate Committee on Agriculture
The Chairman, House Committees on Agriculture
Honourable Members of the Senate and House of Assembly
Hon. Minister, Federal Ministry of Agriculture and Rural Development
Hon. Minister, Federal Ministry of Water Resources
Hon. Minister of State, Federal Ministry of Agriculture and Rural Development
The Executive Governor of Ondo State, His Excellency Arakunrin Oluwarotimi Odunayo Akeredolu SAN
The Executive Secretary, Agricultural Research Council of Nigeria
The Rector, Rufus Giwa Polytechnic Owo
Distinguished Keynote and Plenary Speakers
The Chairman, ADAN and Deans of Faculties of Agriculture here present
Executive Directors of Research Institutes here present
Presidents and Officers of Sister Societies in Agricultural Disciplines
Past Presidents and Fellows of Agricultural Society of Nigeria
Royal Fathers and other titled Men
Invited Guests
Members of the Press
Ladies and Gentlemen

It is my delight to honorably welcome you all to this unique occasion of our 55th Annual Conference of our great Society. Recall that we started this journey as new executive members in October2018 and thus far we have moved the association forward. I am particularly delighted to welcome in a special way, our special Guest of Honour – His Excellency the Executive Governor of Ondo State Arakurin Oluwarotimi Odunayo Akerodolu, the Guest of Honour – Senior Special Assistant on Agriculture and Agribusiness to the Ondo State Governor Pastor Akin Olotu, our keynote speaker –Mr. African Farmer Folumogaji MD/CEO Farm Credit Nigeria and Chairman Agricultural Sector Lagos Chamber of Commerce and Industry and all the plenary speakers. I extend a big welcome to the Chairperson here present and all the Presidents of sister societies here present. To our host, the Rector Rufus Giwa Polytechnic Owo– Mr. Gani Adebowale Ogundahunsi and all the principal officers of the Agricultural Research Council of Nigeria, we sincerely thank you for being part of this process of hosting this conference this year.

AGRICULTURAL SOCIETY OF NIGERIA: A BIRD VIEW

The Agricultural Society of Nigeria (ASN) started in 1962 at the Faculty of Agriculture, University of Ibadan. The society was started by a group of concerned Agricultural Professionals who graduated in various fields of Agriculture, Forestry and Veterinary Medicine, as well as those who had their Diploma Certificates in General Agriculture and Agric. Engineering from Nigeria and abroad. The society was born out of patriotism to assist our nation, Nigeria, to regulate the practice of agriculture in all its fields, which includes plant breeding and genetics, soil science, animal husbandry, agronomy, forestry, plant protection, fishery, veterinary medicine, etc. The Society no doubt has come of age as a legal entity having registered with CAC and is pushing ahead to register agriculture as a professional bodywith a view to encouraging younger generation in taking agriculture as a lucrative and enviable profession.

THEME OF THE 55TH ANNUAL CONFERENCE

The main theme of thisyear's Annual Conference is ***"UNLOCKING THE POTENTIALS OF AGRICULTURAL VALUE CHAIN FOR SUSTAINABLE ECONOMIC DEVELOPMENT IN NIGERIA".*** The theme which is apt and in tandem with policy of the Federal Government was carefully crafted as the importance of agricultural value chain cannot be overemphasized if we must bridge the gap or lapses within the agricultural sector for sustainable economic development and growth within the sector. Some germane issues will be elucidated by the keynote and plenary speakers in trying to disintegrate and make sense of the theme of this year's conference. Ladies and gentlemen, permit me to assure you that our distinguished speakers are seasoned professionals and I have no doubt that they will do justice to the theme's subject matter. Careful implementation of suggested solutions no doubt will go a long way in making our country not only to be self-sufficient in food but also provides means of livelihood to the teeming population through economic diversification and especially create job for the restive youth.

THE NIGERIAN INSTITUTE OF AGRICULTURISTS (NIAg)

Efforts continued in the course of the year to build on the success recorded towards registration of Agriculture as a professional body. The Agricultural Society of Nigeria (ASN) and Association of Deans of Faculties of Agriculture (ADAN) of Nigerian Universities in conjunction with other Agriculturists across the country continued to push further the struggle to establish the Nigeria Institute of Agriculturists (NIAg) as a professional body. This is borne on the premise that registration of agriculture as a profession in Nigeria will reposition agriculture to play its leading role as a major driver of our economy. It is known that all disciplines in agriculture, which are interdependent, cannot stand alone but must come under one multidisciplinary professional body and work in synergy for effective service delivery and for ease of governance. The establishment of NIAg will ultimately serve the same purpose just like COREN is to Engineers and NMA is to medical doctors with their affiliate bodies.

Furtherance to our struggle, permit me to inform this gathering and all our teeming members that the bill has successfully passed through the National Assembly and is presently awaiting accent by the President. We are hopeful that in no distant time. We shall be having our own Institute for professionals in the field of agriculture. I will like to use this medium to crave the indulgence of anyone of us that is well connected to the seat of power especially the presidency to please avail us the opportunity of getting this bill accented to by Mr. President – His Excellency Mohammed Buhari (GCFR)

PUBLICATIONS OFAGRICULTURAL SOCIETY OF NIGERIA

The Society maintains and sustains regular Journal publication. The Journal of the Society contains information on new technologies and inventions in the field of Agriculture which is of high standard and highly subscribed by scientists all over the world. We now publish up to three volumes in a year and the second volume of this year is already published and will be distributed to every registered members of the society in this year conference. The Society also publishes pre-conference digital Proceedings, which is a compilation of the papers to be presented at the conference. The current digital volume will be circulated to members who registered for the conference and also posted on the society's website for download. Due to high cost of production the society stopped production of hard copies of proceedings; however, it can be produced on request if need arises and same backed up with cost of production. In addition to the journal and conference proceedings; the Society also publishes a quarterly Newsletter to give updates on the activities of the Society and new innovations in agriculture.

MEMBERSHIP DRIVE AND CERTIFICATES

The membership of the society has continued to grow. Presently we have over 3,000 members cutting across all the various disciplines in agriculture. This was made possible through our redesigned web site that facilitates online registration and payment. Through our website members are able to register and pay online with ease. Membership certificates are dispatched in record time and this is renewable every year as soon as members pay their annual dues except Life members.

We are in the process of assigning to every member a unique membership number as a means of identity to the society.

2021 ANNUAL CONFERENCE

The NEC on behalf of all the members wishes to thank the Rector of Rufus Giwa Polytechnic Owo Mr.Gani Adebowale Ogundahunsi for accepting to host this conference despite all challenges. We appreciate the support of all the corporate bodies for their various contributions in making this year's conference a success. The hard work by the high quality and experienced personnel in the Local Organizing Committee under the Chairmanship of Dr. Dapo Iwala explains resounding success the Society has recorded in this conference.

The year 2021 is very unique in the sense that due to the adverse effect of COVID_19 global pandemic, two conferences of our dear Society have been successfully organized. These are partially physical and virtual with thanks to ICT that has made that possible. In line with the new normal, in this present conference, members who registered for the conference will also be given the opportunity to present their papers online.

CONCLUSION

Ladies and Gentlemen, I wish to thank you and all the participants at this Conference Opening Ceremony for honouring our invitation. Special thanks go to our host, the Rector – Mr. Gani Adebowale Ogundahunsi for making this Conference a memorable one. I also want to thank the senior special assistant on agriculture and agribusiness to the Ondo State Governor Pastor Akin Olotu, Keynote and Plenary Speakers, ADAN, AESON, CCSN, CODRI Representatives, our farmers and all our important dignitaries for your presence at this Opening Ceremony. I will like to express my sincere appreciation to NEC members for your support and good advice in keeping up the tides of my stewardship. I am immensely grateful to God for his guidance and protection especially in the success we have recorded so far in our NIAg bill.

Thank you and God Bless.

Mohammed N. ISHAQ, PhD, FASN
President – ASN

PROCEEDINGS

55th Annual Conference

Agricultural Society of Nigeria

25-29 Oct., 2021

Rufus Giwa Polytechnic, Owo Ondo State

"OWO MADE"

SUB-THEME 1

Agribusiness, Agripreneurship, Policy and Resource Economics

Socio-Economic Determinants of Yam Production Output in Umuahia Agricultural Zone of Abia State, Nigeria

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PROCEEDINGS
55th Annual Conference
Agricultural Society of Nigeria
25-29 Oct., 2021

ABSTRACT

The study was carried out to assess socio-economic determinants of yam production output in Umuahia Agricultural Zone of Abia State, Nigeria. Structured questionnaire was used to elicit information from the farmers. Multi-stage sampling method was used in data collection. 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 and about 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 determinants such as 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 recommend that male farmers in the area should be more engaged in yam production so as to improve and increase the output of yam produced, since sex was significant but negatively related to yam production output in the study area.

Keywords: Factors, Yam, Production and Output.

INTRODUCTION

Yam is one of the tuber crops produced in Nigeria and it has many species, of which six are economically important staple species. They are *Dioscorea rotundata* (white guinea yam), *D. alata* (yellow yam), *D. bulbifera* (aerial yam), *D. esculenta* (Chinese yam) and *D. dumetorum* (trifoliate yam). Out of these, *D. rotundata* (white yam) and *D. 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 including 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 contributes 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). It is also comparable to any starchy root crops in energy and the fleshy tuber is one of the main sources of carbohydrates in the diet of most Nigerians. 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). There is dearth of information on socio-economic determinants of yam production output in Umuahia agricultural zone of Abia state. Hence, the study to assess the socio-economic determinants of yam production output in the study area. The objectives of the study are to describe the socio-economic factors influencing yam production and the effect of socio-economic factors on yam production output Umuahia agricultural zone of Abia state, Nigeria..

METHODOLOGY

The study was carried out in Umuahia Agricultural Zone of Abia State, Nigeria. 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 Local Government Area (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 and inferential statistics such as frequency, percentages and multiple regression model. The model is implicitly stated as:

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

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

RESULT AND DISCUSSION

Socioeconomic characteristics of respondents

Results in Table 1 shows that majority of the farmers (46.7 %) fall between 41-50 years. This implies that yam production and its increased 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.

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 % were married. Farming it is a necessary condition for families to lift their households out of poverty and ensure hunger free situation in homes.

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

This is in agreement 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 seed.

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

Variable	Linear	Semi-log	Double –log	+Exponential
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 at 1% level, * = significant at 10% level. + Exponential

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), stated that education help 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 determinants such as 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 improve and increase the output of yam produced, since sex was significant but negatively related to yam production output in the study area.

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Socioeconomic Characteristics of Usage of ICT among Researchers in Ilorin Kwara State

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ABSTRACT

The findings from the study (N=94) revealed that Research and Development belongs to different areas of specialization with engineers having the highest 41.5%. Also observed from the study, are 88.3%, 58.5% and 84% researchers in the Centre uses internet, desktop PC and laptop respectively. However, for dissemination of research findings to larger audience 71.32% and 61.7% uses radio and television media respectively. Above 90% of the respondents were acquainted with internet surfing, meanwhile 97.9% were able to operate computer irrespective of their area of specialization. The multiple regression result indicates that the coefficients of marital status, educational level, working experience and career path are statistically significant at 5% level indicating that these variables have great influence on the use of ICT for research and development by the respondents. It was also established from the study that irregular power supply, bad network coverage, and inadequate training on ICT usage are major constraints affecting the uses of ICT in the Centre. The study therefore recommended improvement in the use of alternative power supply (Solar Energy), training of researchers and provision of more ICT tools to enhance effective and accurate conduct of research and this will ultimately increase NCAM researcher's' productivity.

Keywords: ICT Facilities, ICT Utilization, Agricultural Mechanization, Research and Development, and NCAM Ilorin.

INTRODUCTION

The revolution of information communication technology (ICT) globally has opened greater opportunities for efficient information sharing. ICTs have become a driving force in development, providing means of narrowing the information gap between developed and developing countries and among their communities. In research, ICT has brought considerable improvement in information provision. It has become cheaper to digitally store, process and access large amounts of information at greater speed. ICT has controlled the information explosion 'bomb' to such an extent that it is now possible to obtain information from any library anywhere in the world regardless of the geographical location of the user and the library. There is no need for any library to attempt to acquire all publications. This is because, with suitable computer software, telecommunication equipment, memory facilities and input-output devices, a researcher in a remote outpost of civilization would be able to search the comprehensive electronic databases in the advanced developed economies, and be able to obtain needed information in electronic or hard copy format (Effah, 2002).

Several definitions have been given to explain and interpret the acronym ICT and the one given below seems to be the closest. ICT is a generic term referring to technologies that are used for collecting, storing, editing and passing on (communicating) information in various forms.' The above definition separates distinct fields of ICTs and at the same time links them together so as to operate as an entity. Adeya (2002), simplified the definition by describing ICT as an 'electronic means of capturing, processing, storing and disseminating information'.

Research scientists needs adequate training in order to acquire the necessary skills to enable them use computers and other ICT facilities and services. Chisenga (2004) stated that there was the need for ICT users to be trained on how to use the resources. He reiterated that without such training, the ICT resources cannot be used effectively. While Obioha (2005) reiterated the need for continuous training to be given to research officers to enable them use ICT effectively. Amekuedee (2005) also called for the need for librarians and users to be taught skills to equip them to handle automation issues in their libraries. He emphasized the need for such training programs to be continuous.

With reference to the effects of ICT use on research activities, Obioha (2005) stated that some of the achievements that could be ascribed to ICT tools' usage include quick search and easy access to information, varieties of information, ease and speed in processing information, and increased knowledge. She stated that some achievements recorded by the Nigerian Institute for Oceanography and Marine Research in its research activities are partly credited to ICT use, which has played an immense role for the researchers of the Institute in seeking out information through the Internet, the World Wide Web, and CD-ROM databases. However, some problems cited that militate against the effective use of ICT include inadequate funding; lack of adequate and stable power supply; constant breakdown of computers; Internet problems, inadequate training and inadequate ICT Centers among others (Chisenga, 2004; Amekuedee, 2005 and Obioha, 2005).

Bamiro and Liverpool (2002) also observed that computer (ICT) has already invaded and dominated Universities and Research Institutes in the developed world, while its deployment in Nigeria it has been painfully slow. Furthermore, it has been reported that no real effort has been made in ICT development both at the individual and corporate levels, and that most Research Institutes still process results manually (The Guardian, 2006). More so, most researchers are yet to acquire the perquisite ICT skills, and where opportunities exist for them to do so, they shun them because of the phobia some of them have developed for the ICT.

Information Communication Technology (ICT) is on the lips of every nation because it brings innovation into information seeking and knowledge acquisition. However, lack of adequate training and skills to enable research officers' access and use ICT facilities and services available to them has been on increase (Obioha, 2005). In addition, some of the research officers cannot, by themselves, search the various online and CD-ROM databases to retrieve required information necessary for their work. It is on this premise that this study is embarked upon to identify the roles ICT plays in information seeking and usage among researchers and technicians of the National Centre for Agricultural Mechanization. Therefore, the findings of this research will be helpful to NCAM, academicians and researchers in assessing the underlying socio-economic factors affecting the uses of ICT in carrying out research activities. It is against this background that this study is being undertaken, to determine the socio-economic characteristics of usage of ICT among researchers at National Centre for Agricultural Mechanization, Ilorin, Kwara State.

METHODOLOGY

This study was carried out in National Centre for Agricultural Mechanization (NCAM), Ilorin, Kwara State. The population for the study comprises of all researchers and technicians of the Centre. A total of 94 respondents were purposefully selected for the study**.** This formed the sample size of the study. The primary data used for the study were collected from the respondents with the aid of well-structured open and closed ended questionnaire. This was supplemented where necessary with interviews, discussions and direct observations. Data collected were subjected to qualitative and quantitative analysis. The analytical tools used are descriptive statistics, cross tabulations, and regression analysis. A Multiple regression model was used to ascertain the determinants (socio-economic characteristics) of effect of ICT on research and development. The regression model is specified as follows:

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

Where,
Y = ICT effect on research and development. (Dependent variable)
X_1 = age: (measured in years), X_2 = gender; (male = 1, female = 0), X_3 = marital status, (1 for being married and 0 for none) , X_4= education; (measured by the number of years spent in formal education), X_5 = experience (measured in years), X_6 = area of specialization, X_7 = career path and μ =error term

RESULTS AND DISCUSSION

The results of the analysis are presented in the tables below:

Table1A: Socio-Economic Characteristics of the Respondents (N=94)

Variables		Frequency	Percent
Age	18-35	41	43.6
	36-45	32	34.0
	46-50	17	18.1
	51-60	4	4.3
	Total	94	100.0
Gender	Male	68	72.3
	Female	26	27.7
	Total	94	100.0
Marital Status	Single	17	18.1
	Married	74	78.7
	Divorced	1	1.1
	Widowed	1	1.1
	Separated	1	1.1
	Total	94	100.0
Educational Qualifi.	Trade Test	2	2.1
	O Level	1	1.1
	A Level	2	2.1
	OND	4	4.3
	HND	21	22.3
	B,Sc	43	45.7
	M,Sc	18	19.1
	Ph,D	3	3.2
	Total	94	100.0
Work Experience	0-10	52	55.3
	11-20	32	34.0
	21-30	8	8.5
	31-35	2	2.1
	Total	94	100.0
Area of Specialization	Engineers	39	41.5
	Scientist	27	28.7
	Technicians	14	14.9
	Technologist	4	4.3
	Architect	1	1.1
	Farm power and machinery	6	6.4
	General Agriculture	1	1.1
	Food science and technology	2	2.1
	Total	94	100.0

Source: Field Survey, 2019

Table 1B: Awareness of ICT Facilities

Awareness	Opinion		
	Aware	Unaware	Total
Internet Surfing	93.6	6.6	100.0
Networking	90.4	9.6	100.0
E-Mail	97.9	2.1	100.0
Internet Chats/Video Conferencing	92.6	7.4	100.0
Word Processing/Documentation	97.9	2.1	100.0
Webinar (Online Seminar)	81.9	18.1	100.0
E-Library	93.6	6.4	100.0
Remote Sensing (Online Control Of Experimental Reseach)	72.3	27.7	100.0

The result revealed that majority of the respondents (43.6%) fell between 18 and 35 years of age. Another 34% fell between 36 and 45 years while 18.1% fell between 46 and 50 and 4.3% were above the age of 50 years (Table 1A). This generally indicates that most of the respondents were in their productive age which is in line with the study of Agwu and Chah (2007), Muhammed and Yakubu (2013) which suggested that the elderly may be less interested in using hi-tech devices and prefer oral or printed channels which may be less efficient.

The study further revealed that majority 72.3% of research and development activities in the Centre were in the hands of male while 27.7% were female. This agrees with the findings of Adedoyin *et. al* (1999), who reported that males dominate the work in Nigerian agricultural research sector. It may be also connected with the gender disparity found in the public civil service in Nigeria. This may be linked to the socio-cultural factors that restrict contacts between gender in some communities (Arokoyo *et al*.,, 2002). Majority of the respondents (78.7%) were married while 18.1% and 1.1% were respectively single and divorced. The response pattern in Table 1A indicated that research and development activities in NCAM are carried out with various educational backgrounds. Majority of the respondents 45.7% had BSc, 19.1% MSc and 3.2% PhD respectively. These findings have great implications as education is known to be a weapon of social change and development.

According to the data in Table 1A, majority of the respondents (89.3%) had less than 20 years' work experience . Those with between 21 and 30 years of work experience were 8.5%, while those with more than 30 years work experience were only 2.1%. Table 1A further revealed that NCAM staff that uses ICT for research and development activities belongs to different areas of specializations with engineers having the highest (41.5%), followed by scientist (28.7%) and technicians (14.9%) and others respectively.

The result from Table 1B also revealed that majority of the respondents (93.6%) are acquainted with internet surfing, 90.4 and 97.9% were able to network computers and use e-mail while 97.9, 93.6 and 72.3% were able to use computer for word processing, e-library and on-line control experiment respectively. It is important to recognize that awareness among policy makers on the potentials of ICT is a critical element for its development (Agwu *et al*., 2008).

Table 2A: Analysis of Variance (ANOVA) on the Effect of ICT on Research and Development

ANOVA						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1.966	7	.281	3.118	.006
	Residual	7.746	86	.090		
	Total	9.713	93			

Source: Field Survey, 2019

Table 2B: Regression Coefficients on the Effect of ICT on Research and Development

Variables	Coefficients	Std. Error	T-value	Sig.
(Constant)	1.112	0.346	3.215	0.002
Age	0.008	0.054	0.156	0.877
Gender	0.076	0.072	1.051	0.796
Marital status	-0.126	0.064	-1.971	0.052
Highest Educational qualification	0.011	0.034	0.316	0.053
Working experience	0.108	0.057	1.911	0.059
Area of specialization	-0.003	0.023	-0.134	0.894
Career path	-0.273	0.114	-2.395	0.019

Source: Field Survey, 2019

The ANOVA result in Table 2A and the Multiple Regression result in Table 2B shows explicitly as it best explained the relationship in terms of coefficient of multiple determination (R^2) value, sign of coefficients and their level of significance.

The positive coefficients of age, gender, educational qualification and working experience implies that the productivity of the respondents increases with the use of ICT for research and development while on the other hand the negative coefficient of marital status, area of specialization and career path does not translate to increase in productivity of the respondents in research and development. However, marital status, educational level, working experience and career path are statistically significant at 5% level indicating that these variables have great influence on the use of ICT for research and development by the respondents. The effect of ICT on research and development by the respondents is statistically significant at 5%, This implies that ICT has contributed immensely in aiding the respondents to carry out their research activities efficiently and effectively.

CONCLUSION

The multiple regression analysis result indicates that the coefficients of marital status, educational level, working experience and career path are statistically significant at 5% level indicating that these variables have great influence on the use of ICT for research and development by the respondents. It is therefore recommended that for improvement in efficiency and productivity of research from researchers working with research institutes NCAM, there should be provision of adequate infrastructure in ICT, regular training of researchers on usage of ICT and provision of alternative source of power supply. In regards of all these, it is therefore commendable to mention that ICT has impacted immensely in aiding researcher to carry out their research activities efficiently and effectively.

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Food Security Status of Rural Households Adopting Improved Rice Varieties in Niger State, Nigeria

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ABSTRACT
The study determines the food security status of rural households adopting improved rice varieties in Niger State, Nigeria. Sample sizes of two hundred and eighty five (285) rice farmers were selected using multi-stage sampling method. Structured questionnaire complimented with interview scheduled were used for data collection. Data were analyzed using descriptive statistics and food security index. The findings revealed 87.7% and 85.9% of rice farmers adopted FARO 44 and FARO 54 respectively. Also, 90.5% were food secured while 9.4% were food insecure. The most constraints to the adoption of improved rice varieties were land tenure problem (97.9%) and loan and financial acquisition problem (95.8%). It is recommended that feeder roads should be constructed by State and LGAs authority in order to ease the movement of farmers produce from farms to point of processing. It is advice that research institutes should ensure farmers access improved rice varieties with affordable prices and right time in order to enhance their livelihood and food security status.
Keywords: Food Security, Rural, Households, Improved Rice, Varieties

INTRODUCTION
Rice (*Oryza sativa*) is one of the most cultivated crops in the world. It is third most important cereal grown and consumed globally after wheat and maize (Agro Nigeria, 2018). In Nigeria, rice is cultivated in almost all ecological zones of the country as they all provide favourable environments to support the crop cultivation (Agro Nigeria, 2018). This has made rice a staple food crop in the Nigeria as it is consumed by almost every tribe in different forms, example, tuwo rice, joellof, white rice, fried rice e.t.c. Rice is life was adopted to implement the International Year of Rice (IYR), declared by the United Nations, general Assembly during its 57th session. One major objective of IYR was to focus attentions on the role that rice could play in providing the population with food security and addressing poverty alleviation. Rice is the staple food for many African and constitutes a major part of the diet for many others. During the past three decades, the demand for rice has increased steadily, playing a major role in the strategic food security planning policies of many countries in Sub-Saharan Africa (WARDA, 2011). Poor yield among rural household rice farmers have been attributed largely to poor quality of the varieties planted and their inability to adopt new technologies, particularly improved rice varieties. In the past decades' government has committed considerable resources to agricultural research towards developing high yielding rice varieties. More so, effort have been made in the areas of improved rice varieties to increase rural households rice farmer's productivity, income and increase food production so as to be self –sufficient in the area of food security as well as to improve the livelihood status of the rural households. The problem could be associated to wrong perception of rural household farmers on improved rice varieties. Today, Nigeria rural household farmers are unable to attain food secured environment and

improved rural livelihood because some farmers have not adequately adopted improved rice varieties rather still depend on local varieties that are not high yielding. The objectives of the study area to identity the improved rice varieties in the study area; determine the food security of rice farmers in the study area and examine the constraints associated with the use of improved rice varieties

METHODOLOGY

The research was conducted in Niger State, located in the Guinea Savannah ecological zone of Nigeria. In terms of land mass, it is the largest State in Nigeria. It covers a total land area of 74,224km^2 thus accounting for about eight percent of Nigeria's land area. About 85% of its land area is good for arable crop production (Niger State Geographical information system, 2015). It is located within longitude 3° 30' and 7° 20' East and latitude 8° 20' and 11° 30' North, with a population of about 3,950,249 (NPC, 2006) and with a growth rate of 3.2% (Niger State Geographical Information System, 2015). Most of the communities in the State are predominantly agrarian Multistage sampling technique was employed in this study to select the sample size. This involved three (3) stages of selection. The first stage involved random selection of two local government areas (LGAs). In the second stage, three (3) villages were randomly selected from each LGA in selected State making a total of six (6) villages. The third stage involved the use of proportional sampling to select 10% of the respondents from the sampling frame which gave a total sample size of two hundred and eighty-five (285) rice farmers. Data were collected by the reseachers and trained enumerators using questionaire complimented with interview schedule. Descriptive statistics which comprises percentages and frequency counts was used to achieve objective i and iii

Food security Index

To determined food security and livelihood status of adopters of improved rice verities, (Objective II) food security Index was used. The decision on whether the rural households adopting improved rice verities are food secure or insecure ($F_i \geq 1$=food secure household and $F_i < 1$=food insecure household).

Food security model

$$Fi = \frac{per\ capita\ food\ expenditure\ of\ ith\ household}{\frac{2}{3} mean\ per\ capita\ food\ expenditure\ of\ all\ household} \quad (1)$$

Where:
Fi = food security index
Decision Rule:
When Fi ≥1, it implies that ith household is food secure, but when Fi< 1, it implies that the ith household is food insecure

RESULT AND DISCUSSIONS

Improve varieties

Table 1 showed that majority (87.7%) and (85.9%) of rice farmers adopted FARO 44 and FARO 54. This study revealed that FARO 44 is the most improved rice varieties adopted by the respondents in the study area. This might be owing to some favourable qualities exhibited by FARO 44 such as high yield, early maturity, high resistance to pest and diseases and market acceptability. This finding agreed with Tsado *et al.* (2018), who reported that majority of the rice farmers' in Niger State adopted FARO 44 improved rice.

Table 1: Distribution of respondents according to improve varieties (n=285)

Variables*	Frequency	Percentage
FARO 44	250	87.7
FARO 54	245	85.9
FARO 57	229	80.4
FARO 60	220	77.1
FARO 62	214	75.1

Sources: Field survey, (2019). Multiple responses

Food security

Table 2 showed that majority of rice farmers 90.5% were food secured. This is an indication that majority of rice producers in the study were food secured and this is expected to improve their livelihood status and standard of living of rice farmers in the study area. This finding agreed with Owolabi *et al.* (2016) who reported that majority of crop farmers in Kaduna State, Nigeria were food secure.

Table 2: Distribution of rice farmers according to food security (n=285)

Food security	Frequency	Percentage
Secure	258	90.4
Not secure	27	9.6

Sources: Field survey, (2019)

Constraints to the adoption of improved rice varieties

Table 3 showed that land tenure problem (97.9%) was the most ranked problem faced by farmers in the adoption of improved rice varieties. This agreed with Zalkuwi (2019), who reported that land tenure problem is one of the challenges to rice production in Nigeria Land related issues normally occur to inadequate land available for farmers. Poor road network (93.7%) ranked 2nd. This mostly arises as a result of deplorable nature of most roads in Niger State and Nigeria as a whole. The finding was supported by Maxwell (2014), who reported that poor road network is one of the major problem encountered by farmers in Sub-Sahara Africa Also, loan and financial acquisition problem (95.8%) ranked 3rd, implying lack of access to loan or credit facilities from formal or informal institutions that would have positively affect rice farmer's food security. Other finding showed that inadequate output (88.4%), inadequate input (76.1%), marketing channels (68.4%), seasonal attack of pest and diseases (58.9%), inadequate improved varieties (52.6%) and problem of fertilizer and agrochemical (45.3%) ranked 4th, 5th, 6th, 7th and 8th respectively.

Table 3: Constraints to the adoption of improved rice varieties (n=285)

Constraints*	Frequency	Percentage	Ranking
Inadequate output	252	88.4	4th
Inadequate input	217	76.1	5th
Marketing channels	195	68.4	6th
Seasonal attack of pest and diseases	168	58.9	7th
Land tenure problem	279	97.9	1st
Loan and financial acquisition problem	273	95.8	2nd
Problem of fertilizer and agrochemical	129	45.3	9th
Inadequate improved varieties	150	52.6	8th
Poor road network	267	93.7	3rd

Sources: Field survey, 2019. Multiple responses

CONCLUSION

Based on this findings, it can be concluded that majority adopted FARO 44 and are food secure. The major constraints to the adoption of improved rice varieties were land tenure system and loan and financial acquisition problem. It is recommended that feeder roads should be constructed by State and LGAs authority in order to ease the movement of farmers produce from farms to point of processing. It is advice that research institutes should ensure farmers access improved rice varieties with affordable prices and right time in order to enhance their livelihood and food security status

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Adoption of Vitamin-A Fortified Cassava Recommended Technology Among Rural Farmers in Benue State, Nigeria

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ABSTRACT
The study assessed adoption of vitamin A fortified cassava recommended technology among rural farmers in Benue State, Nigeria. A sample size of 118 adopters and 118 non-adopters of vitamin A fortified cassava farmers were selected in the state using multi- stage sample method. structured questionnaire complimented with interview scheduled were used for data collection. Data were analyzed using descriptive statistics and adopters. The findings revealed that 69.0% of the respondents were male. Also, 9.35 of the vitamin A fortified cassava adopters were food secured. The major constraints associated with adoption of vitamin-A fortified cassava farmers in the study area were poor credit facilities (n=2.4) and inadequate inputs (n=2.4). It is recommended that credit facilities and other incentives should be provided for vitamin-A cassava farmers in order to increased and enhance their food security in the study area, more extension officers should be employed and deployed to rural farmers to educate them on new farming technologies, thus increase their knowledge and create more awareness about vitamin A fortified cassava.

Key words: Cassava, vitamin A fortified, Technology, Adoption, Food security, Rural Farmers.

INTRODUCTION
Agricultural sector plays a key role in the development of most developing Nations (Ajayi *et al*., 2017). It is a major tool used to describe the most powerful nations of the world, because the country that is self-sufficiency in food production would curbed food insecurity and reduce poverty of its citizenry. Food production could be increased, through the adoption of vitamin A fortified cassava technology by rural farmers thereby enhancing food security and alleviating thier poverty status. Vitamin A fortified cassava varieties have the potential of providing up to 25% of daily vitamin A requirement of children and women since the presence of pro-vitamin A (Beta – carotene) in the new cassava could improve the nutritional status of the consumers (Micronutrient Initiative, 2019). Therefore, there is a need to evaluate the adoption of vitamin A fortified cassava on food security status of the farmers. The overall aim of this study is to assess the Adoption of vitamin A fortified cassava recommended technology on food security status of rural farmers in Benue state, Nigeria.

METHODOLOGY
The research was conducted in the three agricultural zones of Benue state. The state is located in the Guinea savannah ecological zone of Nigeria. The state has 23 Local Government Area (L.G.A) with a land mass of 30,955 square kilometers and estimated population of 4,219,244. (NBS, 2019). Eight five (85%) percent of the population in the state are farmers, the inhabitants of the Riverine areas engage in fishing as their primary or secondary occupation.

The state is acclaimed the "Food Basket" of the nation, because of it rich and diverse agriculture produce, these included Vitamin A fortified cassava, yam, soya bean, sorghum, Fruits and vegetables. Multistage sampling technique was adopted for the selection of the respondents for the study. The first stage involves random selection of one ocal Government Area from each Agricultural Zone. The second stage involved random selection three villages in each of the selected Local Government to give a total of nine villages. At the third stage, proportionate selection, 10% of farmers from the selected nine villages was used for this study. A total of 236 respondents were selected for the study from the sample frame of 2400 farmers. Data were collected on the socio-economic characteristics of the Vitamin A fortified cassava farmers, adoption level and constraints associated with the adoption of vitamin A fortified cassava technology. Data were collected by the researchers and trained enumerators using questionnaire complemented with interview schedule. Descriptive statistics which comprises frequency distribution, percentages, mean and mode was used to achieve objective I, objective ii was calculated using adoption index and Kendell's Coefficient of concordance was used to determine the factors affecting the adoption of vitamin A fortified cassava.

RESULT AND DISCUSSIONS

Socioeconomic characteristics of respondents

From the results obtained, Table 1 indicated that 61.0% of the respondents were males, while 39.0% were female. This indicates men were more into cassava cultivation. The result showed that the mean age of respondents in the study area was 45.0 years. This indicated that the respondents were young, strong and very active to farming business included adoption of new technology such as vitamin A Fortified cassava. This result concurs with that of Onunka *et al* (2011) who reported that majority of pro-vitamin A cassava production technology in Abia state, Nigeria are young farmers. Study also revealed that the mean farming experience of the respondents in the study area was 2 years

Table: 1: Distribution of respondents according to socio-economic characteristics' (n=236)

Variables	Frequency	Percentage	Mean
Sex			
Male	144	61.0	
Female	92	39.0	
Age			
<21	2	0.8	
21-30	14	5.9	
31-40	80	33.9	
41-50	73	30.9	
>50	67	28.4	45
Farming Experience			
<11	51	21.6	
11-20	89	37.7	
21-30	57	24.2	
31-40	33	14.0	22
>41	6	2.5	
Access to Credit			
No	169	71.6	
Yes	67	28.4	

Sources: Field survey, 2021

Constraints associated with the Adoption of vitamin-A fortified cassava

Table 3 showed the following constraints were severe, inadequate input for cultivation (2.4) and poor credit facilities for vitamin A fortified cassava production (2.4) were ranked 1st and high cost of hired labour was ranked 2nd

Table 3: Distribution of respondents according to constraints associated with adoption vitamin A fortified cassava

Variable	Weighted sum	Weighted mean	Ranks	Remark
Inadequate farm land for vitamin A fortified	469	1.9	4th	Not severe
Inadequate input for cultivation	555	2.4	1st	Severe
Cost of vitamin fortified cassava tech.	376	1.6	6th	Not severe
Poor extension services to cassava farmers	444	1.9	4th	Not severe
Poor Credit facilities to cassava farmers	560	2.4	1st	Severe
Poor soil fertility for vitamin A cassava	422	1.8	5th	Not severe
Decaying of tubers immediately after maturation	362	1.5	7th	Not severe
Complexity of technology for adoption	310	1.3	9th	Not severe
Difficulty of sprouting in vitamin A fortified cassava	323	1.4	8th	Not severe
High cost of vitamin A fortified cassava stem	492	2.1	3rd	Severe
Inadequate information on vitamin A fortified cassava	453	1.9	4th	Not severe
High cost of hired labour	539	2.3	2nd	Severe
High incidence of pests and disease	338	1.4	8th	Not severe
Transport	428	1.8	5th	Not sever

Sources: Field survey, 2021

Level of Adoption of Recommended Technology for Vitamin-A Fortified Cassava by Farmers

Result in Table 4 showed the farmers level of adoption of recommended technology for the cultivation of vitamin A fortified cassava in the study areas. It is clearly showed that majority of the farmers are slow in the adoption of the recommended technology for the cultivation of the introduced cassava variety.

Table 4: Recommended Technology for Vitamin-A Fortified Cassava

Recommended technology	Adopted	Not Adopted
Soil selection		
Light soil	75 (31.8)	161 (68.2)
Soil with PH	111 (47.0)	125 (53.0)
Land preparation		
Plough before	84 (34.7)	154 (65.3)
Plough after	75 (31.8)	161 (68.2)
Planting date		
June-July	147 (6`2.3)	89 (37.7)
September	49 (20.8)	187 (79.2)
Spacing		
Spacing` (25cm by 25cm	36 (15.3)	200 (84.7)
Spacing (25cm by 50cm)	106 (44.9)	130 (55.1)
Spacing (50 by 50)	57(`24.2)`	179(75.8)
Seed rate		
Seed rate (20 - 35kg)	35 (14.8)	201 (85.2)
Seed rate (35 – 50kg)	109 (46.2)	127 (53.8)
Seed rate (50 bundle)	20 (8.5)	216 (91.5)
Seed rate (60 bundle)	14 (5.9)	222 (94.1)
Seed rate (150 bundle)	16 (6.8)	220 (93.2)

Source: Field survey, 2021. Note: Numbers in parenthesis are the percentages

CONCLUSION

Based on the findings, it can be concluded that majority of the respondents both the Adopters and non-adopters were male with acceptable food security status. The major constraints associated with adoption of vitamin A fortified cassava production were inadequate input for cultivation and poor credit facilities for vitamin-A cassava farmers in the study area. It is recommended that vitamin-A fortified cassava farmers should engage and form cooperatives societies among themselves in order to raise funds for their farming business. Also, credit facilities and other incentives should be provided for vitamin-A fortified cassava farmers in order to increase production and enhance their food security.

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Analysis of Return To Scale Among Vegetable Farmers In Abakaliki Metropolis, Ebonyi State, Nigeria

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ABSTRACT
This study x-rayed return to scale in vegetable production in Abakaliki metropolis, Ebonyi State, Nigeria. A descriptive cross-sectional study was conducted on sixty (60) vegetable farmers. Data were collected from using structured questionnaires and interview schedule in the case of illiterate ones. Data generated were analyzed using Cobb-Douglas frontier production function. From the result, the poor (R^2) obtained was not relevant for the study because, that was not the focus and hence, ignored. Also, the level of significance of the production inputs were not the primary interests. The primary interests were the coefficients of the production inputs which were regarded as the elasticities of production. The summation of the coefficients of the individual production inputs (elasticity of production), was a measure of return to scale in vegetable production. Return to scale was 1.3697, which implied increasing return to scale for vegetable farmers in Abakaliki metropolis.
Keywords: Return to scale, Vegetable, Abakaliki, Metropolis, Ebonyi

INTRODUCTION
Vegetables may be described as those plants, which are consumed in relatively small quantities as a side dish with the staple food. The term 'vegetable' can also be used to designate the tender edible shoots, leaves, fruits and roots of plants that are eaten whole or part, raw or cooked as a supplement to starchy foods and meats (Bamire and Oke, 2003). Vegetables can be distinguished from field crops by the fact that, vegetables are harvested when the plant is fresh and high in moisture content while the fields crops are harvested at the mature stage for their grains seeds, roots fibre etc. In human nutrition, vegetables are essential protective food containing vitamins and minerals. Any balanced diet should include vegetables and fruits for this reason. The proportion of vegetables required in a balanced diet per capi/ meal is of the order of 4 total volume of the food (Olasantan, 2007). Vegetables supply considerable quantities of vitamins A, B, C, D, E and K. According to Kasiime *et al* (2018) vitamin A maintains health of the respiratory and the eye tissue; vitamin B is essential for development of the nervous system; vitamin C maintains health of blood cells and tissues; vitamin D maintains health of bones and teeth; vitamin E maintains heath of the reproductive system; and vitamin K is essential for blood clotting. Iron, which is particularly plentiful in green vegetables, is part of hemoglobin which is found in the blood. The high fiber content of vegetables is essential to maintain bowels health , and a diet which is low in fruit and vegetables frequently results in constipation (Danso *et al* (2003)). In recent times there has been a tremendous interest and increase in vegetable crop production in West Africa. This is because of the urgent need to stop the importation of vegetables and vegetable products to help conserve foreign exchange and feed the increasing number of processing factories while exporting the rest to earn more foreign exchange (Schipper, 2000). Vegetables and fruit add about 3% to the GDP of Nigeria economy. Even though the contribution to the GDP is very small, its importance cannot be

overlooked because without it a diet is not balanced (Ajekiigbe *et al* 2017). In Abakaliki metropolis, vegetables are produced in small scale basis by mostly women, mostly non indigenes who see the enterprise as their means of livelihood, embarking on both wet and dry season production at the comfort of their homes or home gardens. Surprisingly, they use the proceeds to feed their family, train their children in school and carter for other family needs, thus, compelled me to investigate the return to scale in vegetable production in the area.

METHODOLOGY

The study was conducted in Abakaliki metropolis, Ebonyi State, Nigeria. The metropolis is made up of two Local Government Areas (LGAs) namely; Abakaliki and Ebonyi LGAs. It is bounded by other LGAs such as Ezza Soutt, Ezza North, Izzi, Ikwo and Ohaukwu. The metropolis is not entirely urban, some parts are still rural and are mainly occupied by indigenes. The combined population of the two LGAs that make up the metropolis as at 2006 population census was 276,909 (NPC, 2006).

Sampling Techniques

A descriptive cross-sectional study was conducted on sixty (60) vegetable farmers using a purposive sampling technique to select the farmers. The vegetable farmers were purposively selected through close contact and monitoring to get those farmers who are really into vegetable production within the metropolis. Data were collected using structured questionnaires and interview schedule in the case of illiterate ones. Data generated were analyzed using Cobb-Douglas frontier production function.

Model Specification

For our empirical analysis, the Cobb-Douglas frontier production function specifies the technology of the vegetable production process. The variables associated with production are categorized into output (Y) vegetables in kilograms, Labour (Lab) in mandays. Quantity of manure / fertilizer (M/F) used in kilograms, Quantity of pesticides applied in litres, Capital (Cap) used in naira, and material (Mat) are other inputs measured as the value of other inputs including fertilizers, manure, seeds and pesticides. The model is implicitly defined as:

$$Y = f\,(\text{Land, lab, Cap, Mat, Pest, M/F}) \qquad (1)$$

The explicit form of Cobb-Douglas stochastic frontier function for vegetable production will be expressed as:

$$LnY = b0 + b1lnLand + b2lnLab + b3lnCap + b4lnMat + b5lnPest + b6\ lnM/F + Ei \qquad (2)$$

Y is the output, Cap is the value of capital equipment at current cost on the plot, Lab is the number of mandays labour working on the field, PMat is the value of seeds, Pest is the value of pesticides and other agrochemicals, M/F is the value of manure/fertilizer, Ei is the error term, Ln is the logarithm of the variables, b1-b6 are the coefficients of the explanatory variables. The summation of these coefficients were used as a measure of return to scale in vegetable production in Abakaliki metropolis

RESULTS AND DISCUSSION

From the result in Table 1, the poor R^2 obtained was not relevant for the study because, that was not the focus and hence, ignored. Also, the level of significance of the production inputs were not the primary interests. The primary interests were the coefficients of the production inputs which were regarded as the elasticities of production.

Table 1: OLS Estimates of Vegetable Production Using Cobb-Douglas Frontier Function

Variables	Coefficients	Standard error	t-value
Land	0.1473	0.5968	2.166*
Labour	0.4614	0.2902	0.911
Capital	0.3688	0.2105	4.621
Planting Materials	0.1883	0.3641	4.312**
Pesticides	0.2101	0.3013	3.316**
Manure/Fertilizer	0.1821	0.2878	0.661
Constant	3.2858	0.5171	9.413**
F-Statistics	12.11		
R-Square	0.3158		

Source: Field Survey, 2021

The summation of the coefficients of the individual production inputs (elasticity of production), was a measure of return to scale in vegetable production in the study area (Table 2).

Table 2: Return to Scale in Vegetable Production in Abakaliki Metropolis

Explanatory Variables	Coefficients (Production Elasticities)
Land	0.1473
Labour	0.4614
Capital	0.3688
Planting Materials	0.1883
Pesticides	0.2101
Manure/Fertilizer	0.1821
Total (Return to Scale)	**1.3697**

Source: Field Survey, 2021

The coefficients of explanatory variables in Table 1 were used as production elasticities in Table 2. The sum of the elasticities of the individual production inputs were used as the measure of return to scale in the production of vegetable. Return to scale was 1.3697, which implied increasing return to scale for vegetable farmers in Abakaliki metropolis. The result of increasing return to scale was in agreement with the findings of Ajibefun (2002) who reported that increasing return to scale is a function of a unit increase in the factor inputs used in the production processes.

CONCLUSION

The major finding of the study showed increasing return to scale in vegetable production in Abakaliki metropolis. The study recommended training and empowerment of the vegetable farmers within the metropolis, arming them with required vegetable production techniques and inputs to expand their scopes of production.

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Extension Agents' Use of Information Communication Technologies in the Dissemination of Agricultural Information in Delta North and South Agricultural Zones, Delta State, Nigeria

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ABSTRACT
Information Communication Technologies (ICT) is a modern means of disseminating agricultural extension services to farmers. Extension agents' use of ICT in the dissemination of agricultural extension services to farmers in Delta State, Nigeria was examined in this study. The objectives were to describe the socio-economic characteristics of the Extension agents, identify the ICTs that are within the Extension agents reach for use and ascertain respondents level of adoption of ICT. Fifty-eight respondents were randomly selected for the study. Descriptive and inferential statistics were respectively used to analyze the data and hypotheses of the study. Results revealed that the average age, household size and work experience were 43.28 years, 6 persons and 13.05 years respectively. The respondents' level of adoption of ICT tools was high (72.41%) and there was a significant difference between respondents with high from those with low level of adoption of ICT. The study recommended an inclusion of more females in the job to make it more gender friendly.
Keywords: ICT tools, farmers, dissemination, extension services, extension agents

INTRODUCTION
Agricultural extension is defined as a service which assists farm families through educational procedures to improve farming methods and techniques, increase production efficiency and income and better the levels of living and the social and educational standards of rural people (Okwuokenye and Urhibo, 2019). The primary role of agricultural extension is to transmit improved agricultural technologies to farmers who are the end users of all findings emanating from agricultural related researches and as well taking their (farmers) problems to appropriate research or government agency for solution (Erie, 2009). The dissemination of agricultural extension services is linked with the use of different communication means and strategies (Ovwigho *et al.*, 2014). The most recent according to Ovwigho *et al.* (2014) is the use of Information Communication Technology (ICT).

Michiels and Vancrowder (2001) defined ICTs as range of electronic technologies which when converge in new configuration are flexible, adaptable, enabling and capable of transforming organizations and redefining social relations. As far as agricultural extension is concerned, ICT is known to be an embodiment of different equipment like television, radio, mobile phones, Web, search engines, video, e-mail, computers, cameras, DVD, CD-Roms, just to mention a few (Odame *et al.* 2002). Odame *et al.* (2002) maintained that the use of ICT in extension service delivery has a direct impact on agricultural productivity. This study therefore aims to: Describe the socio-economic characteristics of the Extension agents in Delta State, identify the Information and Communication Technologies that are within the Extension agents reach for use and ascertain the level of adoption of Information and Communication Technologies (ICT) by Extension agents in disseminating agricultural information to farmers in the study area. The hypothesis of the study is: Extension agents with high level of adoption are not significantly different from those with low level of adoption of ICT in disseminating agricultural information.

METHODOLOGY

Area of Study

Delta State is one of the oil producing States of the nation and it is one of the two states that made up the former Bendel State. The state has always been cherished by successive governments because of its oil production. It has an approximate population size of 5,663,400 (NPC, 2018), most of whom are engaged in agricultural production. Delta State has 25 local government areas with Asaba as its capital and many other developed towns which include Warri, Ughelli, Agbor, Sapele, Koko, Oghara, Ogwashi-Uku, among others (DTSG Agric. Policy, 2006). DTSG Agric. Policy (2006) also cleared that apart from oil, other mineral deposits of the state are natural gas, kaolin, laterite, clay, gravel, silica sand bauxite and granite.

Sampling Techniques and Sample Size

The population of the study was made up of extension agents who are active and still in service. The study adopted the multi-stage random sampling method which involved first, the random selection of two agricultural zones (Delta North and Delta South) out of the existing three, this was followed by the random selection of six (6) local government areas (LGAs) from each of the agricultural zones and this brought the number of LGAs used for the study to twelve (12) (Ika North-East, Ika South, Ukwuani, Ndokwa West, Oshimili South and Aniocha South LGAs were randomly chosen from Delta North; while Isoko North, Isoko South, Bomadi, Patani, Warri North and Warri South LGAs were randomly selected from Delta South Agricultural zone). The third stage involved the random selection of five extension agents from each of the LGAs and this resulted to having sixty (60) extension agents who were administered with the question instrument (questionnaire). From the returned questionnaires fifty-eight (58) of them suitable for analysis were used for the study.

Analytical Techniques

Descriptive statistics were used to analyze the respondents' socio-economic characteristics and their responses to level of adoption of ICT in the dissemination of agricultural information to farmers. Likert scale was used to identify the Information Communication Technologies that are within their reach for use. The scale ranged from "Strongly Agree" (coded 4), "Agree" (coded 3), Disagree (coded 2) and Strongly Disagree (coded 1) and it then produced a weighted mean score of 2.50 which was obtained thus: 4 + 3 + 2 + 1 = 10 / 4 = 2.50. The value of ≥ 2.50 was considered as important in agreeing to the ICT tools within extension agents reach. On the other hand, values less than 2.50 were considered contrary.

Product Moment Correlation Coefficient (r) was used to analyze the hypothesis. The correlation coefficient measures linear association between interval variables (Okwuokenye and Urhibo, 2019). Okwuokenye and Urhibo (2019) further explained that the coefficient can take a value between -1 to +1. When "r" = +1, it means that there is a perfect linear relationship between X and Y. An inverse relationship is expected when the value is -1. The computation of Product Moment Correlation Coefficient is shown below:

$$r = \frac{n\sum XY - (\sum X)(\sum Y)}{\sqrt{[n\sum X2 - (\sum X)^2]\,[n\sum Y2 - (\sum Y)^2]}} \tag{1}$$

***Decision rule*:** The Product Moment Correlation produces coefficient estimates (X) and standard errors (E). Where the standard error of the independent variable (X) is smaller than half of the value of the parameter estimate of the variable, we conclude that the estimate of the variable is statistically significant thereby leading to acceptance of the alternative hypothesis and rejecting the null.

RESULTS AND DISCUSSION

Socioeeconomic characteristics of respondents of the study

Table 1 shows the socio-economic characteristics of the extension agents. It revealed that extension services in the study area was dominated by males (89.66%) most (70.69%) of whom were married. Having most of them as married people is an indication that they are responsible people. Similar results have been obtained in the above cases by Okwuokenye and Okoedo-Okojie (2014). The average age of the extension service providers was 43.28 years with the majority (41.385) of them been between 40 – 49 years and this indicates that the workers were in their active age group. Erie (2009) obtained similar result. On educational status, it was revealed that most of the extension workers (65.62%) were literate and had First Degree qualification or its equivalent. (B.Sc, / B. Agric/ HND). This implies that the workers are well trained and grounded in extension issues or matters. Similar results on educational status were obtained by Okwuokenye and Ovharhe (2017).

The respondents' average household size was 6 persons with majority (48.28%) of them having between 4 – 6 persons. This indicates that the extension agents have a household size that is within their economic carrying capacity. The modal work experience of respondents (37.93%) was 10 – 14 years. On the average, they have 13.04 years' experience, thus implying that they are experienced in the job and such level of experience helps to build capacity on how to handle agricultural information.

Table 1: Socio-economic characteristics of respondents (n = 58)

Socioeconomic variables	Categories	Frequency	Percentage	Mean
Gender	Male	52	89.66	
	Female	6	10.34	
Age range (years)	< 30	6	10.35	
	30 – 39	13	22.41	
	40 – 49	24	41.38	
	50 – 59	15	25.86	43.28
Educational status	NCE/OND	15	25.86	
	B.Sc/B.Agric/HND	38	65.52	
	M.Sc	5	8.62	
Marital status	Single	6	10.35	
	Married	41	70.69	
	Divorced	8	13.79	
	Widowed	3	5.17	
Household size (years)	1 – 3	7	12.07	
	4 – 6	28	48.28	
	7 – 9	19	15.52	
	10 – 12	4	6.90	6.03
Work experience (years)	< 5	5	8.62	
	5 – 9	9	15.52	
	10 – 14	22	37.93	
	15 – 19	13	22.41	
	≥ 20	9	15.52	13.05

Source: Field survey, 2021

Information and Communication Technologies available for use by the extension agents in disseminating agricultural information to farmers

Table 2 shows the different information communication technologies (ICT) tools that were used in one form or the other for disseminating agricultural information's to the farmers. The extension personnel were requested to respond to those ICT tools that were available for use to disseminate agricultural information to the farmers. Among the ICT tools, mobile phones had mean of 3.12. This was followed by audio cassette player (mean = 2.87), radio (mean = 2.82) and use of computer (mean = 2.73). They actually ranked 1st, 2nd, 3rd and 4th ICT tools that were available for use by the extension agents. The findings of Ovwigho *et al.* (2014) revealed the availability of similar ICT tools within the reach of extension personnel and so supports this result.

Going further, television, DVD/VCD, video and flash drive / rewritable CD respectively had means of 2.65, 2.62, 2.52 and 2.51. By these, they ranked 5th, 6th, 7th and 8th ICT tools that were within extension personnel reach and used in disseminating agricultural information. The availability of these ICT tools for use by the extension personnel would go a long way in enhancing their reach-out to the farmers thereby improving information flow and farmers' productivity, income and livelihood. The result corroborates that of Ovwigho *et al.* (2014) which revealed the availability of similar ICT tools within the reach of extension personnel's for the dissemination of information.

Table 2: Information and Communication Technologies available for use by the extension agents

Modern ICT available within the extension agents' reach	Mean	Standard Deviation	Ranking
Mobile phones	3.12	0.56	1st
Radio	2.82	0.59	3rd
Television	2.65	0.63	5th
Audio cassette player	2.87	0.61	2nd
DVD/VCD	2.62	0.57	6th
Video	2.52	0.64	7th
Computer	2.73	0.51	4th
Flash Drive / Re-writable CD	2.51	0.58	8th
Diskette	1.82	0.76	12th

Source: Field survey, 2021 Agreed = Mean $\geq$ 2.50

Respondents level of adoption of ICT in disseminating agricultural information to farmers

Table 3 shows a dichotomous categorization of extension personnel level of adoption of ICT in disseminating useful information to the farmers. The result revealed that most (72.41%) of the respondents were of high level of adoption while the other fraction (27.59%) were low adopters of ICT tools in disseminating information to the farmers.

Table 3: Respondents level of adoption of ICT in disseminating agricultural information to farmers (n = 58)

level of adoption	Frequency	Percentage
High	42	72.41
Low	16	27.59

Source: Field survey, 2021

Relationship between extension agents with high level and those with low level of adoption of ICT in disseminating agricultural information to farmers

The relationship between extension agents with high level and those with low level of adoption of ICT in their agricultural information dissemination was analyzed using the Product Moment Correlation Coefficient. This was expressed in hypothesis two and it states that: extension agents with high level of adoption are not significantly different from those with low level of adoption of ICT in their agricultural information dissemination to farmers. Product Moment Correlation (r) was used to determine the statistical significance of extension agents with high level of adoption of ICT and those with low level of adoption of ICT.

The Results is shown as:
Parameter Estimate = 0.5496
Standard Error = 0.1241
R^2 = 0.6713

Conclusion: Half of the parameter estimate was 0.2748 (this was obtained thus: 0.5496 / 2 = 0.2748). This half of the parameter estimate is greater than the standard error (0.1241) of the estimate. This implies that the estimate or equation was significant. It therefore implies that extension agents with high level of adoption are significantly different from those with low level of adoption of ICT in their agricultural information dissemination to farmers. This result led to the rejection of the null hypothesis and the acceptance of the alternative hypothesis.

CONCLUSION

The study found that extension job is mostly undertaken by males who are expected to be educated and responsible to family life. The younger extension agents and those with more working experience show more pragmatism to the use of ICT in disseminating agricultural information to farmers. However, based on findings of the study, there is a need to incorporate more qualified females into the agricultural extension job. This has become necessary just to make the profession more gender friendly and for better reach out to farmers.

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The Place of Agribusiness in Stimulating the Growth of Nigeria's Economy and Mitigating Youth Unemployment: A Thematic View

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ABSTRACT
For decades, agriculture and foreign trade powered Nigeria's growth and economic performance. During the colonial period, the economy was totally dependent on earnings from the agricultural sector. All these have changed because of over dependence on petroleum. Emerging turns in government policies impacted agriculture and agribusiness significantly. Agribusiness involves the entire agricultural production spectrum of farm input suppliers, food processors; those in food packaging, farm produce transporters and marketing companies all in the linkage. It also covers third party firms that facilitate agribusiness operations such as the bankers and the brokers, advertising agencies and marketing information firms. The contributions of agriculture and agribusiness in our economy can be evaluated and measured by the value added to the GDP which has remained low and weak. Nigeria has a widespread youth unemployment which may be influencing the economy and GDP values, this is pivotal to policies in agricultural development and transformation. Agribusiness can play critical roles in the provision of job opportunities, economic transformation through the growth of agro-based industries, successful agribusiness investments and agricultural growth through the provision of new markets and the development of a vibrant input supply chain to economic sectors outside ensuring regular supply of food and fibre to the industries
Keywords: Agriculture, Agribusiness, Economy, Employment

INTRODUCTION
Decades ago, agriculture and foreign trade were responsible for Nigeria's growth and economic performance. During the colonial period, the economy was totally dependent on earnings from the agricultural sector especially from cocoa, rubber, cotton, palm oil, palm kernel, groundnut and coffee. These were responsible for over 75per cent of Nigeria's annual exports (Ekpo and Egwaikhide 1994; Oyejide 1998; Okoruwa *et al,* 2003 in Tijani et al, 2017). This changed when petroleum became the chief export earner, becoming prominent in the 1970s, when it constituted about 95 per cent of foreign exchange earnings and 65 per cent of budgetary revenues (CBN 2011). This induced the neglect of the agricultural sector. The federal government has made several attempts at restoring the agricultural sector to its former place in the economy through the National Accelerated Food Production Project (NAFPP, 1972), the River Basin Development Authority (RBDA, 1973), the Agricultural Development Project (ADP, 1975), the Operation Feed the Nation (OFN, 1976) and the Green Revolution Programme (1980). Other ancillary initiatives include the Multi-state Agricultural Development Project (MSADP, 1986), the Nigerian Agricultural Insurance Scheme (NAIS, 1987), the National Fadama Development Project (NFDP II & III, 1992-2010), the National Special Programme for Food Security (NSPFS, 2003). To make sure the sector remained competitive, government initiated and established a number of agencies to regulate the system. These include; Standard organisation of Nigeria (SON), established in 1971; National Agency for Food and Drugs Administration and Control (NAFDAC), amongst others. Despite the

importance of agriculture and the accompanying agribusiness and the seeming efforts made to develop the sector, agribusiness as a sector and the developing linkages in the economy remain very weak. Thus, elucidating the need for strong policies to enhance agribusiness development as an economic diversification strategy (Tijani et al, 2017)

Agribusiness as a concept is credited to John H. Davis and Ray A. Goldberg. The duo defined agribusiness as "The sum total of all operations involved in the manufacture and distribution of farm supplies, production operations on the farm; and, the storage, processing and distribution of farm commodities and items made from them" (Davis & Goldberg, 1957). Commenting on the definition, Ikennwa *et al* (2017) citing King, Boehleje, Cook, and Sonka (2010) opined that the most important articulates of both Davis and Goldberg are that food systems need to be seen as an integrated system. The author believed the work of Davis and Goldberg stimulated novel interests in linkages between aspects of food system, the co-ordinations across these aspects, their performances and, in strategy formulation in terms of their interdependence.

As a term, agribusiness is composed of two words; Agriculture and Business (Cafiero, 2003). Agriculture is mainly the production of plants and animals for human and industrial uses. Business on the other hand is organised and systematic activities that involve manufacturing of goods and provision of services aimed at making profits. According to the World Bank (2013), Agribusiness is any organised firm (from small and medium enterprises to multinational corporations) that is involved in raw agricultural produce to the downstream transformation, smallholders and micro-enterprises engaging in food processing and retail activities that are market-oriented. This implies that agribusinesses are principally engagements in value addition for primary agricultural products, catalysing the development of efficient value chains, contributing to better product quality and safety, and the provision of services that allow food and agricultural produce to move from production to the end user (Tijani et al, 2017).

Igbokwe et al, (2015) in the same vein saw Agribusiness as an aspect of agricultural activity comprising of production, manufacture and distribution of farm inputs, equipment and supplies in one hand and on the other, the processing, storage and distribution of farm commodities. This implies that the entire agricultural production spectrum involves the farm input suppliers, food processors, those in food packaging, farm produce transporters and marketing companies, restaurants and shopping malls are all in the linkage. It also covers third party firms that facilitate agribusiness operations such as the bankers and the brokers, advertising agencies and marketing information firms (Yumkella et al., 2012 in Igbokwe et al 2015). All these point to agribusiness being the sum total of all the operations in the manufacture and distribution of farm supplies, production activities on the farms and the storage, processing and distribution of off-farm commodities and the derivatives from them. Simply put, it is the combination of agriculture and the range of business activities in modern food operations. Agribusiness can be argued to be the base of any economy be it in the third world or developed economies because agriculture and the food concept are found everywhere even at the international space centre as the astronauts must eat. Get agribusiness correct and see the economy thrive.

The potential of Nigeria's agriculture sector is significant and the country has a substantial base on which to build upon. It has good arable lands, favourable climate and rainfall regime and a history agrarian economy. Nigeria is one of the largest producers of cassava, cashews and tubers globally, fruits and grains production is also significant. The country's population showcases a large domestic market that can support local production and processing. There are also tremendous opportunities in the West African regional markets. However, there is limited collaboration along regional value chains; it is observed that there is greater collaboration between West African nations and their colonial masters or the United States, than exists with their neighbours. This has caused significant loss in opportunities in agribusiness and unnecessary dependence on imports (Okonkwo, 2010)

Tersoo (2014), in reference to Marchet et al (2001) observed that agribusiness concerns in Nigeria make up to 70% of businesses operating in the country and a survey showed that 41 percent of agro industries are sole proprietorships, 41 percent private limited liability companies, 4 percent government owned, and 5 percent of partnership nature while 8 percent are public liability companies. Agribusiness is divided into four sectors; farm inputs supply companies; producing farm firms, processing agribusiness firms and food marketing and distribution. All these encompass farm and nonfarm activities that can enhance rural and non rural real incomes through job creation, industrialization, and other nonfarm opportunities will increase farm based education and a variety of related social and welfare services. Agribusiness will bridge inequalities in the distribution of rural incomes, lessening of urban-rural imbalances in incomes and economic opportunities.

Umebali (2001), Oyeranti (2008) and Onwumere (2013) have also noted that the agribusiness sector of any economy comprises businesses that supply farm inputs, value addition such as processing or are involved in the marketing of farm products through warehousing, wholesaling and retailing which dependence on the foreign markets has weakened. The agribusiness sector therefore can be considered as consisting of activities that relate to the supply chain of agricultural inputs and the supply chain of agricultural products. Onwumere, 2013) noted that the agribusiness sector has supported economic growth and development since 1960. Citing Nto and Mbanasor (2011), Onwumere (2013) noted that the agribusiness sector productivity was essential in achieving sustainable economic growth and significant level of food security in a developing economy like Nigeria.

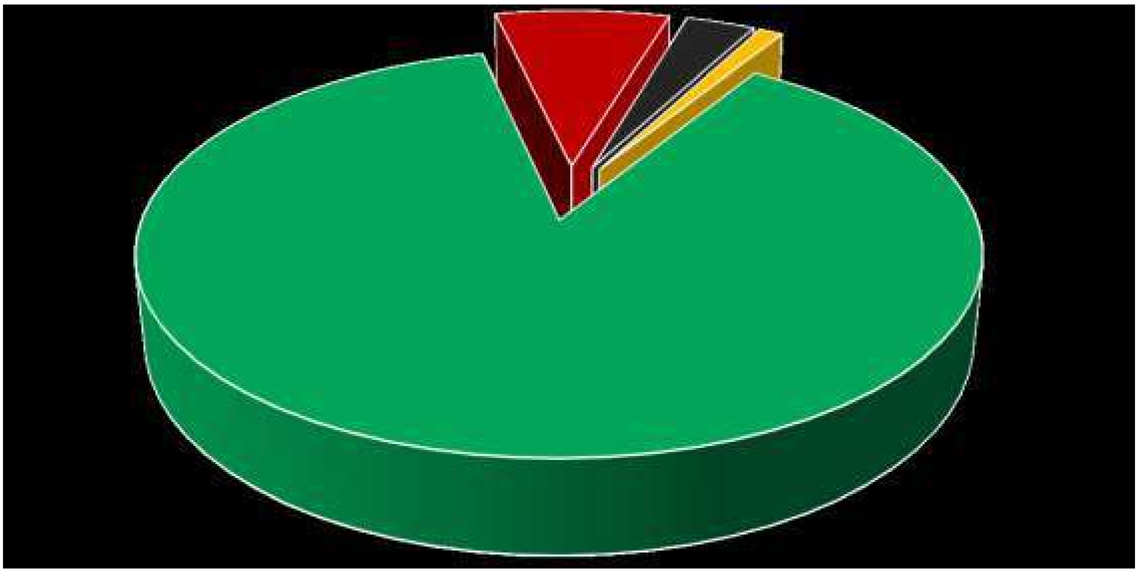
Despite several earlier policies and programmes in Nigeria that seemed to promote agribusiness, events suggest that those were mere window shopping and political gimmick because they keep failing and the country has not received substantial plausible support from the government to attain the 10% minimum budgetary allocation to agriculture following the Mozambique Maputo declaration in 2014. This smacks a lack of support for agribusiness that has all it takes to drive the economy and create jobs. To check this trend, the federal government of Nigeria initiated the N-Power as a Social Investment Programme in 2016 which is still running; however, its efficacy is debatable. (Ogunmodede, 2020).

Other policies and programmes have been initiated to develop the agribusiness sector. Such policies include the Federal Agricultural Promotion Policy (APP) strategy initiated to tackle limited production and delivery of quality standard foods that had its thrust on partnering private investors across various farmer groups and companies, to develop and improve on an end to end value chain solutions that will not only improve supply of inputs, but also increase use of high technologies that will facilitate distribution system of produces. We are yet to see a significant bite of these policies and programmes.

Agribusiness and the GDP

Okonkwo (2010) thinks Agriculture is the most important sector in the Nigerian economy and rightly so. It employs more Nigerians and contributes significantly to the country's GDP despite being treated with neglect and marginal and cosmetic interest. Like in other African countries, agriculture in Nigeria is largely focused on food crops and serves largely the domestic market. In spite of all these, Nigeria remains a net importer of food for some reasons. Many agriculture based operations in Nigeria are small-scale; possess limited capacity for innovations regarding inputs, harvesting, processing, distribution, and access to markets. Large number of people in agriculture is at the subsistence level, many are uneducated with limited access to training. There are evidences of significant underinvestment in agriculture by the public and private sectors. This has been exacerbated by weak, poorly implemented and cosmetic policies at all levels of the economy.

Agriculture is divided into four sectors – crop production, fishing, livestock and forestry. Crop production is the largest segment for now and account for about 87.6% of the sector's output and consequently contributes the highest value from the agricultural sector to the GDP. This is followed by livestock, fishing and forestry at 8.1%, 3.2% and 1.1% respectively. Agriculture sits as the largest sector in Nigeria's economy contributing on the average 24% to the nation's GDP from 2013 –2019. The sector also employs about 36% of the country's labour force; this ranks the sector as the largest employer of labour in the country (oyeniran, 2020). This is despite being given marginal consideration and not getting needed attention.



- Fishing sector 3.2%
- Livestock sector 8.1%,
- Crop production sector 86.7%
- Forestry sector 1.1%

Source: NBS (2021)

It could be seen that the crop sector offers lots of agribusiness opportunities considering its size and can thus contribute significantly to the GDP. The contributions of agriculture in our economy can be evaluated and measured by the value added as a percentage of GDP. The agricultural sector contributed 24.6% to the GDP in the second quarter of 2020, better than the previous quarter and the same quarter in 2019 (NBS, 2021).

From 2016 to 2019, a space of four years, Nigeria's cumulative imports stood at N3.35 trillion, four times her agricultural export of N803billion within the same period. The contribution of agriculture to Nigeria's export earnings remains low compared to crude oil exports. For example, in 2019, agriculture accounted for less than 2% of total exports relative to crude oil (76.5%), (oyeniran, 2020). Imagine what will happen if the sector is given the same attention as the petroleum sector. Note that some economies thrive largely on agriculture, given the favourable climatic conditions Nigeria enjoys; the earnings from the sector can dwarf what comes from the petroleum sector. In spite of the touted investments in agriculture, export from the sector declined by about 11%, falling from N302.2 billion in 2018 to N269.8 billion in 2019. Within the same period, Nigeria's agricultural imports rose by 12.7% moving from N851.6 billion to N959.5 billion, the highest value ever recorded in the country loudly announcing the country's membership in the committee of nations known for being net importer of food. This widened our agricultural trade deficit with imports exceeding exports by N689.7 billion in 2019 in comparison to N549.3 billion of 2018(Oyeniran, 2020).

Nigeria GDP	Last	Previous	Highest	Lowest	Unit
GDP Growth Rate	-13.90	9.68	12.12	-14.27	percent
GDP Annual Growth Rate	0.51	0.11	6.88	-6.10	percent
GDP	432.30	448.10	546.70	4.20	USD Billion
Gross Fixed Capital Formation	2944319.35	2396979.75	3108123.30	17236.65	NGN Million
GDP per capita	2273.22	2374.37	2550.47	1139.82	USD
GDP per capita PPP	4916.72	5135.50	5516.39	2901.77	USD
GDP From Agriculture	3760880.60	5268290.12	5484063.93	2594759.86	NGN Million
GDP From Construction	692520.88	679254.80	752833.66	369190.91	NGN Million
GDP From Manufacturing	1670393.69	1681421.10	1718985.30	875408.17	NGN Million
GDP From Mining	1556073.55	1147137.70	2406675.90	1147137.70	NGN Million
GDP From Public Administration	278241.06	435517.94	614330.87	278241.06	NGN Millions
GDP From Services	6836847.32	7707176.57	7707176.57	4564086.31	NGN Millions
GDP From Transport	231805.43	258748.42	296779.23	118654.96	NGN Millions
GDP From Utilities	394015.61	118494.67	394015.61	51342.43	NGN Million

Source: NBS (2021). *Dates: 2010 – 2021. Frequency: Quarterly. Constant 2010 Prices, NSA*

Despite the increased investments in the agribusiness sector through government policies and programmes to encourage agribusiness, it is still of utmost importance to study the impact of Agribusiness on the economic growth of Nigeria. In 2020, agriculture's contribution to the economy amounted to about 24.14 percent of Nigeria's GDP, 28.22 percent by the industrial sector, and 46.39 percent from services (O'Neill, 2021). A breakdown of economic activities in Nigeria and a look at these three economic sectors will provide information that will shed more light on the potentials of agribusiness. The sectors' contributions to GDP, and their impacts on the economy, are easily visible when viewed from the performance of these three sectors (O'Neill, 2021)

In most thriving economies, the services sector is more visible especially in Nigeria. This is because more and more people are migrating from the rural villages to the cities in search of jobs. Nigeria's dependence on oil is an important contributor to its economic success; however, oil was also responsible for GDP growth slump in 2016 and for the trade deficit over the years (O'Neill, 2021). Agribusiness has all it takes to sustain the GDP with less reliance on foreign inflows which however is also important for foreign exchange. Take a look at the table below.

The agricultural and agribusiness sectors have managed to survive in spite of being on auto pilot and bedevilled by largely ineffective government policies. The other sectors have always received visible government assistance monetarily and otherwise with significant investment opportunities. Arguably, one may be tempted to point to recent gains made by the Buhari administration especially in rice production, but how much is a 50Kg of rice now and before the inception of this administration? What are the market prices of all agricultural produce now and then? Can we claim that the policies were effective? Did the real farmers (and not the political ones) access any of the advances and investments into the agricultural sector? Your guess is as good as mine. Some individuals however argue that agriculture has been a major sector of the economy, providing employment for about 70% of the population which comprise mostly of smallholder farmers who practice subsistence farming. This notwithstanding how has the agriculture and the agribusiness sectors mitigated the high rate of unemployment ravaging the economy presently? As usual however and again, the sector is been touted as being in the process of transformation through commercialization into large-scale enterprises at some levels (Igbokwe, 2015). Events will justify these claims.

Table 2: Distribution of gross domestic product (GDP) across economic sectors from 2010 to 2020

Year	Agriculture	Industry	Services
2020	24.14%	28.22%	46.39%
2019	21.91%	27.38%	49.73%
2018	21.2%	25.73%	52.02%
2017	20.85%	22.32%	55.8%
2016	20.98%	18.17%	59.79%
2015	20.63%	20.16%	58.12%
2014	19.99%	24.64%	54.15%
2013	20.76%	25.74%	52.37%
2012	21.86%	27.07%	50.19%
2011	22.23%	28.28%	49.24%
2010	23.89%	25.32%	50.79%

Source: O'Neill (2021)

Harvest seasons have always witnessed monumental agricultural produce wastages and by implication economic losses which could have been converted to GDP values. Was agribusiness a veritable priority, these would have been salvaged. Technically, much noise is being made about agribusiness; there is much movement but little motion. Every aspect of agriculture has value that can be converted to money, no waste in reality even the cow dung is money.

Agri-business and Food Security

The agricultural sector in Nigeria seem to be characterized by limited competition and investments, however, growing demand for food, and other ancillary products signals a favourable environment for agribusiness. Evident trade deficits in agricultural products as demands continue to rise offer immense opportunities for agribusiness to thrive. Although the agricultural sector is yet to attain its potential production levels, crop and livestock production has remained below domestic demand and inadequate to support the growing population. As a result, Nigeria has become a net importer of food and events point to exponential increases in food demand to feed the growing population. For example, Nigeria's fish production is estimated at only 0.5 million tons, and true potential 2.5 million tons annually. The rest are imported to meet demands, this begs for opportunities for investment (Igbokwe, 2015).

Agribusiness has the capacity and potential to bridge the food demand gap because of its link to agricultural production and other enterprise avenues (Stanton, 2000). However, most agribusiness enterprises in developing countries have significant challenges that have stagnated entrepreneurial development and expansion (Olowa and Olowa, 2015). These challenges have limited free movement of foods, fibers and services across geographic borders because of regulations. This has resulted in the dearth of needed food to the growing populations in the region and may have been limiting investment in agribusinesses. There has also been a reduction on available resources for food production because of urbanisation, economic globalisation and the liberalisation of international trade. All these have further undermined agribusiness development (Tijani et al, 2017).

Agribusiness is capable of ensuring the availability of sufficient food, can ensure food availability and encourage plenty alternative commodities for the people (Haruna and Umar 2011 in Tersoo, 2014). Africa's food import bill is by projection expected to rise to US$110 billion by 2025. In the same estimation, the agribusiness sector is also projected to reach $1 trillion in 2025, driven by the rapidly growing middle class. However, Africa's agricultural sector has the problem of weak value chain. This has manifested in different forms especially in export trades. Out of a trade volume of US$62 billion of agricultural products exported from Africa in 2017, only US$12 billion were processed goods. Furthermore, within the same period about 90% of the agricultural exports to non-African markets were dominated by primary or semi-processed products but half of the intraregional trade were processed products (Oyeniran, 2020). Processing limits wastage, spoilage and prolongs the shelf life of agricultural produce thus ensuring regular supply of food which will also impact on the price of the products. To encourage agricultural transformation and advancement in our clime and promote food security and competitiveness of the agricultural value chains, there is the need to scale up investments in agro-production, processing and marketing infrastructure. An easy access to cross border importation of food products can facilitate the achievement of food security (Oyeniran, 2020)

Agri-business and Youth Employment

According to NBS (2010), the national unemployment rate was 19.7 percent and the youth accounting for about 75 percent of that statistics. Encouraging the involvement of the youths in agricultural activities will reduce the twin problems of ageing farm population and youth unemployment (Akpan, 2010). Akinwumi Adesina, a onetime Agriculture minister in Nigeria called for entrepreneurial skills development for a profitable agriculture and agribusiness enterprises among African youth (ADB, 2021). This call aimed at creating awareness on the importance of youths in agribusiness using a value- and supply-chain approach in agribusiness as a solution to the high youth unemployment rate we are experiencing in Nigeria and poverty reduction. Ojukwu, Director of the AfDB Agriculture and Agro-Industry Department (OSAN) has also underscored the need for us to resort to research, science and technology to enhance agricultural productivity and make farming attractive to youth (ADB, 2021).

Africa's youths are facing the socioeconomic problem of unemployment; this is a serious issue because the region is home to the youngest and fast growing population in the world. Since these young African men and women reside in rural areas they therefore have limited opportunities for gainful employment. However, they possess untapped potentials to transform the agricultural sector through innovation and entrepreneurship.

According to Ogunmodede (2020), 'Nigeria is a paradigm of widespread youth unemployment which has been a central issue to the economy, and this is pivotal to policies in agricultural development and transformation'. The level of unemployment poses grave danger to economic and social harmony and will require urgent attention since the youths have what it takes to propel the society to greater economic heights the author believes. Despite several interventions by successive administrations towards curbing unemployment rate, unemployment still remained high. By the third quarter of 2018, the unemployment rate in Nigeria was 23.13%, up from 21.1% in 2010; in the same period, the youth unemployment stood at 55.4%. With 60% of the more than 200 million of our population being youths, and 55.4% of the unemployed/underemployed; youth unemployment is a challenge that must be tackled if the economy must survive and social harmony assured. On this premise, agribusiness becomes a good strategy towards curbing the menace because with increased investment and plausible policies, agribusiness holds considerable potential opportunities for gainful employment for the youth, the multiplier effects could be humongous because it cuts across all strata of the nation's economic sphere, from the farmer to the service sectors. Previous studies have shown the place of agribusiness in job creation, none evaluated the impact of past and present agricultural programmes on employment creation among youths in Nigeria, pointing to a dearth of evidence on what was effective and what was not, making it difficult for informed evidence-based policies (Ogunmodede, 2020)

Nigeria's government at different times had made efforts to stimulate the interests of the youths in agricultural production and processing (agribusiness). The National Directorate of Employment (NDE) was established in 1986 to provide vocational training for the youths. In

1987, Better Life Programme came on board to empower women, especially female youths through skills acquisition. The People's Bank followed by the Community Banks took the stage in 1989 and 1990 respectively, to provide credit to low income earners in agricultural production and other micro enterprises, with youths who are engaged in agricultural production as target. In recent times, the Fadama programme kick started and was aimed at enhancing food self sufficiency, poverty reduction, and the creation of employment opportunities for youths in the rural areas(Akpan, 2010). Despite all these incentives and evident expansion of markets for primary and secondary agricultural commodities, youth involvement in agricultural and agribusiness activities have steadily declined in recent years(Adekunle et al. 2009).

As agribusiness plays critical roles in economic transformation through the growth of agro-based industries, successful agribusiness investments induce agricultural growth through the provision of new markets and the development of a vibrant input supply chain to economic sectors (Igbokwe, 2015). The market potentials of the agricultural sector in Nigeria is huge. All activities needed to transform the Nigerian agriculture hinge on agribusiness which spans from production to services, manufacturing of agro-inputs, packaging and distribution outside extension of credit for agricultural investments (Igbokwe, 2015).

Should we examine the logic so far presented about agribusiness and employment generation, it will become visible that, there is a synergy between the agribusiness and job creation nexus through inputs supplies, processing and distribution. Agribusiness could provide much employment and ensure food security for the labour force, expand the market, encourage incomes for those involved in the supply components, processing and distribution of agro-industrial products. An intrinsic value of agribusiness is its ability to constitute a synergy between agro-industrial linkages involved in the production and distribution of food, fibre or raw material needs of the economy. It can generate a backward integration and forward linkage, hence facilitating the release of labour from the farm to other sections of the economy. This synergy is viewed by many as an interesting option for industrialization which can transform agriculture and also create new industrial jobs and incomes (Tersoo,2014).

Da Silva et al (2009) and associates have noted that moving agricultural economic activities from the farm gate to the agro-industries and the subsidiary services developed may be aspects of productive diversification that may lead to greater productivity and income generation and will raise the shares of non-farm employment in the rural areas. This picture will be made feasible through links between the farm sector; rural based industries and all the accompanying activities (tersoo, 2014).

Agriculture which is seen as a dominant sector of some developing economies employs about two third of the people in the rural sector. It will be of significant importance if it is aided to engender a rapid development and productivity linkage with the industry. The link between these two sectors is necessary because of the need to develop an integrated production structure, which generate opportunities that will facilitate employing the surplus labour from agriculture despite creating a backward integration and forward linkages. The place of agriculture as a catalyst in industrialization will produce a synergy according to agro-industrial concept that emphasizes synergy between agriculture and industry (Tersoo 2014). This concept emphasizes three principal contributions of agriculture that will aid industrialization viz: increased food production, supply of industrial raw materials, provision of capital flow and expanded market for the manufacturing industry (Meier, 1976, Dunmoye, 1987,).

The Challenges to Nigeria's Agribusiness

Igbokwe (2015) observed certain drawbacks that must be tackled if the agribusiness sector must move forward and suggested some panacea to these banes of agribusiness in Nigeria. Some of these drawbacks as he noted manifest as imbalances and maladjustments because of uneven progresses in the growths and developments from agriculture to agribusiness. Some of these drawbacks include glutted markets, uneconomic farm units, inadequate managerial training and faulty agribusiness policies. The consequential results are cost-price squeeze which has impacted the income of farm families, limited capital formation and retarded progress of farming aggregates. These results mainly because of the farmer's poor management ability to link output and capital accumulation with the market demand. The number of entrepreneurs in the farming aggregate is large and the inability to link output to market demand at a price comparable to national economic levels is a huge management problem. The author also noted that many Nigerian farmers live and work as subsistent farmers. At this level, there is shrinking and depleted farms coupled with the problem of an ageing farm population, there is therefore an urgent need to evaluate and explore the potential profitability of agricultural investments and determine their financial viability both in the short, medium or long-term.

Tijani et al, 2015) also identified some constraining factors to agribusiness in Nigeria. They include faulty policy framework, poor commitment to agricultural technology, infrastructure deficit finance, risk management, institutional reforms and realignment. All these impacted the country in two principal ways; the inability to meet domestic food requirements and the export of quality products required for market success. For Nigeria's agribusiness sector to grow, it will, require actions to solve these two identified gaps above, with a view to boosting agribusiness (FMARD**,** 2016). These challenges can be tackled through the evolution of market based policy by the government that is anchored on promotion of agricultural investment; financing agricultural development programmes and research for agricultural innovation and productivity.

CONCLUSION

The agricultural sector is the highest employer of labour in Nigeria. Creating a viable commercial value for it will certainly induce an agrarian change that will impact the greater number of individuals. Agribusiness is a veritable tool for farm-non-farm linkages that will create employment, increase income and reduce poverty. Policy emphases for agribusiness development should aim at creating equitable and enabling environments for stakeholders through macro policies, enhancing physical infrastructure and institutional mechanisms for coordination, access to adequate inputs, credits, and agricultural services and markets. The different government's efforts in the past at promoting agriculture and agribusiness may have had better opportunities to succeed if the poor approach at implementing the formulated policies were tailor-made.

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Assessment of Major Credit Source of Maize Farmers in Western Agricultural Zone of Bauchi State, Nigeria

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ABSTRACT

The study examined major credit sources of maize farmers in western agricultural zone of Bauchi State. The objectives of the study were to: describe the socio-economic characteristics of respondents and identify major credit source of maize farmers. A multi-stage sampling technique was used to collect primary data with the aid of a structured questionnaire. Results obtained showed that 63.9% of respondents in the study area were in their prime stage of production and majority (79.1%) of the respondents had one form of western education. It also revealed that 34.7% of the respondents' major credit sources is the NGOs/CBOs; supported by a test statistic of 0.000 P value at P< 0.05 level of significant using 'Z' test. The study concluded that NGOs/CBOs are the major source of credit to maize farmers in the study area. Extension service providers in western zone of Bauchi State Agricultural Development Programme (BSADP) should encourage farmers to keep records since most of them can read and write; The Government should consider the NGOs/CBOs operating in the study area as a means of reaching out to farmers with credit facilities.

Keywords: Major credit source, maize farmers

INTRODUCTION

Over 70% of Nigerian populations are rural dwellers where farming activities is the major occupation (Mark, 2011). The agricultural sector has been poorly served by the financial system partly on account of the unfavorable policy environment, which includes weak regulatory regimes, poor physical and financial infrastructure, and policies that repress the formation of effective linkages between the financial and real sectors of the economy; especially the value chain in agricultural sector. The Nigerian financial sector has witnessed fundamental reforms since 2005, but the effects on agricultural financing have been lackluster (Aderibigbe and Kwabena, 2014). Recently Nigeria government have embarked on good credit policies to ensure availability and accessibility of credit to enhance rural farming, such as rural banking programme, micro finance banks, agricultural credit guarantee scheme and Bank of Agriculture (John and Osondu, 2015). Because of factors, including harsh economic conditions, high poverty rate and low savings, it has been difficult for farmers and other actors along the value chain to rely on equity capital to meet their needs. They have therefore continued to seek debt capital from various sources. The informal sources of credit to smallholder farmers as identified in the study area were family or friends, money lenders and farmers' cooperatives, while the formal sources of credit were development bank, microfinance banks, commercial bank and NGOs/CBOs. Some work had been done on this topic by other researchers; but isn't sufficient. This study becomes pertinent in view of the foregoing and the dynamic (in respect to time and place) nature of humans in general and farmers in particular. Credit sources of famers across the country may be similar but vary from place to place. What then are these various credit sources; and which is the major among them? Answering this question is a key: if significant amount of loans from government or donor agencies must reach our rural farmers. The research therefore, assessed the major credit source among maize farmers in western agricultural zone of Bauchi State, Nigeria and the specific objectives are to: (i) describe the socio-economic characteristics of the respondents, and (ii) identify major credit source among maize farmers.

METHODOLOGY

The study was carried out in Bauchi State, Nigeria. The state is located in the northeastern part of Nigeria; 10.7761N and 9.9992 E. It covers a total of 49, 259,01km^2 of land mass with 20 Local Government Areas. The vegetation of the state ranges from Sudan savanna from the south to Sahel savanna with annual mean rainfall of 1,091.4 mm (BASG, 2020). A multi-stage sampling technique was used to select farmers for the study. Five sub zonal offices (Alkaleri, Bauchi, Dass, Kirfi and Toro) were purposely selected based on interest on maize farmers. Two blocks were randomly selected per sub-zone, two cells in each block and two sub-cells from each cell. Four respondents were randomly selected from each sub-cell: given rise to 8 respondents per cell, 16 per block, 32 per sub- zone and finally a total of 160 respondents. These maize farmers were sampled through the assistance of selected contact farmers; but 157 questionnaires were retrieved and analyzed.

Descriptive statistics was used to analyze objective one and inferential statistics for objective two. Descriptive statistics: percentage and frequency distribution, inferential statistics, 'Z' Test.

$$Z = \frac{\text{P1} - \text{P}}{\delta}$$

Where; P1= Actual proportion; P= Hypothesized proportion and δ= Standard Deviation

RESULTS AND DISCUSSION

Table 1 revealed the socio-economic characteristics of the respondents; Respondents' age showed that majority (63.9%) of the farmers in the study area were between 31-50years while 14.8% were below 31years and only 7.7% were above 60 years. The implication of this result is that majority of the farmers are in their active age and can contribute immensely to food production to ensure food security in the study area, the state and the nation at large. This corroborates the findings of Yohanna *et al.*, (2014). Who reported 41years as the mean age of farmers. Majority (72.0%) of the respondents were males. This implies that men in the study area were more involved in maize production than the women. In accordance with the prevailing culture, men are to cater for the households needs and may be assisted by other members of the household. This result is in line with the findings of Babalola and Olayemi (2013), who in their study on Determinants of farmers' preference for sustainable land management, in Ogun State, Nigeria; reported that most (92.0%) farmers are males. Majority (82.2%) of respondents are married, followed by 11.5% who are single, then 5.1% widow and 1.3% who are divorcees. The high percentage of married individuals may be attributed to regional factors where religion, norms and culture encourage marriage among citizens. This result is in agreement with the findings of Babalola and Olayemi (2013), who in their study on Determinants of Farmers' Preference for Sustainable Land Management, in Ogun State, Nigeria reported that most (93.8%) of the farmers in the study area are married. Similarly, Ofuaku (2011) found that, married farmers had responsibilities that must be reflected on their farming activities. The results also revealed that 28.80% of maize farmers had attended one form of tertiary education or the other. Next is secondary education with 29.7%, followed by primary education which is 19.4% and then Quranic education constituted 16.8%. The high percentage of maize farmers with tertiary education is peculiar to western zone that has high percentage of educated farmers as reported by BSADP in 2006.

Major Source of Credit

Major sources of credit here refer to the most important place, person or organization from which the farmer gets his capital from and make arrangement to pay latter. Results from Table 2 generally shows that most (62.1%) of the farmers get credit from the formal source and particularly shows that 34.7% of respondents source their credit from NGOs/CBOs, development banks (13.7%) and the least was commercial banks with 6.3%. On the other hand, 37.9% of the farmers get their credit from the informal source with credit from friends and relatives (14%) on the top. This does not agree with John and Osondu (2015), in their studies on Agricultural Credit Sources and Determinant of Acquisition by Farmers in Idemili Local Government of Anambra State; who reported that cooperative societies as the major source of credit with 43.33%, while friends and families came second (30%) and the least was commercial bank (1.11%) which is similar to this research in this respect. Mgbakor et'tal (2014), in their studies on sources of Agricultural Credit to Small-scale Farmers in Ezeagu Local Government Area of Enugu State, Nigeria reported money lenders (38%) as the major source of credit among farmers with relatives and neighbours (30%) as the second, with commercial bank as the least (12%); which is in contrast with this finding in the first instance but similar in the latter. It is obvious that the "one medicine for all" treatment may not be applicable here; the dynamic nature of human beings is playing a major role in this case. The contrast may be due to difference in the geographical locations where the researches were conducted. Table 3 shows a test of our hypothesis which reveals a Z value of 81.41 and P value of 0.000 at $P < 0.05$. This shows a high significant statistical difference between actual and the hypothesized proportion. It means that the 34.7% of the farmers who indicated NGOs/CBOs as their source of credit is confirmed not to be as result of random variables or occasional factors but real. We therefore reject null hypothesis because there are no evidence to accept it; and thus the hypothesized proportion and the actual proportion are statistically different.

CONCLUSION

Most of the maize farmers in the study area were male who were in their prime age of production and married. Majority of them has formal education with farming as their primary occupation. Respondents' major sources of credit on the general note are the formal sources and particularly the NGOs/CBOs, in significant number. Extension providers in western zone of BSADP should encourage farmers to keep records since most of them can read and write; this will not only help the farmers but extension system as a whole.

Government and Donour agencies should reach out to farmers through the best empirical channels of each zone or locality that differs from place and time to time, and not base on unproven or generalized assumptions. The Government should consider the NGOs/CBOs operating in the study area as a means of reaching the farmers with credit facilities.

Table 1: Socio-economic characteristics of respondents

Variable	Frequency	Percentage
Age range		
Below 21	11	7.1
21-30	12	7.7
31-40	51	32.9
41-50	48	31.0
51-60	21	13.5
Above 60.	12	7.7
Total	155	100
Sex		
Male	113	72.0
Female	44	28.0
Total	157	100
Marital status		
Married	129	82.2
Single	18	11.5
Widow	8	5.1
Divorce	2	1.3
Total	157	100
Education level		
Primary	30	19.4
Secondary	46	29.7
Tertiary	23	14.8
Quranic	26	16.8
None	30	5.4
Total		100

Source: Field survey, 2016

Table 2: Major credit source

Variables	Frequency	Percentage
credit sources		
Formal sources	16	7.4
Microfinance Bank	15	6.3
Commercial Bank	20	13.7
Development Bank	47	34.7
NGOs/CBOs	***98***	***62.1***
Sub-total		
Informal sources	21	14.7
Friends and Relatives	19	11.6
Cooperative society	17	8.4
Money lenders	2	3.2
Others	***59***	***37.9***
Sub-total	**157**	**100**
Grand Total		

Source: Field survey, 2016

Table 3: Hypothesis test (One sample 'Z' test)

Credit source	Mean	SE	Z value	P value
Decision				
NGOs/CBOs	5.000	0.0583	81.41	0.000
Significant				

Source: Field survey, 2016

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Effects of Livelihood Sustenance activities on Off-Farm Income of Subsistence Crop Farmers in Niger State, Nigeria

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ABSTRACT
The study analyzed off-farm income activities and its effects on livelihood sustenance of subsistence crop farmers in Nige r State Nigeria. Multistage sampling technique was used to select 240 crop farmers. Three Local government areas were purposively selected namely: Mokwa, Mashegu and Paikoro from three Agricultural zones in the state. Primary data were used only for the study and were obtained with the aid of structured questionnaire. Data were analyzed using descriptive statistics such as frequency counts, percentages and mean, and inferential statistics such as Tobit regression. Livelihood index was used to examine the livelihood status of the farmers. The findings from the study revealed that the mean age of the respondents was 38 years, mean household size was 7 people, mean farming experience was 12.5 years and mean farm size was 2.10 hectare. The major off-farm income activities of the respondents examined were marketing (52.9%), petty trading (23.3%) and commission agents (18.8%). Based on the livelihood index classification, majority (74.1%) of the respondents were found to have low livelihood status. Tobit regression result revealed that sex (1.76, $p<0.1$), household size (2.97, $p<0.01$), education (4.16, $p<0.01$), experience (2.25, $p<0.05$), farm size (2.03, $p<0.05$), access to credit (2.16, $p<0.05$), extension contact (2.24, $p<0.05$), cooperative (3.84, $p<0.01$) and off-farm income (10.40, $p<0.01$) were statistically significant, thus had effect on livelihood status of the small-scale crop farmers. Results showed that: Livelihood sustenance activities of subsistence crop farmers positively and significantly affected their off-farm income. It is recommended that government should come up with policies that will center on establishment of more livelihood sustenance activities for crop farmers that will generate and increased off-farm income and promote agricultural development simultaneously.
Keywords: Livelihood status, Off-farm Income, Subsistence crop farmers

INTRODUCTION
In many developing countries, and particularly in Africa, agricultural income represents an essential component of rural households' subsistence. However, this type of income exhibits a high seasonality and leads to uncertain outcomes, mainly due to market prices volatility and environmental hazards. Consequently, household members partly allocate their working time to activities which provide a more stable income so as to cope with adverse shocks (Ellis, 2000). Therefore, off-farm income activities are those extra-agricultural jobs which farmers engage in to complement and supplement their income. It is the extra income derived from other sources that are not farm-related. According to Loison (2015), off-farm income is that portion of household income which is obtained off the farm. It includes non-farm wages and salaries, trading and interest on farm income given out as loan, and share dividend earned by farm families.

In Nigeria, off-farm income activities play a vital role in sustainable development and poverty reduction in rural areas (Shehu and Abubakar, 2015). It reduces the pressure of unemployment and the demand for land by the poor in rural areas; contributes to breaking down the vicious cycle of poverty among the rural populace and the income obtained from off-farm activities can significantly increase total household income and hence enhance the investment capacity in farm activities (Babatunde *et al.,* 2010). Therefore, off-farm income activities is often a source of savings, which plays an important role in food security and livelihood. The households that diversify their income by participating in off-farm income activities are more capable of overcoming negative shocks from poor harvest (Myyra *et al.,* 2011).

Rural areas usually provide two categories of income sources to their dwellers; Farm and the non-farm economy. In the rural areas of Nigeria, the majority of households are involved in farm activities and many of them get their income from non -farm activities (World Bank, 2008). Thus, in the rural area, it is hard to find peasants who do only farming. According to FAO (2012), out of 3 billion people living in rural areas in the world, 2.5 billion people derive their livelihood from non-agricultural enterprises. For instance, Haggblade *et al* (2010) observed that non-farm income accounts for between 65% and 80% of total income of rural households in developing countries. Oxford policy management (Opm, 2004), noted that majority of households across all income strata in Nigeria are involved in several off-farm activities, whose importance has increased over the last 25 years. In Nigeria, majority of the farm household populace either depend entirely on farming for survival and generation of income, or depend on farming to supplement their main sources of income (World Bank, 2010). Sample studies show that on average, roughly 50 percent of rural household income in sub-Saharan African are generated from engagement in non-farm activities and transfer from urban areas or abroad, with remittance and pension payments being the chief categories of such transfer (Ellis 2000; Ellis and Freeman, 2004). Evidence from a sample of rural villages in Tanzania (Chapmen and Tripp, 2004; Ellis and Madox, 2003) shows that on average, half of the household income came from crops and livestock and the other half from non-farm wage employment, self-employment and remittance. The proportion of non -farm income was higher for the upper income groups than for the lowest income groups. Therefore, the poorest households were more reliant on agriculture, and the reliance on agriculture decreased with increased diversification into non-farm activities.

The aim of the study is to analyse the effects of livelihood sustenance activities on Off-farm income of subsistence crop farmers in Niger State. The specific objectives to be achieved are to: i. describe socio-economic characteristics of the subsistence crop farmers, ii. examine off-farm income activities and livelihood status of the small-scale crop farmers and iii. analyze effect of off-farm income activities on livelihood status of small-scale crop farmers.

MATERIALS AND METHOD

Study Area

The study was conducted in Niger State. Three Local Government Area where purposively selected namely, Mokwa, Mashegu and Paikoro respectively. Niger State is located between Latitudes $8^{0}22^{/}$N and $11^{0}30^{/}$N and Longitudes $3^{0}30^{/}$E and $7^{0}20^{/}$E, and covers 76,363 square kilometers of land mass which makes it the largest Nigerian State by land mass. However, using the population growth rate of 3.2%, the projected population of the State was 5,764,755 as at the end of 2018

Method of Data Collection

Primary data was used for the study. The data was collected using a well-structured questionnaire administered to the respondents by the researcher through multi stage sampling techniques.

Analytical Techniques

Combinations of analytical techniques were used to analyse data collected from the field. It includes descriptive statistics and inferential statistics. Objectives (i) was achieved using descriptive statistics such as frequency distributions and means score. Livelihood index model was also used to achieve objective (ii) and Tobit regression model was used to achieve objective iii.

Model Specification

Livelihood index model

Livelihood indicators among the respondents as used in this study include household assets, livestock assets and production assets.

i. Household assets: This include ownership of land properties, furniture, houses, cars, bicycle, motorcycle, radio and television among others measured as dummy variable (i.e. 1 if owned, 0 if otherwise).

ii. Livestock assets: This include ownership of cow, sheep, goat, dogs, chicken, horses and donkeys among others measured as dummy variable (i.e. 1 if owned, 0 if otherwise).

iii. Production assets: This include ownership hoes, cutlasses, matchet, plough, ridger, water pump, ox-cart, milling and grinding machines among others measured as dummy variable (i.e 1 if owned, 0 if otherwise).

Livelihood status of the respondents was measured using livelihood index as used by Olughu (2019). The index is expressed as in equation (1):

$$LI = \frac{\text{Number of off-farm livelihood indicators owned by the respondents}}{\text{Total number of off-farm livelihood indicators}} \qquad (1)$$

Where,

LI = Livelihood Index

Meanwhile, the LI was categorized further by the researcher as follows:

≤ 0.26 = low livelihood status

0.26 – 0.50 = moderate livelihood status

0.51 – 0.75 = high livelihood status

≥ 0.75 = very high livelihood status

Tobit regression model

Tobit Regression model was used to determine factors influencing livelihood status of the small-scale crop farmers in the study area which is the objective (iii). The Tobit model as proposed by Greene (2003) and adopted by Isaac (2009) could be explicitly expressed as in equation (2):

$$Y = \beta_o + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \ldots + \beta_{11}X_{11} + U \qquad (2)$$

Where,

Y = Livelihood status of the small-scale crop farmers measured using LI

X_1 = Age of farmers (years).

X_2 = Sex (1 if male, 0 if otherwise)

X_3 = Education (years)

X_4 = Household size (number)

X_5 = Farm size (ha)

X_6 = Years of farming (years)

X_7 = Market accessibility (distance in kilometres)

X_8 = Credit received (naira)

X_9 = Membership cooperatives society (1 if member. 0 if non member)

X_{10} = Off-farm income (Naira)

X_{11} = Distance to farm (km)

U = Error term

β_0 = Constant term

$\beta_1 - \beta_{11}$ = Regression coefficient

RESULTS AND DISCUSSION

Socioeconomic Characteristic of Farmers in the Study Area

The findings from the field survey reveal some personal and household characteristics of the respondents in this study are presented in Table 1. Results in Table 1 show that majority

(36.7%) of the respondents were within the age group of 26 – 35 years with mean age of 38 years. This implies that the respondents were in their active and productive age where they could diversify into off-farm income generating activities to improve their livelihood. This finding is in agreement with that of Odoh and Nwibo (2017) who reported that the majority of household in South-Eastern Nigeria that diversified into off-farm income are younger and active in their respective occupations. That greater proportions (68.8%) of respondents were male whiles (31.3 %) were females. This implies that male are the dominant gender in off-farm activities in the study area. This could be due to the fact that they are major decision makers regarding off-farm income generating activities. This agrees with the findings of Okere and Shittu (2012) who revealed that the males dominated the work force in Nigeria's agricultural communities. Majority (40.2%) of the respondents had household size of less than 11 people with a mean household size of 7 people implying a relatively large household size which is very important in agricultural production. This result agrees with the findings of Okere and Shittu (2012) who posited that larger households are likely to diversify into off-farm income activities than smaller households.

Years of farming experience reveals tha (22%) of the respondents had farming experience between > 21 years with a mean of 12.5 years of farming experience. This implies that the small-scale crop farmers in the study area are relatively experienced and exposed to various forms of off-farm activities that could enhance income and livelihood. This finding is in consonance with that of Babatunde and Qaim (2009) who reported that highly experience farmers diversified into non-farm income activities in Nigeria. Also many of the respondents (30%) had farm size between 1.1 – 2 hectares with a mean of 2.1 hectares. This implies that the respondents are actually producing crops on a small-scale basis. This finding agrees with that of Adeoye *et al*. (2019) who reported that larger proportion of households in Nigeria operate on small scale basis.

Table 1: Distribution of respondents according to socioeconomic characteristics (n=240)

Variables	Frequency	Percentage	Mean
Age			
< 26	30	12.5	37.8
26 – 35	88	36.7	
36 – 45	71	29.6	
46 – 55	38	15.8	
> 55	14	5.4	
Sex			
Male	165	68.8	
Female	75	31.3	
Marital status			
Married	201	83.7	
Single	25	10.4	
Widowed	10	4.2	
Divorced	4	1.7	
Household size			
< 6	97	40.7	7.0
6 – 10	97	40.2	
11 – 15	32	13.3	
> 15	14	5.8	
Educational status			
Adult	27	11.2	8.9
Primary	53	22.0	
Secondary	59	24.5	
Tertiary	35	14.6	
None	66	27.5	
Farming experience(yrs)			
< 6	56	23.2	12.5
6 – 10	50	20.7	
11 – 15	40	16.6	
16 – 20	42	17.4	
> 21	52	22.0	
Farm size(ha)			
< 1.1	66	27.5	2.1
1.1 - 2.0	72	30	
2.1 - 3.0	65	27.1	
3.1 - 4.0	22	9.2	
> 4.0	15	6.3	

Source: Field Survey, 2021

Off-farm income activities of the respondents

Table 2 showed the distribution of respondents based on their off-farm income activities in the study area. The result revealed that marketing (52.1%) ranked 1st among the off-farm activities engaged by respondents, implying that the respondents engaged in marketing as a mean of livelihood. Petty trading (23.3%) ranked 2nd which could be due to the fact that trading is the most common business among households in the rural area. Commission agent (18.8%), civil servant (18.3%) and tailoring (14.9%) ranked 3rd, 4th and 5th, respectively. This implies that most of the small-scale crop farmers engaged in various off-farm activities to help support farm income in taking care of household expenditure. This finding agrees with Batool *et al.* (2017) who reported that most farm families diversify their income sources mainly into off-farm and self-employment such as engaging in agricultural wage-labour, small manufacturing factories, construction and transportation as a means of shielding themselves from risk and uncertainties of agricultural production.

Table 2: Distribution of respondent based on off-farm income activities (n=240)

Variables	Frequency	Percentage	Rank
Marketing	125	52.1	1st
Petty trading	56	23.3	2nd
Tailoring	36	15	5th
Plumbing	2	0.8	13th
Motorcycle riding (Okada)	30	12.5	5th
Car washing	5	2.1	11th
Carpentry	23	9.6	7th
Civil servant	44	18.3	4th
Bricklaying	13	5.4	9th
Weaving	17	7.1	8th
Knitting	27	11.2	6th
Sales of herbs	7	2.9	9th
Commission agent	45	18.8	3rd
Black smiting	4	1.7	12th
Handcraft	6	2.5	10th

Source: Field Survey, 2021

Livelihood status of the respondents

As revealed in Table 3, majority (74.1%) of the respondents had low livelihood status, while 20% had moderate livelihood status and only few (4.8%) had high livelihood status. This implies that the small-scale crop farmers had low livelihood status which could influences off-farm income activities in the study area. This finding contradicts that of Ifeanyi-obi and Mathews-Njoku (2014) who reported that majority of farmers in South East of Nigeria had high livelihood, Afeez *et al*. (2016) reported that most of the rural women farmers in Oyo State, Nigeria, had moderate livelihood.

Table 3: Distribution of the respondents based on their livelihood status (n=240)

Livelihood status	Frequency	Percentages(%)
Very High	0	0.0
High	14	4.8
Moderate	48	20
Low	178	74.1
Mean Livelihood Index	0.2014	
Minimum Livelihood Index	0.0588	
Maximum Livelihood Index	0.5294	

Source: Field Survey, 2021

Effect of off-farm income activities on the livelihood of respondents

Table 4 showed the Tobit regression estimates on the effect of off-farm income activities on the livelihood of small-scale farmers in the study area. The result indicated that the z-vale of age (-1.85, p<0.1) was negatively significant implying that as the small-scale farmers advances in age, their interest to join many enterprises for better livelihood reduces. This could be attributed to the fact that the mental and physical energy required for engaging in off-farm income activities for improved livelihood status declines with age. This finding agrees with that of Odoh and Nwido (2017) who reported that age increase affect livelihood status of farmers in South Eastern States of Nigeria. The z-value of sex (1.76, p<0.1) was positively significant indicating that men are likely to engage more in off-farm activities to better their livelihood than women. The z-value of household size (2.97, p<0.01) was positively significant implying that increase in household members stimulate engagement in off-farm activities in order to cater for the needs of the households. The z-value of education (4.16, p<0.01) was positively significant signifying that an increase in literacy level among small-scale farmers will enhance their involvement in off-farm activities for improved livelihood. This is consonant with Shehu and Abubakar (2015) who reported that educated and younger ones were more likely to diversify into off-farm economic activities. Farming experience (2.25, p<0.05) was positively significant implying that many years of experience in farming could lead to improve livelihood status. This finding is in agreement with that of Babatunde and Martin (2019) who reported that many years in non-farm activities eventually translate to improve livelihood among respondents in their study area.

The z-value of farm size (2.03, p<0.05) was positively significant signifying that access to more farmland enhances increased output and improve livelihood. Access to credit (2.16, p<0.05) was positively significant implying access to credit from either formal or informal institutions is expected to better small-scale crop farmers' livelihood status. The z-value of extension contact (2.24, p<0.05) was positively significant implying that more extension contact could enhance farmers' livelihood. This is because extension is always associated with dissemination of improved knowledge, skills and innovation that is expected to facilitate off-farm income diversification for improved livelihood.

The value of off-farm income (10.40, p<0.01) was positively significant signifying that increase participation in off-farm income generating activities will increase the livelihood status of the small-scale farmers. This finding tends to conform with the apriori expectation that farm households who engaged in off-farm income activities will have a better livelihood status than those who did not. Thus, engagement in off-farm income activities had significant effect on livelihood status of small-scale farmers in the study area. This finding is in agreement with that of Odoh and Nwibo (2017) who reported that high income base tends to improve the livelihood status of rural households in Nigeria.

Table 4: Regression estimates on effect of off-farm income activities on livelihood status

Variables	Coefficient	Z-value
Age	-0.0022298	-1.85*
Sex	0.0256825	1.76*
Household size	0.0103716	2.97**
Education	0.0035909	4.16***
Farming experience	0.0036185	2.25**
Farm size	0.0150177	2.03**
Access to inputs	-0.0164611	-0.49
Access to credit	0.0262668	2.16**
Cooperative society	0.0056434	3.84***
Off-farm income	5.25e-07	10.40***
Constant	0.2637916	6.34***
Sigma	0.0859	20.45***
Chi-squared	151.98***	
Pseudo R2	0.7034	
Log likelihood	201.9364	

Source: Field Survey, 2021. ***implies significant at p<0.01, **implies significant at p<0.05, *implies significant at p<0.1

CONCLUSION

Based on the empirical evidence from the findings of this study, it could be concluded that majority of the respondents were in their active and most productive age, married and relatively experienced in farming activities. The small-scale crop farmers engaged majorly in marketing, petty trading and commission agents as off-farm income activities for improved livelihoods. Most of the respondents were found to have low livelihood status in the study area, thus off-farm income activities had significant positive effect on livelihood status of the small-scale crop farmers. However, inadequate capital, climatic risk and uncertainties, and poor marketing facilities were the major constraints mitigating against off-farm income activities in the study area. It was therefore recommended that credit facilities should be provided for small-scale farmer by financial institutions in order to increase their participation in off-farm income activities. Also, Government and Non-Government Organizations should help to provide rural infrastructure such as good road, ultra-modern market and storage facilities for small-scale farmers particularly in the study area. Lastly study recommends that government should come up with policies that will be center on establishment of more livelihood sustenance activities for crop farmers that will generate and increase off-farm income and promote agricultural development simultaneously.

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Determinants of degree of Adoption of Pro Vitamin A Cassava Varieties among Farmers in Delta State, Nigeria

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ABSTRACT

The success of any agricultural innovation depends on its adoption by farmers. The study examines the determinants of adoption of vitamin A bio-fortified cassava variety among farmers by investigating the level of adoption and determinants of adoption among farmers. Four stages of random sampling procedure were used to select 120 cassava farmers. The data obtained were analyzed with descriptive statistics and a Tobit regression model. The study revealed that the level of adoption of the first and varieties released vitamin is moderate. The study also revealed that level of education, household size, farming experience, farm income and access to extension visit amongst others, are the determinants of adoption of vitamin A bio-fortified cassava variety in the study area. It is therefore recommended that more efforts of the extension workers in collaboration with the technology developers are highly needed to carry out nutritional information campaigns and agricultural shows with regards to pro vitamin A cassava to sensitize the farmers more to take advantage of the benefit of the innovation and boost the degree of adoption in the study area.

Keywords: Determinants, Pro vitamin A cassava, Farmers, Adoption, Varieties

INTRODUCTION

Cassava production plays a vital role in alleviating poverty in Nigeria, as it is virtually impossible that an average household will not consume a cassava product in a day. Therefore, cassava is an important factor in ensuring food security, poverty alleviation, reducing rural urban drift, reducing unemployment and improving dietary intake, among others (Okpukpara, 2006, Opeyemi *et al*., 2017). Based on that, Nigeria released six improved pro vitamin A cassava variety in an effort to maintain its lead as the world's largest producer of the root crops, eradicate vitamin A deficiency and improve incomes of farmers (IITA, 2017). The roots of these varieties are yellow and contain moderate levels of pro-vitamin A that can take good care of vitamin A deficiency among the growing population. Vitamin and mineral deficiencies affect more than two billion people worldwide, causing illness, disability and mortality. The problem is most severe in developing countries, where a third of the children under the age of five suffer from vitamin A deficiency and one fifth of maternal deaths are attributed to iron deficiency anemia during pregnancy (Micronutrient Initiative, 2009).

Vitamin A and iron deficiencies have several negative health and economic consequences, including early mortality and reduced productivity. Vitamin A deficiency (VAD) leads to night blindness, corneal scarring and blindness in children under the age of five (Stein *et al*., 2008). The new yellow root cassava varieties have the potential of providing up to 25% of daily vitamin A requirement of children and women. Since the presence of pro-vitamin A (β-carotene) in the new cassava could improve the nutritional status of the consumers, there is therefore a need to evaluate the adoption of these newly bred crops.

Technology adoption by farmers is an essential pre-requisite for the economic prosperity in Nigeria. Therefore, adoption of pro vitamin A cassava is an important route to improve health and nutritional status of poor cassava farmers by enhancing pro vitamin A cassava productivity. The objectives were to determine the levels of adoption of pro vitamin A cassava among farmers, to assess the factors affecting adoption of pro vitamin A cassava and analyze the degree of adoption of pro vitamin A cassava in Delta state.

METHODOLOGY

The study was conducted in Delta State, Nigeria. Delta State has a population of 4,112,445 (males: 2,069,309; females: 2,043,136) (NPC, 2006). It has an estimated area of 762 square kilometres (294 sq m) and a total land area of 16,842 square kilometres (6,503 sq mi) (Wikipedia, 2017). The state is divided into three agricultural zones namely: Delta North, Delta Central and Delta South. A multistage sampling procedure was used in selecting the sample for this study. In the first stage two agricultural zones (Delta North and Delta Central) were purposively selected. This is because pro vitamin A cassava has been massively disseminated in those areas. The second stage involved the selection of three (3) blocks from each of the two agricultural zones, making up a total of six (6) blocks. The third stage involved the random sampling of two (2) circles from each of the blocks totaling twelve (12) circles. Ten (10) pro vitamin-A cassava farmers were randomly selected from the list of pro vitamin-A cassava farmers in the area, making it a total number of 120 farmers for the study. A well-structured questionnaire was used to elicit information from the respondents. Data were analyzed by the use of descriptive statistics like five (5) point rating scale and three (3) point rating types and inferential statistics (Tobit Regression model). The model as used is specified thus:

$$Y = f\,(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8 + ei)$$

Where,

Y = Level of adoption of pro vitamin A cassava (measured by number of adoption score of the respondents) to get the mean score.

X_1 = Educational qualification (years of schooling)

X_2 = Household size: (No. of persons in a household)

X_3 = Farming experience (years)

X_4 = Farm size (hectares)

X_5 = Farm income: (in Naira)

X_6 = Easy access to farm credit (mean: very easy, hardly easy, not at all)

X_7 = Member of cooperative (years)

X_8 = Participation in extension activities (mean: very often, hardly often, never)

ei = Error term

RESULTS AND DISCUSSION

Adoption of Pro Vitamin-A Cassava

The result of Table 1 on degree of adoption of pro vitamin A cassava varieties shows that the mean of $\bar{x}$ =2.28 implies that there were moderate adoptions of the first pro vitamin A cassava varieties while the mean of $\bar{x}$ =2.21 implies that there were also moderate adoptions of the second pro vitamin A cassava varieties disseminated in the study area. The reason for moderate adoption of the first and second varieties could be as a result of inadequate cassava stem and the quality of the varieties. Generally, the grand mean result of $\bar{x}$ =4.49 also indicates moderate degree of adoption. The moderate adoption recorded might be because of its quality and the level of nutritional information of the cassava created among the farmers by the disseminators. The finding is in agreement with the findings of Ironkwe (2012) that farmers adopt technologies that had relative high impact on their socio-economic status.

Table 1: Mean score responses on farmers' level of adoption of pro vitamin-A cassava varieties

Pro vitamin A cassava Varieties	Never Adopted	Adopted and Stopped	Adopt and still Use	Total	Mean
1st three varieties released					
UMUCASS 36 TMS011368	25(25)	36(72)	59(177)	274	**2.28***
UMUCASS 37 TMS1011412					
UMUCASS 38 TMS1011371					
2nd three varieties released					
UMUCASS 44 TMS070220					
UMUCASS 45 TMS1070593					
UMUCASS 46 TMS1070539	30(30)	34(68)	56(168)	266	**2.21***
Grand mean					**4.49****

Source: Field survey, 2018. Mid Score Decision Rule: 2.0 and above is *** Very high adoption ** High adoption * Moderate adoption.

Factors affecting adoption of pro vitamin-A cassava varieties

The factors affecting the adoption of pro vitamin A cassava were determined on the basis of level of severity of all the results in Table 2. The result showed that inadequate funding ($\bar{x}$ =4.65) and Cost/unavailability of pro-vitamin A stem ($\bar{x}$ =4.18) were the major factors affecting adoption of pro vitamin A cassava among farmers in Delta state. The grand mean of $\bar{x}$ =3.2 which is above the decision mean cut-point showed the factors are more or less retrogressive to the dissemination and total adoption goal of the vitamin A varieties. This finding is in line with Onyeneke *et al*., (2018) who reported that reality of new hybrid varieties and its improved farming system, sometimes introduces certain difficulties for smallholder farmers to adopt due to inadequate fund

Table 2: Factors affecting adoption of pro vitamin A cassava among farmers

Perceived factors	$\bar{x}$	SD
Cost/unavailability of pro-vitamin A stem	4.18	.4488
Diseases and pest infestation	2.43	.7741
Poor extension contact	2.28	.6633
Literacy level of farmers	3.58	.9489
High cost of labour	4.07	.3831
Lack of farm credit	4.12	.4137
Inadequate information	3.59	.9393
Inadequate funding	4.65	.4787
Inadequate planting materials	4.05	.2188
Unavailability of flour processing machine	4.09	.2897
Herdsmen/cattle menace	3.74	,9570
Grand mean	**3.2**	

Source: Field survey, 2018.

Determinants of degree of Adoption of pro vitamin A cassava by farmers

Table 3 shows the result of the tobit regression analysis on determinants of adoption of pro vitamin A cassava by farmers in the study area. The results revealed that the coefficient of determination (R^2) was 0.469, which implies that 46% of the variations in adoption of pro vitamin A cassava by farmers is determined by the independent variables discussed in the study and statistically significant at 1 % level of probability (prob> Z = 0.0049). The estimate shows that educational level, household size and year of experience had positive influence on their degree of adoption of pro vitamin A cassava at 1% and 5% significant level of probability while farm income and access to extension services had negative influence on their degree of adoption of pro vitamin A cassava at 10% significant level of probability. This implies that the higher the level of education, household size and farming experience, the higher the probability of adoption of pro vitamin A cassava increases. This agrees with the findings of Ume et al,

(2013) and Nwakor (2014) who found that education helped to facilitate adoption. This finding is also in line with *a prior* expectation and findings of Anyanwu *et al*, (2016) who reported that increase in years of experience would enable farmers to efficiently produce effectively and maximize agricultural output for improved income. This result also agrees with the findings of Abdoulaye *et al, (*2015) that large households are better adopters of improved cassava varieties in Nigeria. However, the result disagrees with the findings of Anyanwu, *et al*; (2016) who says that a unit increase in income will cause increase in adoption of the technologies. This is also not in line with the report of Onyeneke, *et al*; (2018) who reported that access to extension services proved essential in the dissemination and acceptance of the new technology of pro-vitamin A bio fortified cassava varieties in Delta state.

Table 3: Tobit regression estimates of the determinants of adoption of pro vitamin A cassava Delta state, Nigeria

Variables	Coef.	Std. Err	Z	P>|z|
Educational qualification	.3160592	.194666	2.62	0.004***
Household size	.2810248	.2374742	2.18	0.030**
Farming experience	2.246621	1.059881	2.12	0.034**
Farm size	2.8402	8.302079	0.34	0.732
Farm income	-1.827466	.00003	-0.73	0.035*
Easy access to credit	.0475136	.1232401	-1.34	0.181
Member of cooperative	.021803	.1232401	0.18	0.860
Access to extension services	-.0744428	.1062948	-0.70	0.484*
Chi^2(X^2)	20.35***			
Prob>	0.0049			
R^2	0.469			
Log Likelihood	-11.51517			

Source: field survey, 2018. *, ** and *** is significant at 10%. 5% and 1% level of probability

CONCLUSION

The study has shown that both the first and second pro vitamin A cassava varieties have been adopted by farmers in Delta state, though at a moderate degree. The respondents identified inadequate funding and high cost/unavailability of pro-vitamin A stem as major factors affecting the degree of adoption. The study also concluded that explanatory variables such as level of education, household size and farming experience positively influenced farmers' degree of adoption of pro vitamin-A cassava varieties while farm income and access to extension services negatively influenced their degree of adoption of pro vitamin-A cassava varieties. This paper therefore recommends that more efforts of the extension workers in collaboration with the technology developers are highly needed to carry out nutritional information campaigns and agriculture shows with regards to pro vitamin A cassava to boost the degree of adoption in the study area.

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Profit Analysis of Soybean Processing in Tsibiri, Giwa Local Government Area, Kaduna State, Nigeria

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ABSTRACT
The study analyzed the profitability of soybeans processing in Tsibiri village, Giwa Local Government Area of Kaduna State. Specific objectives were to; describe the level of awareness of improved techniques in soymilk and soy yoghurt processing, determine the costs and returns of soymilk and soy yoghurt processing and identify the constraints in soybeans processing. Purposive and random sampling techniques were used to sample one hundred women processors. Data were obtained using questionnaire and personal interview. Data were analyzed using descriptive statistics and budgetary analysis. The result revealed the awareness status of soybean processors before and after training for soymilk and soy yoghurt processing. Budgetary analysis revealed that soymilk enterprise attracts a gross margin of ₦5,952 while soy yoghurt enterprise attracts a gross margin of ₦5,752 per processing cycle. The return on investments was 3.91 and 3.56 respectively. The major constraints to soymilk and soy yoghurt processing were lack of refrigerator, erratic power supply and inadequate capital. Soybeans processors should form cooperative society in order to pool their resources and purchase cold stores for refrigeration and increase shelve life of products.
Keywords: Profitability, Soybeans processing, Soymilk, Soy yoghurt

INTRODUCTION
Soybean (*Glycine max*) is a leguminous vegetable of the pea family that grows in tropical and temperate climates. It was domesticated in the 11th century around northeast of China (Glycine max, 2012). It grows in the tropical, subtropical and even the temperate climate and was introduced to Africa in the 19th century by Chinese traders along the East Coast of Africa (IITA, 2015). Soybean has been described as a near-perfect crop for a country like Nigeria, expressing that nutritionally; they carry double the protein of meat or poultry and contain all the eight essential amino acids needed for childhood development (Lukas, 2010; Soybean, 2012). Soybeans are also good for the environment. Soybean is among the major industrial and food crops grown in every continent. The crop can be successfully grown in many states in Nigeria using low agricultural input (Lukas, 2010). Major Soybean producing states in Nigeria are; Benue, Kaduna, Plateau, Niger, Nasarawa, Kebbi, Kwara, Oyo, Jigawa, Borno, Bauchi, Sokoto, Taraba and the Federal Capital Territory. Nigeria's domestic soybean production is estimated at 500,000 metric tons despite an existing huge potential to produce more. Soybean is usually discussed as a single entity, a particular food which is consumed in various forms. In Africa dry soybeans are used to produce milk substitutes and flour. The bean curd is fried and eaten as a snack or breakfast food. Mature beans are not easily digested and contain toxic compounds, which require soaking and prolonged cooking. Soy cheese is the dry roasted soybean and soymilk is used as substitute for cow milk (Strom, 2001; Hoogenkamp, 2005). Soybean contains 40% high quality protein, 20% edible vegetable oil, a good balance of amino acids. It is used in the production of many products such as bread, cookies, biscuits, pasta, cakes, baklava, dumpling, cornet, noodle, pasty, tarhana, nuts, baby food, confectioneries, chocolate, halva, milk, yogurt, cheese, ice cream, tomato paste, meat, coffee, special dietetic

products, dry and cold ready food mixture, soap, paper, wax, gum substances, digital printing inks and lamp oil (Tuğay, 2007; Elden, 2009). It is known as "miracle plant" in many regions because of its high nutritional value especially in terms of protein content. It is also an important source of linoleic acids. Soybean products which include high protein content, isoflavones, omega-3 fatty acids and dietary fibers are very important functional food components (Nilüfer, 2007). However, soybean cannot be consumed unless it undergoes some level of processing (Miniello *et al*, 2003). Soybeans are now widely consumed and are readily used in the production of soymilk, soy cake, soy yoghurt and the fortification of local carbohydrate-based Nigerian food staples. Processed soybean also serves to extend the availability of the product beyond the area and season of production, thus stabilizing supplies and increasing food security of individuals (IITA, 2015).

Statement of the problem

Soybeans processing in the society have been assumed as an insignificant enterprise. Therefore, if transformed into the modern processing methods which could play a very significant role in the overall development in the community, local government area, state and the country as a whole. The only unfortunate situation is that, despite the existence of enabling environment created of soybeans production, the community is yet to take advantage of the potential for its processing. Therefore, this gap of non-processing has led to the need for this researcher to enlighten the people of the community in the processing of their soybeans.

To attain good health in Nigeria, the importance of protein in the daily meal of every citizen cannot be overlooked. FAO (2011) recommends that every individual is expected to consume soybean. Unfortunately, the rural women after harvesting, dehulling, or decortications would have no option left than to sell out the soybeans using measuring cups or in bags. Despite the potential it holds for wealth creation as well as the availability of soybeans production in the rural areas of Nigeria, the village is yet to take advantage of this potential for it processing. The major challenge facing soybean producers is the inability to add value to the soybean through processing it into different products that will bring satisfaction to the consumers.
In view of the problems stated, the study seeks to answer the following research questions:

i. were the community women aware of any technology for soybeans processing?
ii. what are the costs and returns of soy milk and soy yoghurt production and marketing?
iii. what are the processing constraints experienced by the people of the study area?

Objectives of the study

The broad objective of the study was to analyze soybeans processing and value addition in Tsibiri in Giwa local government area of Kaduna State.
The specific objectives of the study were to:

i. examine the level of awareness of improved technology of soymilk and soy yoghurt processing.
ii. determine the costs and returns of soy milk and soy yoghurt production and marketing.
iii. identify the constraints experienced by the soy milk and soy yoghurt processors

Justification of the study

Malnutrition is endemic in Nigeria and soybeans are a near perfect crop to address the problem. Soybean proves to be the most popular means of relief from protein calorie malnutrition (PCM) as protein from animals is beyond reach, many people can't afford it. To bridge the widening gap between protein requirement and availability of protein, soybean is expected to constitute the main source of protein for the future. Although, a lot has been achieved, a lot still has to be done in processing. The findings of this study will provide information on women Socio-economic characteristics that influence soybean farmers' decisions on the adoption of recommended soybean processing practices. This research directly addresses the problem of harvesting and selling immediately, which generally gives low income. Consequently, the problem of ailing economic condition of the village could be revitalized through empowering women to learn more methods of processing soybeans and marketing the products.

METHODOLOGY

The study was conducted at Tsibiri village in Giwa Local Government Area of Kaduna State. This LGA lies between latitudes 11.20° and 11.50°N and longitudes 7.0° and 7.5°E. The targeted populations of the study area were all women, who are the soybeans processors within the study area. Purposive and random sampling technique was used to sample the respondents. One hundred (100) women participated in the study from the community under the study area.

Data collection

Data was obtained using questionnaire, personal interview and focus group discussion (group formation) was used to obtain relevant data. Primary data such as socio-economic characteristics, processing methods, cost and returns and constraints were obtained.

Data Analysis

Descriptive statistics such as frequency distribution table, percentages, and means were used to achieve objectives 1, and 3. Budgetary analysis such as gross margin was used to achieve objective 2. Likert scale was used to rank the perceptions of the rural women to the improved soy beans processing methods. Likert scale was used to measure the perception of the women processors to the introduced innovation.

i) Aware   ii) Unaware   iii) Undecided

$$GM = TR - TVC$$

GM= Gross margin

TR = output x unit price

TVC= Total variable costs

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

RESULTS AND DISCUSSION

Level of awareness of improved technology of soymilk and soy yoghurt processing

Table 1 shows the awareness of soy bean processing in the study area. The result shows that 94% of the processors were aware that soybean can be processed into different products while 6% indicated that they were not aware. This implies that majority of the processors (women) were aware that soy bean can be processed into products that satisfies human wants. Some of the common products in which soy bean can be processed into in the study area were: Soy cheese, *Gauda* and *Kara'i*. In terms of awareness, 70% indicated that they were aware that soy bean can be processed into soy cheese (*Awara*) while 30% indicated that they were not aware. Furthermore, 89% indicated that they were aware that soy bean can be processed into *Gauda* while 11% indicated that they were not aware. In addition, 73% indicated that they were aware that soy bean can be processed into *kara'i* while 27% were not aware. This implies that majority of women were aware that soy bean can be processed into different products. According to Jack and Tobia (2017) signified that farmers make multiple choices in the agricultural cycle on adoption of products and practices. Taking right decision by households depend so much on the quantum of knowledge they have at their fingertips.

Table 1: Awareness of soybeans processing into some different products.

Variable	Frequency	Percentage (%)
Processing into products		
Aware	94	94.0
Not aware	6	6.0
Products		
Soy cheese		
Aware	70	70.0
Not aware	30	30.0
Gauda		
Aware	89	89.0
Not aware	11	11.0
Kara'i		
Aware	73	73.0
Not aware	27	27.0

Source: Survey data 2021

Costs and Returns

Costs and Returns of Soy milk Production

Table 3 shows the cost and returns of soy milk production in the study area. The result shows that the total variable cost incurred in the production of soy milk was ₦2, 048 from a measure of soy beans. The purchasing cost of soy bean accounted for 39% of the total variable costs. The revenue generated from the production of 80 bottles of 35cl at ₦100 was ₦8, 000. The gross margin was ₦5, 952 and the return on investment (ROI) was 3.91 implying that for every ₦1 invested ₦2.91 is recouped from the investment. The operation ratio was 0.26 implied that the business will span for a long period provided best practices are maintained. This agrees with the findings of Ettah and Okorie, (2018), who reported that the high value of processed soybeans explains the profitability of soybean processing.

Table 3: Cost and Returns of Soy milk Production

Items variable	Cost (₦)		Percentage (%) Returns
Purchase of soybeans	800 (2.5kg)		39.06
Cost of milling	80		3.91
Cost of sugar	640		31.25
Cost of preservative	60		2.93
Cost of the bottles	268		13.09
Cost of firewood	200		9.77
Total variable cost		2,048	
Revenue (80 bottles x 100)		8000	
Gross Margin (TR-TVC)		5,952	
Return on Investment (ROI) $\frac{TR}{TVC}$		3.91	
Operation ratio (OR) $\frac{TVC}{TR}$		0.26	

Source: Survey data 2021

Costs and Returns of Soy Yoghurt Production

Table 4 shows the cost and returns of soy yoghurt production in the study area. The result shows that the total variable cost incurred in the production of soy yoghurt was ₦2, 248 from a measure of soybeans. The purchasing cost of soy bean accounted for 36% of the total variable costs. The revenue generated from the production of 80 bottles of 35cl at ₦100 was ₦8000 the gross margin was ₦5, 752 and the return on investment (ROI) was 3.56 implying that for every ₦1 invested ₦2.56 is recouped from the investment. The operation ratio was 0.28 implied that the business will span for a long period provided best practices are maintained.

Tables 4: Cost and Returns of Soy yoghurt Production

Items variables	Cost (₦)		Percentage (%) Returns
Purchase of soybeans	800 (2.5kg)		35.59
Cost of milling	80		3.56
Cost of sugar	640		28.47
Cost of preservative	60		2.67
Cost of flavor	200		8.90
Cost of bottles	268		11.92
Cost of firewood	200		8.90
Total Variable Cost		2,248	
Revenue (80 Bottles x ₦100)		8000	
Gross Margin (TR-TVC)		5,752	
Return on Investment (ROI) $\frac{TR}{TVC}$		3.56	
Operation ratio (OR) $\frac{TVC}{TR}$		0.28	

Source: Survey data 2021

Constraints to Soy Milk and Soy Yoghurt Production

Table 5 shows the constraints to soymilk and soy yoghurt production in the study area. The result shows constraints faced by women processors. About 41% reported lack of refrigerator a as primary constraint to soymilk and soy yoghurt production, 27% indicated erratic power supply as a constraint to soymilk and soy yoghurt production. These can make it impossible to preserve both soy milk and soy yoghurt for long period of time. However, 8% of the soy bean processors indicated heat as constraint soymilk and soy yoghurt is high in protein and therefore prone to spoilage.

1. **Inadequate Refrigerator:** Soy yoghurt and Soy Milk should be stored in the refrigerator below 40^0C. When properly stored the shelf life will be met because lack of storing in the refrigerator reduce the shelf life and deteriorate the quality, without refrigerator molds, yeast and slow-growing bacteria grow and spoil the product.
2. **Erratic Power Supply:** In a Condition during which power supply is not stable, not regular in pattern. This can hinder so many things and progressive development. Soy yoghurt and soy milk required to be refrigerated and without adequate powers supply, the efficiency of refrigerator will be hindered.
3. **Inadequate Capital:** lack of Capital is a common reason for small businesses failure. There is an expression that gives “people don’t plan to fail; they just fail to plan”. No entrepreneur going into business does so with a plan to fail, but inadequate access to working capital and other financial options is a huge contributor to a business’s lack of success and ultimate failure.
4. **Heat:** Soy Beans Products such as the Soy Milk and soy yoghurt are high in protein and easily result to spoilage when exposed to heat. Soy beans products like most other foods that we can consume allows the growth of microorganism that use the nutrients in milk and in many cases are harmful for our health. The rate of growth of harmful bacteria increases as the temperature at which the milk is stored is increased.
5. **Poor market outlet:** Soy Yoghurt and Soymilk are milk extracted from soy beans grains. Milk is a highly perishable (Non-stock) Commodity with a daily flow of marketable streams. Poor market outlets face the risk of spoilage.

Table 5: Constraints to Soymilk and Soy yoghurt production

Problem	Frequency	Percentage (%)
Inadequate Refrigerator	54	40.91
Erratic power supply	36	27.27
Inadequate capital	20	15.15
Heat	10	7.58
Poor market outlet	12	9.09

Source: Survey Data, 2021 **Multiple responses

CONCLUSION

The study revealed the awareness status of soybean processors before and after training. The result showed that soybeans processing is profitable based on the gross margin and returns on investment. However, lack of refrigerators, erratic power supply and inadequate capital were the major challenges in the study area. It is therefore recommended that soybeans processors should form cooperative society in order to pool their resources and purchase cold stores for refrigeration of their products and alternatively purchase of ice blocks for cooling their products. They should also be regularly trained on the best and affordable processing technologies available.

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Effect of Selected Agricultural Extension Strategies on Poverty Alleviation in Umuahia South L.G.A of Abia State, Nigeria

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ABSTRACT
The study focused on the effect of selected agricultural extension strategies on poverty Alleviation in Umuahia South LGA of Abia State. The specific objectives were to describe the socio-economic characteristics of the respondents, identify agricultural extension strategies extended and determine the effect of agricultural extension strategies in alleviating poverty in the study area. A structured questionnaire was administered to 120 respondents randomly selected from Umuahia South LGA of Abia State. Data obtained were analyzed using descriptive statistics. The result obtained shows the major agricultural extension strategies for poverty alleviation were formation of farmers' association (50%) perceived as very effective while community empowerment (54.2%), farmer to farmer (50%), focus on high value enterprise (50%) and T & V based extension strategy amongst others were perceived as effective. The study recommends that farmers should be encouraged to form associations so as to enable them build social capital, pool resources together and obtain loans and credits easily from financial institutions and participatory extension service should be practiced which would enable farmers to determine and accept change.
Keywords: Agricultural Extension Strategies, Effect, Poverty Alleviation, Umuahia South L.G.A.

INTRODUCTION
Agricultural extension is one of the main institutional components of agriculture as it promotes the transfer and exchange of information that can be converted into functional knowledge. It is better to say that agricultural extension is the instrument which is helpful in developing enterprises that promote productivity and generate income in the present scenario of change, which can ultimately reduce poverty in developing as well as developed countries (Anderson and Feder, 2003). Most agricultural extension leaders are still operating on the basis of the 20th century agricultural development strategy when food security was the national priority (Swanson *et al.,* 2003). In the past, agriculture was the mainstay of Nigerian economy, a period when the sector was taken as a matter of importance, just as the nation was blessed with abundant natural resources. However, the situation has changed since the advent of oil boom era in the early seventies, which has made the country to shift her attention away from agriculture. Consequently, it is now becoming increasingly difficult to get food on the table of the common man (Torimiro, 2006). Fritschel (2003) says that globalization of the world's food system represents both an opportunity for small scale farmers. Without immediate assistance from public research and extension, small scale farmers will be increasingly marginalized by globalization and will soon lose access to even their traditional domestic market hence constituting poverty.

MATERIALS AND METHODS
The study was conducted in Umuahia South Local Government Area of Abia State, Nigeria. The headquarters is at Apumiri-Ubakala. It has an area of 140km^2 and a population of 138,

570 people (National Population Census, 2006). Umuahia South L.G.A lies within Latitudes 5^0 31' and 9^0 68" North of the Equator and Longitudes 7^0 29' and 10^0 60" East of the Greenwich meridian (Wikipedia, 2017) and elevation of 55 meters above sea level. The climate is tropical and humid all year round. Annual rainfall ranges from 2000mm to 2500mm while the temperature ranges from 22^0C and 31^0C. It has three notable clans which are sub-divided into autonomous communities. The clans are Olokoro, Umuopara and Ubakala. They consist of thirty-six (36) villages and twenty-three (23) autonomous communities namely; Umuajameze, Ekenobizi, Amachara, Nsirimo, Amankwo, Ehume, Ugbodiukwu, Umuihie, Ogbodi n'ihe, Ohiya, Eziama, Amuzu, Nsukwe, Umuogo, Amaibo, Umuajata, Amizi, Itaja, Itu, Okwu, Avonkwo, Agbama, and Umuoperaezora. The major occupation of the people is farming. The soils in the area are fertile and the major food-crops grown in the area are cassava, yam, maize, cocoyam, local beans, melon and various types of vegetables. Crops grown under plantation are raffia palm, palm tree, plantain and banana.

The farm animals reared include sheep, goat, pigs, rabbits, chickens and snail. Multistage random sampling technique was employed in the selection of respondents for the study. In the first stage: Three (3) communities were randomly selected from the twenty-three (23) Autonomous Communities in the L.G.A. In stage two: Four (4) villages were randomly selected from each of the selected communities, making a total of twelve (12) villages. Stage three: Ten (10) farmers were randomly selected from each of the selected villages giving a total of one hundred and twenty (120) respondents as sample size. A semi-structured questionnaire was used in soliciting information from the respondents. Objectives i, ii and iii were analyzed using descriptive statistics such as percentages and frequency counts presented in tabular forms.

RESULTS AND DISCUSSION

The socio-economic characteristics of the respondents is shown in Table 1. Result revealed that males constituted a large proportion (55.83%) of the respondents in Umuahia South LGA of Abia State, Nigeria. The dominance of male farmers is probably because the male owns most of the farm assets including lands and therefore had an edge over the female. This is in line with the generally held view and common practice in developing countries to direct extension and training services primarily towards the men because they are more likely to adopt technologies faster than the females (Nwaneri, 2018 and Nwaneri *et al*., 2019). The table further revealed that fairly good proportion (49.17%) of the respondents were within the ages of 20 and 39 while 28.33% of them were within ages of 40 and 59. The respondents were relatively energetic and at productive age.

The table also showed that a fairly good proportion (40.83%) of the respondents had tertiary education. Nwaneri (2018) opined that education enlightens one and makes him/her more responsive to new technologies, and this fact probably accounts for the high percentage of farmers with tertiary education involved as ADP contact farmers. The table also showed that a fairly good proportion (40.83%) of the respondents had household sizes of between 4and 6 members. The implication of this revelation is that large household sizes is an advantage to farmers in terms of labour supply. (Nwaneri *et al.*, 2019) asserted that family sizes are the most important sources for unpaid labour. Also, the table revealed that a fairly good proportion (46.67%) of the respondents had farm sizes between 2 and 4 hectares. Nwaneri (2018) reported that increased farm sizes significantly result to increased farm output and also influence the adoption decision of the farmers.

The distribution of respondents according to Agricultural extension strategies extended to them is shown in Table 2. The table revealed an overwhelming (100%) indication of the extension of strategies like; agricultural capacity building, participatory extension, focus on high value enterprises, formation of farmers' association, formation of self-help groups, farmer to farmer extension and community empowerment were the strategies extended to respondents in the study area. While T & V based extension strategy and workshop and seminars had fairly good proportion (77.50% and 81.67% respectively) indication as being available in the area. It is one thing for an innovation to be available and a different thing for the technology to be utilized (Nwaneri., *et al* 2019; Nwachukwu and Onuegbu, 2005).

Table 3 presents the respondents' perception on the extension strategies needed for effective poverty alleviation among farmers in Umuahia South Local Government Area. The table revealed that Community empowerment is the most effective strategy as agreed to by 65(54.2%) of the respondents. By taking a livelihoods and rights approach to reducing poverty, the empowerment of poor people to have the capacity to access new opportunities for wealth creation and cope with their vulnerability moves Centre stage. Such empowerment enables poor people to build on their strengths and assets and to engage with local structures and processes. The above findings are in line with Percy and Tanko (2003), who posited that farmers have and will continue to manage their farming systems whether or not extension services are available. Formation of farmers' associations were perceived by 50% of the respondents as a very effective factor that facilitates the building of social capital. Social capital is the ability to facilitate collective action for mutual benefit through the organization and participation of farmers and rural people. Putnam (2000) differentiated social capital into two primary categories: bonding and bridging, both of which, can link producer groups to external markets or processing firms that can open up new market opportunities.

The most effective means of reaching the rural poor is through women's groups. This is in line with Swanson (2004) who posited that building of social capital is a critical element in an overall agricultural development strategy aimed at reducing poverty. Again, for extension to contribute to reducing poverty it is therefore important to identify the problems and needs of the farmer. This was agreed to by 50% of the respondents and which is in agreement with the findings of Bonye *et al.,* (2012) who opined that extension services carried out based on the identified needs of the farmers yields a desirable result as the programs are structured to meet the exact needs of the farmers. Comparing the strategies as indicated by the extension beneficiaries, farmer to farmer, focus on high value enterprise and community empowerment had the closest margin between the respondents. By taking a right approach to reducing poverty, the farmer to farmer 60(50%) and the community empowerment of the poor people to have the capacity to access new opportunities for wealth creation and cope with their vulnerability more centre stage. Such empowerment enables poor people to build on their strengths and assets to engage with local structures and processes.

The above findings are in line with Anderson and Feder (2003), which posited that Agricultural extension is the instrument which is helpful in developing enterprises that promotes productivity and generate income in the present scenario of change, which can untimely reduce poverty in developing as well as developed countries. Here, farmer to farmer extension can bring extension closer to poor farmers, if it is aimed at strengthening the relationships between communities, service providers and government and build community initiatives enables new opportunities and linkages which builds farmers confidence in their own knowledge and ability to be managed.

CONCLUSION

Agricultural extension strategies perceived as extended included; agricultural extension capacity building, Workshop and Seminar**,** Participatory Extension Strategy**,** Focus on High Value Enterprises**,** Formation of Farmers Association**,** Formation of Self-help Groups**,** Farmer to Farmer Extension and Community empowerment. The result further showed that Community empowerment is the most effective strategy as agreed by 65(54.2) of the respondents while formation of farmers' associations where perceived as a very effective factor that facilitates the building of social capital. Comparing the strategies indicated by the extension beneficiaries, farmer to farmer, focus on high value enterprise and community empowerment had the closest margin between the respondents. By taking a right approach to reducing poverty, the farmer to farmer 60(50%) and the community empowerment of the poor people to have the capacity to access new opportunities for wealth creation and cope with their vulnerability more Centre stage. Based on the findings of this study, the following recommendations were made: Farmers should be encouraged to form associations so as to enable them build social capital, pool resources together and obtain loans and credits easily from financial institutions and participatory extension service should be practiced which would enable farmers to determine and accept change.

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Table 1: Characteristics of Respondents in Umuahia South L.G.A, Abia State (N= 120)

Characteristics	Frequency	Percentage
Gender		
Males	67	55.83
Females	53	44.17
Age (years)		
20 – 39	59	49.17
40 - 59	34	28.33
60 – Above	27	22.50
Level of Education		
No formal education	4	3.33
Primary school	31	25.83
Secondary school	36	30.00
Tertiary school	49	40.83
Household size		
1 – 3	47	39.17
4 – 6	49	40.83
Farm size (Ha)		
0.1-1	40	33.33
2-3	56	46.67
4-5	15	12.50
6 - Above	9	7.50
Total	**120**	**100**

Source: Field Survey data, 2021

Table 2: Distribution of Respondents According to Agricultural Extension Strategies Extended in Umuahia South LGA

Packages Extended	*Frequency	Percentage
Agricultural Extension Capacity Building	120	100.0
T & V Based Extension Strategy	98	77.50
Workshop and Seminar	93	81.67
Participatory Extension Strategy	120	100.0
Focus on High Value Enterprises	120	100.0
Formation of Farmers Association	120	100.0
Formation of Self-help Groups	120	100.0
Farmer to Farmer Extension	120	100.0
Community empowerment	120	100.0

Source: Field Survey Data,2021 *Multiple responses recorded

Table 3: Effect of Selected Agricultural Extension Strategies for Poverty Alleviation in Umuahia South LGA, Abia State

Strategies	Effective	Very Effective	Fairly Effective	Not Effective
	F(%)	**F(%)**	**F(%)**	**F(%)**
Agricultural Extension capacity building	50 (41.6)	30 (25)	20 (16.6)	20 (16.6)
T &V based Extension strategy	60 (50)	25 (20.8)	10 (8.4)	25 (20.8)
Workshop and seminar	50 (41.6)	30 (25)	25 (20.8)	15 (12.5)
Participatory Extension strategy	40 (33.3)	30 (25)	30 (25)	20 (16.6)
Focus on high value enterprises	60 (50)	30 (25)	20 (16.6)	10 (8.4)
Formation of farmers association	40 (33.3)	60 (50)	10 (8.4)	10 (8.4)
Formation of self-help groups	50 (41.6)	40 (33.3)	20 (16.6)	10 (8.4)
Farmer to farmer extension	60 (50)	50 (41.6)	5(4.2)	5(4.2)
Community empowerment	65 (54.2)	25 (20.8)	20 (16.6)	10 (8.4)

Source: Field Survey Data, 2021. Multiple responses recorded, F= Frequency, % = Percentage

Determinants of E-Resource Utilization in Extension Delivery Service in Katsina State, Nigeria

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ABSTRACT
The all-inclusive application of information communication technology in extension service delivery has impacted prominently in agricultural production. This great feat positively influenced the workers' development and mode of work delivery of the extension personnel. The study examined the e-resources utilization in extension agents' service delivery in Katsina State, Nigeria. A two-stage sampling technique was used to collect primary data through the aid of well structured, pretested questionnaire from 74 Extension Agents in the study area. Descriptive statistics shows that the Extension Agents had the mean age of 41.49 years with 37% of them falling between 41-50 years. Probit regression analysis shows that age of the Extension Agents was negatively significant (P<0.10). This implies that as the extension agents grow older there is less likelihood to use E-resources in their day to day delivery of extension services to the farmers. Household size was positively significant (P<0.10). This connotes that as the household size increases there is more likelihood for extension agent to use E-resources. Education level was positively significant (P<0.05). This signifies that the more educated the extension agent the more likelihood to use E-resources. The study concludes that E-resources exploration productively enhanced the extension service delivery in the study area. The study recommends that capacity building that will foster the intellectual proficiency and upsurge the horizon of the extension agents should be organized by the research institution.
Keywords: E-resources, extension-agents, Agricultultural-zones, Katsina-state.

INTRODUCTION
Agricultural Extension service delivery is rapidly changing with the current global advancements in Information and Communication Technology (ICT). Information communication technology has a great potential to revamp agricultural extension in a big way. Until now ICTs offers farmers a channel for communicating directly with distant technicians and experts, many farmers could wait months or years for an extension agent to provide technical advice and often that advice don't seems to address their immediate concerns, e-resources has become a global tool often used by individuals, organizations and intergovernmental organizations for personal or official activities. Its application cut across all fields of human endeavor like medicine, education, library services, architecture and agriculture. In agricultural sector, weather information system, market information, insect-pest surveillance, internet, e-agriculture, agricultural information databases and other applications are used commonly in extension services, as reported by (Aliyu and Umar 2019). In Africa, this advancement in ICT is ushering in new opportunities for African farmers to improve their knowledge and livelihoods (Salau and Saingbe 2008). As reported by Albert (2014), agricultural extension services delivery all over the world has been concerned with communicating research findings and improved agricultural practices to farmers. In Nigeria,

agricultural information comes mainly from research institutions which generate new technologies to farmers. Thus, it follows that the agricultural research information service Centre is the custodian of several information resources including agricultural information providers such as international organizations, non-governmental organizations, and community based organizations, farmers' magazine, newspapers, posters, leaflets, handbooks, radio, television, videos and the mobile telecommunication systems (Thanuskodi, 2010).

E-resources requires computer access or any electronic product that delivers a collection of data, be it text, referring to full-text bases, electronic journals, image collections, other multi-media products and numerical, graphical or time based as a commercially available title that has been published with an aim to be marketed (Idiaka *et al.,*2016). For users, E-resource has the advantages of time and place convenience, ability to search directly on text, ability to link to further reading material and ability to disseminate and share information (Salau and Saingbe, 2008).

The influence of technology in agriculture has been established over the years with the introduction of chemicals, fertilizers, labor, improved seeds and better farming methods and systems. The introduction of various relevant e-resources in agricultural information dissemination could help farmers' access market information, land resources and services, management of pests and diseases and rural development programme (*Meera et al., 2004*). Agricultural extension agents need to keep abreast of information and developments in their areas of specialization. This is because they are actively involved in improving animal and plant species, technology and sustaining best practices necessary for meeting production in the agricultural sector. There is a paradigm shift in the way people now collaborate and network with the advent of the internet, which indeed is a network. The aim of this study is to ascertain the use of e-resources among extension agents in Katsina state. Specifically, the study finds out the e-resources tools available to extension agents and the factors influencing the use of e-resource was also examined.

MATERIALS AND METHODS

Study Area: The study was carried out in Katsina State. Katsina is located in the North-Western region of Nigeria. The state covers an area of 24,192sq.km and is located between latitudes 12°15′N and longitudes 7°30′E. The climate is semi-arid with average annual rainfall of about 689mm' falling between May and September. The major crops grown in the state are maize, cotton, groundnut, millet, sorghum, cowpea and vegetables among others. The state lies within three agro-ecological zones: Sahel savannah, Sudan savannah and Northern-Guinea savannah. The state is bounded by Niger Republic to the North, Jigawa and Kano States to the east, Kaduna State to the south and Zamfara state to the west. Katsina state has rich cultural values with annual rainfall ranging from 80mm to 100mm.

Sampling Procedures: A two-stage sampling technique was used to select the respondents for this study. In the first stage, Funtua and Dutsin-Ma Agricultural Zones were purposively selected from because they have the highest number of extension personnel owing to greater intense agricultural activities among the three ADP Zones in Katsina State. The second stage involved a proportionate random selection of extension agent from the two zones. This result to selecting thirty-six (36) respondents from zones II (Funtua) and thirty-eight (38) respondents from zones III (Dutsin-Ma) of KTARDA making a total of seventy-four (74) respondents for the study.

Analytical Model: The Probit regression model was used to determine the factors influencing the e-resource utilization among the extension agent. The model is specified in explicit form as:

$$Y = \alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6 X_6 + \beta_7X_7 + \beta_8X_8 + \mu$$

Where,

Y_i = Dependent variable (E-resource usage=1, 0 otherwise)

B= Parameter
X_1 = Age (years)
X_2 = Gender (1 = male, 0 = female)
X_3 = Marital Status (married; = 1, 0 otherwise).
X_4 = Household size (number)
X_5 = Educational level (years)
X_6 = Working Experience (years)
X_7 = Income (naira)
X_8 = Computer Literacy (literate = 1, 0 otherwise)
μ= error term

RESULT AND DISCUSSION

Socio-economic Characteristics

The result in Table 1 shows that most (50%) of the respondents were 41-50 years old, which suggest that the extension personnel were middle aged with the mean age of 41.49 years. Ezeh (2013) reported the productive age range of extension agents to be between 40 and 60 years of age. Therefore, this implies that majority of the respondents were within the economic active/productive age which could enhance their use of innovations in extension service delivery including e-resources while the least age range 21-30 were just 5.40% of the sample population. The results is in line with the findings of Kehinde et al., (2015) who reported that, none of the agricultural extension agents is below the age of 20 and majority (41 – 50 years) constituting the active work force in study conducted on the training needs assessment on the use of social media among extension agents in Oyo state, Nigeria. Similarly, this also agrees with the findings of Yakubu et al, (2013) which reported that majority (48.8%) of the extension agents within the range of 41-50 were in their middle ages and are therefore old enough to take decision on the use of ICTs. The results revealed majority of the extension agents were male (87.80%) and married 93.20% while relatively few 12.2% were females. The result is in consonance with the findings of Purnomo et al. (2010) in their study on the assessment of readiness and barriers towards ICT programme implementation: perceptions of agricultural extension officers in Indonesia. This implies that there were more male extension agents in the study area. Kehinde et al. (2015) further noted that, the dominance of agricultural extension service work by male gender is not good for gender equality in extension services.

Table 1 further reveals that respondents had different educational levels ranging from Diploma to Doctorate degrees and 45.90% having OND/NCE as the highest qualification, 35.14% were HND holders, 13.51% were BSc holders and 5.40% were MSc, as their highest educational level attained. This finding is similar with the work of Idiakke-Ochei *et al*. (2016) in their work on Information-seeking behaviour of extension personnel in Edo State, Nigeria that majority (52.6%) of the respondents were literate having OND/NCE as their major qualification. This therefore indicates that, the entire respondents had one educational qualification or the other; they were therefore literates and could utilize e-resources tools to improve their work as change agents and this also indicates they have basic educational knowledge to understand the technicalities of e-resources tools and there is a higher probability that they can handle it and use it effectively for specialized purposes such as for disseminating agricultural information. Findings also showed that the majority (60.80%) of the respondents received N50, 000-100,000 (60.81), (29.73%) earned <50,000 while (9.46%) received between 100,001-150,000 as monthly income. This entailed that the extension agents were average earners; hence they may possess the financial power needed to procure and utilize e-resources tools. The mean household size was 6.91 persons. This means that extension workers in the area had considerable large household size.

Table 1 Distribution of Respondents According to Socio-economic Characteristics (n=74)

Characteristics	Frequency	Percentage	Mean
Age (Years)			
21-30	4	5.40	
31-40	28	37.80	
41-50	37	50.0	41.49
51-60	5	6.80	
Gender			
Male	65	87.80	
Female	9	12.16	
Marital status			
Single	2	2.70	
Married	69	93.20	
Divorced	3	4.10	
Household size			
1-5	29	39.20	
6-10	34	45.90	6.91
11-15	9	12.20	
16-20	2	2.70	
Educational level			
OND/NCE	34	45.95	
HND	26	35.14	
B.SC	10	13.51	
M.SC	4	5.40	

Source: Field Survey, (2021)

Accessibility of E-resources tools

The result in Table 2 revealed that 86.50% of the respondents have access to Email, 78.5% accessed WhatsApp, 77.00% have access to E-radio and 77.00% also have access to Facebook, 62.20% accessed U-tube, 60.80% accessed Twitter, 39.20% accessed E-journal, 35.10% have access to E-magazine, 33.80% have access to E-agriculture, 27.00% have access to E-marketing, 25.70% have access to Online database, 18.90% have access to E-commerce, 18.90% accessed E-video conferencing and lastly 17.60% have access to E-library

Table 2: Distribution of respondent by accessibility to e-resources tools

E-resources tools	Frequency	Percentage (%)
Email	64	86.5
WhatsApp	58	78.4
Facebook	57	77.0
E-radio	57	77.0
U-tube	46	62.2
Twitter	45	60.8
E- journal	29	39.2
E-magazine	26	35.1
E -agriculture	25	33.8
E -marketing	20	27.0
Online databases	19	25.7
E-video conferencing	14	18.9
E-commerce	14	18.9
E-library	13	17.6

Source: Field Survey, (2021).

Factors influencing the usage of e-resources tools by Extension Agents.

The result of the probit regression analysis in table 10 shows the factors that influence the usage of e-resources among extension agents in Dutsin-ma and Funtua Agricultural Zones of Katsina State. From the result, four variables were significant out of the eight variables considered for the analysis. The result shows that age of the extension agents was negatively significant at 5% probability level. This connotes that, there is a negative relationship between age of the respondents and e-resources usage. This implies that as the age of the extension agents increases, it would give rise to decrease in e-resources usage.

Also, the household size was positively significantly at 1%. This means there is more likelihood for extension agent with larger household size to use e-resources for their activities. Large household size could predispose members to varied sources of agricultural information (Anyoha et al., 2010). This can be that the household members who are literate will assist in the use of e-resources. This is similar to the findings of Benjamin et al,.(2020) which revealed that smallholder farm families in developing countries such as Ghana tend to have large household size which serves as a source of agricultural labor.

Education was positively significant at 5%. This connotes that there is more likelihood for extension agents to use e-resources. Level of education increases the magnitude of respondents' perception of the benefits derivable from the use of e-resources in extension delivery (Ajuka et al, .2013). This is in agreement with a priori theoretical expectation. The study corroborate with the study of (Mtega et al., 2014) who revealed that the use of e-resources increased with an increase in level of education of the agricultural researchers and extension staff and decreased with an increase in age of the respondents respectively. Also this result is in consonance with the findings of Salau and Saingbe (2008 as stated by Ajuka et al, .2013) that the higher the level of education, the higher the level of ICT utilization. Computer literate was also significant at 1% level of probability. This connotes that there is more likelihood for the extension agents to use e-resources.

Table 3: Probit Estimate of factors influencing the usage of e-resources tools by Extension Agents in Dutsin-ma and Funtua Agricultural Zones of Katsina State.

Variable	dy/dx	Regression Coefficient	Standard Error	Z-value
Age	0.02026	-0.18500*	-0.09064	-2.04
Sex	0.03271	0.73402	0.14260	0.53
Household Size	-0.05605	0.05117***	0.01420	3.60
Level of Education	0.01050	0.09588***	0.02661	5.80
Working Experience	-0.00446	-.04074	0.06287	-0.65
Monthly Income	-8.74e-07	-7.97e-06	0.00013	-0.62
Computer Literacy	0.03830	0.67749***	0.06920	9.79

Source: Field survey, 2021. ***Sig@1% *Sig@10%

CONCLUSION

The study concludes that E-resources exploration productively enhanced the extension service delivery in Katsina state. it is of paramount importance therefore that the use of e-resources among extension agents in Katsina State is encouraging, this is because email, whatsApp, facebook, e-radio, e-video conferencing, e-library, online databases, e-commerce were the most available, accessible and frequently used. Moreover, findings revealed that lack of skills in e-resources usage, low literacy level of extension agents, distance of internet connectivity from office, high cost of e-resources facilities, very limited access, lack of money to access the e-resources tools, lack of skill in e-resources usage, low literacy level of extension agents, very limited access to internet. The following recommendations were therefore put forward.

i. Capacity building that will foster the intellectual development and increase the horizon of the extension agents should be organized by the research institution
ii. Institutional management should priotise the use of ICT by the use of down to-the-earth facility so that the extension agent can be ICT compliant and be well informed.
iii. Government should provide internet access to extension workers, as well as the requisite e-resources tools like online databases, e-marketing and e-journal.
iv. Government should develop electronic institutional repositories for researchers output so that extension agents/staff can access local contents immediately to help solve practical problems faced by local farmers.

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Rain-fed Food Crops Production, Extension Challenges and Adaptation Strategies by Women Farmers in Ebonyi State, Nigeria

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ABSTRACT
This study was designed to analyse rain-fed food crops production, extension challenges and adaptation strategies by women farmers in Ebonyi State. The specific objectives were to describe the socio-economic characteristics of women farmers under rain-fed farming in Ebonyi State, identify food crop extension challenges to women farmers under rain-fed farming and to determine factors that influenced yield of rain-based major food crops (yam, maize, cassava, rice) by women farmers in Ebonyi State. Descriptive and inferential statistics were used as tools for analysing data. Multi-stage random sampling technique was employed to select 120 women farmers. The primary data generated were analysed using both descriptive and inferential statistics such as frequency distribution tables, percentages, Pearson's Moment Correlation and Ordinary Least Square(OLS) multiple regression technique. Among the functional forms tried namely the linear, exponential, cobb-douglas and semi-log functional forms, only the cobb-Douglas form gave the best fit and therefore was chosen as the lead equation with a high R^2 value of 0.831. The results showed that age of farmers, marital status, household size and farming status of the farmers had positive influences on rain-fed food crop production. The regression estimates revealed that age, level of education, farming experience, farm size, extension contact and use of labour had direct relationships on output of rain-based food crops. The result of Pearson's Moment Correlation showed that there was a positive correlation between the output of rice and amount of rainfall at 5% level of probability. The result further revealed a negative relationship between the quantity of cassava produced and amount of rainfall. This implies that cassava production does not rely much on high amount of rainfall. Governments should further train extension agents on issues of rain-fed crop production to help them acquire the needed knowledge which they could in turn impact on women farmers to adopt to necessary changes needed in rain-fed crop production.
Keywords: Adaptation, challenges, extension agents, rain-fed crop, production

INTRODUCTION
Rain-fed agriculture is a type of cultivation that does not use any form of irrigation but depends on rainfall for crop cultivation. It accounts for more than 95% of farmed land in poor communities in Ebonyi State Nigeria. In Sub-Saharan Africa, more than 95% of the farmed land is rain-fed, while the corresponding figure is almost 90% for South Asia (FAO STAT, 2005). Despite large strides made in improving productivity and environmental conditions in these developing countries, a great number of families in Africa and Asia still face poverty, hunger, food insecurity and malnutrition where rain-fed agriculture is practiced. The common characteristics of rain-fed agriculture especially in tropical and the semi-arid agro ecosystem are low crop yields that are far below potential yields attainable in the regions, and areas of farm water losses. For example, cereal yields from rain-fed cultivation are generally around 1+ha^{-1} (Rockstrom,2001) as against potential yields of 3-5tha^{-1}(Barron, 2004) attainable in the region.

Ebonyi State is one of the States in Nigeria often referred to as food baskets of the nation; in spite of wide spread practice of rain-fed agriculture. It produces a wide variety of crops such as rice, cassava, cocoyam, potato and vegetables among others(Wikipedia,2012). The farmers in the State are overwhelmed by myriad of problems within their production environment including marketing information in local dialects, unreliable weather forecast and lack of latest improved technologies for managing agricultural risk as it concerns rain-fed farming. As reported by Ikeme (2009). Nigeria has experienced increasing incidence of diseases, declining agricultural productivity, increasing number of heat waves, unreliable or erratic weather patterns, flooding and declining rainfall. In Ebonyi State less than 7% of the land is irrigated (IFAD 2009 a). The general objective of the study is to analyse food crop production, extension challenges and adaptation strategies by women farmers under rain-fed farming in Ebonyi State Nigeria. Specific objectives are to describe the socio-economic characteristics of women farmers under rain-fed farming in Ebonyi State; identify food crop extension challenges to women farmers under rain-fed farming and to determine factors that influenced yield of rain-based major food crops (yam, maize, cassava, rice) by women farmers in Ebonyi State.

MATERIALS AND METHODS

The study was conducted in Ebonyi State, Nigeria. The State has a total number of thirteen Local Government Areas(LGAs) that are demarcated into three agricultural zones namely: Ebonyi North, Ebonyi Central and Ebonyi South Zones. The people of Ebonyi State are predominantly farmers. They grow crops like cassava, rice, yam, cocoyam, maize, vegetables, fruits and as well as keeping of some small ruminants and rearing of cattle(Echiegu,2002). There exist huge salts deposits at Okposi and Uburu salt lakes, the biggest salt deposit in Nigeria. The population for the study was rain-fed food crop women farmers in Ebonyi State Nigeria. Data were collected with the aid of a structured questionnaire that was administered to the respondents. A five stage random sampling technique in selecting Agricultural Zones, local government areas, communities, villages and the farmers. In the first stage, two out of the three agricultural zones were randomly selected for the study. In second stage three local government areas were randomly selected from each of the chosen agricultural zones to give a total of six local government areas for the study. In the third stage, two communities were randomly selected from each of the six local government areas to give a total of twelve communities. In the fourth stage two villages were randomly selected from each of the twelve communities to give a total of twenty-four villages. At the final stage a random sample size of five women farmers was taken from the list of farmers in each village to give a sample of one hundred and twenty (120) rain-fed food crop women farmers.

RESULTS AND DISCUSSION

Socioeconomic findings revealed that age of farmers and their level of education had a very high significant but negative influence on the yield of major rain-fed grown crops in the area. Farming experience and number of contacts with extension officers had very significant but positive influence on yield of major rain-fed grown crops between 2013-2020.Pest and diseases, high cost of inputs, small farm holdings, poor supporting infrastructure, inadequate improved varieties, low technological utilization were the major challenges being encountered on the farmers of rain-fed food crops. The output of rice had a positive relationship with the incidence of rainfall and was significant at 5.0% alpha level of probability.

CONCLUSION

From the findings of the objectives, it showed that rice production required reasonable amount of rainfall for effective production. However, there was negative relationship between quantity of cassava and maize produced and amount of rainfall. Cassava production required minimal amount of rainfall for it to survive and grow well. There was a positive relationship between output of maize and quantity of rainfall. Maize production requires moderate amount of rainfall. Pest and diseases affected rain-fed crops seriously. This showed the precarious nature of rain-fed crops.

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Table 1: Determinants of Yield of Rain-Fed Crops of Women Farmers in Ebonyi State

Variables	Linear	Exponential	Cobb Douglas	Semi log
Constant	369661.654	10.884	11.250	584438.398
	(3.190)***	(19.863)***	(7.296)***	(1.722)*
Age	-9082.355	-0.022	-1.232	-469035.640
	(-5.419)***	(-2.744)***	(-3.261)***	(-5.642)***
Marital Status	33740.745	0.148	-0.005	-17175.216
	(1.048)	(.970)	(-.037)	(-.566)
Education	-15879.491	-0.071	-2.104	-372296.382
	(-1.222)	(-1.154)	(-3.003)***	(-2.414)**
Farm	22882.529	0.088	2.743	580118.288
Experience	(6.273)***	(5.121)***	(7.466)***	(7.175)***
Farm income	0.184	4.297	0.144	62150.278
	(2.338)**	(1.158)	(1.451)	(2.837)***
Extension	72498.676	0.857	0.934	92655.167
contact	(1.503)	(3.760)***	(4.944)***	(2.228)**
Farm Size	55689.805	0.120	0.526	229153.464
	(3.480)***	(1.580)	(2.396)**	(4.742)***
Labour	-26798.439	0.338	0.368	23791.643
	(-.572)	(1.527)	(1.849)*	(.544)
R^2	0.729	0.798	0.831	0.754
F-ratio	37.314***	54.792***	68.081***	42.549***

Source: Field survey 2014. *** significant at 1%, ** significant at 5%, * significant at 10%;+ indicates lead equation while figures in parentheses are the t-ratios.

Effect of E-wallet on Cassava Farmers in Nkanu East Local Government Area of Enugu State, Nigeria

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ABSTRACT
This study was designed to analyse the effect of E-wallet on cassava farmers in Nkanu East local Government area of Enugu State. The specific objectives were to describe the socio-economic characteristics of the beneficiary farmers, ascertain farmers' perception on the effectiveness of E-wallet practices in agricultural food production, identify the challenges/constraints faced by farmers in the scheme. Descriptive and inferential statistics were used as tools for analysing data. Multi-stage random sampling technique was employed to select ninety (90) respondents for the study. The result showed that majority of cassava farmers in the area were females who were of middle age, married and had household size of the range of 6-10 people. Among the functional forms tried namely linear, exponential, cobb-douglas and semi-log functional forms, the linear functional forms are the best fit and therefore as chosen as the lead equation with a high R^2 value of 0.878. The regression estimates revealed that age, level of farming experience, marital status, annual income and farm inputs had a positive direct relationship on farmers' perception effectiveness of E-wallet practices in agricultural food production. The challenges encountered in the scheme are inadequate fertilizer and seeds, poor telephone network and cumbersome procedure of accessing the inputs, poor logistics and low level of awareness. Government should, institutionalize necessary procedure so that the verification process would be made simple for farmers. Also cooperative formation among farmers should be encouraged to make assessment of funds much easier.
Keywords: E-wallet, cassava farmers, challenges, perception

INTRODUCTION
Agriculture has been the main stay of the Nigerian economy for several years and is still contributing significantly to the Gross Domestic Product (GDP) of the country. Agriculture is the bedrock of economic growth and development in the developing countries. Agriculture has the potential for employment generation, food security and poverty reduction in Nigeria. This potential however has remained ineffectively untapped over the years. Agricultural production in Nigeria is mainly carried out by farmers in rural areas. Most of the farms are fragmented, have low input and low output. The usage of farm machines, fertilizer and improved seeds has been very low. According to IFDC (2013), the average usage of fertilizer in Nigeria is 13kg/hectare while the meantime rest of the world average annual usage in Asia reached up to 150kg/hectare.

The E-wallet approach is designed for smallholder farmers, who appear the most hit and vulnerable by the impropriety in the fertilizer and other input distribution apparatus of the Ministry of Agriculture. The criteria for farmer participation include; farmers being above 18 years old, have participated in a survey authorized by government to capture farmers personal detailed information, must own a cell phone with a registered SIM CARD and have at least fifty-naira credit in the cellphone. The fulfilment of these conditions guarantees the issuance of e wallet voucher to the farmer. The voucher is used to redeem fertilizers, seeds and other agricultural inputs from agro-dealers at half the cost (Signal Alliance, 2014). Adebo (2014) further highlighted that for an agro input dealer to participate in the program, the individual must own a cellphone with a registered SIM CARD, understand the process of using e-wallet, and attend training program designed for the project.

The general objective of the study was to show the effect of E-wallet among farming households in Nkanu East Local Government Area of Enugu State. Specific objectives are to describe the socio-economic characteristics of the beneficiary farmers, ascertain farmers perception on the effectiveness of E-wallet practices in agricultural food production, identify the challenges and the constraints faced by farmers in the scheme.

MATERIALS AND METHODS

The study was conducted in Nkanu East Local Government Area of Enugu State. Nkanu East Local Government Area shares boundaries in the south with Uburu in Ohaozara local government area of Ebonyi State, Isu in Onicha local government area of Ebonyi State and in the south west, it shares boundaries with towns like Nenwe, Oduma, Ogbaku and Agbogugu all in Awgu local government area of Enugu State. Udi and Ngwo communities bound Nkanu in the Western part, while it is bounded with Ezza in the East.

Nkanu East local government area comprises of thirteen (13) communities namely, AKpawfu, Ugbawka, Nkerefi, Mburubu, Nomeh Unateze, Nara Unateze, Owoh, Ubahu, Amaechiildodo, Amankanu, Oruku, Amagunze and Ihuokpara. The people of Nkanu East grow crops such as oil palm, oil bean, bread fruit, cassava and yam. They are also predominating in goat and poultry rearing. Other economic activities being practiced by the people are petty trading, hunting, palm wine tapping, civil service and barbing. Data were collected with the aid of structured questionnaire that was administered to the respondents.

A multi stage random sampling was used to select respondents. The first stage was random selection of six communities from the local government area. The communities were Nkerefi, Ugbawka, Nara Unateze, Ihuokpara, Nomeh and Mburumbu. The second stage involved the selection of six villages namely Enuogu, Imeoha, Isigwe, Umuokparangene, Isiogbonara and Amofu. The final stage involved random selection of fifteen (15) farmers from each of the selected village to give a sample size of ninety respondents.

RESULTS AND DISCUSSION

As showed in Tables 1-4, socioeconomic findings revealed age, marital status, reasonable household size and long experience associated with farming played a great role in the acceptance of E-wallet scheme. Age, marital status, farming experience, education, farm inputs and annual income were variables that significantly influenced food production in the E-wallet systems.

CONCLUSION

Based on the findings of the study, it was concluded the e wallet, an innovative and motivational mobile technology was designed to assist farmers to access agricultural inputs, without intervention of the middlemen, thereby increasing the yields and output of farmers. It also removed corruption on fertilizers and renewed farmers' confidence in government program. The study also revealed that effectiveness of E wallet is influenced by practices such as availability, quality and cooperation. However, the scheme was not without some weakness, including inadequate quantities of inputs, allocated to each farmer, late supply of inputs, poor mobile network coverage, few numbers of redemption centers, low level of awareness and cumbersome procedure in getting approval from cellulant.

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Table 1: Distribution of Respondents According to Age

Age	Frequency	Percentage
21-30	9	10
31-40	21	23.3
41-50	38	42.2
51-60	22	24.5
Total	90	100

Source: Field survey, 2021

Table 2: Distribution Respondents According to Marital status

Marital status	Frequency	Percentage
Single	9	10
Married	40	44.5
Widowed	31	34.4
Separated	10	11.1
Total	90	100

Source: Field survey, 2021

Table 3: Distribution of Respondents according to Household size

Household size	Frequency	Percentage
1-5	44	48.9
6-10	46	51.1
11-15	0	0
16-20	0	0
Total	90	100

Source: Field survey, 2021

Table 4: Distribution of Respondents according to farming experience

Farming experience	Frequency	Percentage
4-8	24	26.7
9-14	44	48.9
15-20	18	20
21-35	4	4.4
Total	90	100

Source: Field survey, 2021

Table 5: Regression Estimates of the factors that affected farmers' perception on the effectiveness of E wallet system.

Variables	Linear+	Exponential	Cobb Douglas	Semi-log
Constant	-547.236	8.911	-763	7.241
	(-3.575)	(15.697)	(-1.321)	(17.683)
Age	1683.766	-0.011	-0.004	0.005
	(2.323)***	(-0.73)	(-0.354)	(0.71)
Gender	-1285.166	0.001	0.006	0.003
	(-0875)	(0.536)	(1.136)	(0.748)
Marital status	108.223	127046.221	0.435	127058.209
	(0.263)***	-(0.642)	(3.226)***	(4.226)***
Household size	-0.003	0.004	0.006	0.544
	(-0.141)	(0.824)	(1.008)	(1.331)
Farming experience	0.56	453.402	4.331	0.223
	(4.125)***	(0.523)	(7.562)***	(0.335)
Education	2113.243	244.263	0.001	-0.005
	(2.356)***	(0.438)***	(0.417)	(0.43)***
Income	26.082	12010.7	0.826	12036.5
	(3.136)***	(0.143)	(4.782)	(0.155)
Farm Inputs	31.0474	5923.32	7553.21	0.166
	(3.103)	(1.302)	(1.432)	(1.337)
R^2 value	0.878	0.761	0.773	0.825
F-ratio***	2816.246***	193.624***	191.622***	192.446***

Source: Field survey, 2021

***Significant at 1%, **significant at 5%,*significant at 10%, + indicates lead equation while figures in parenthesis are the t-ratios.

Table 6: Constraints to Farmers Access to Inputs in the E-wallet scheme in Nkanu East Local Government Area

Constraints	Frequency	Percentage
Lack of education	10	4.7
Poor logistics	20	9.5
Insufficient seed	10	4.7
Insufficient fertilizer	40	19.0
Low level of awareness	30	14.2
Cumbersome procedure	12	5.7
Low density	30	14.2
Poor telephony network	15	7.1
Bureaucratic bottleneck	20	9.5
Quality of farm inputs	15	7.1
Poor living conditions	8	3.8

Source: Field survey, 2021. Multiple responses

Agribusiness: Value Chain for Sustainable Economic Development in Nigeria

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ABSTRACT
The paper examines the challenges hindering agribusiness value chain in stimulating sustainable economic development in Nigeria. The dominant variables militating against agribusiness value chain were inadequate technological expertise, lateness in input disbursement in agribusiness value chain and mismatch between education and employment. To carry out this research, one hundred copies of structured questionnaire based on the Likert 5-point scale were distributed and analyzed using Statistical Package for the Social Sciences (SPSS). The study used descriptive, random sampling and inferential statistics to analyze the data. Based on the findings, it was discovered that technological expertise is the key antecedent for agribusiness value chain to stimulate sustainable economic development in Nigeria. Again, mismatch between education and employment showed significant relationship with sustainable economic development. Some other factors analyzed showed positive relationship such as poor social amenities and economic exclusion, inadequate market linkage and physical infrastructure and lateness in input disbursement. The study, therefore, strongly recommends that agribusiness value chain to function effectively requires technological expertise and mismatch between education and employment to be reviewed positively to enhance faster sustainable economic development in Nigeria. More so, the government has to minimize lateness in input disbursement, provision of social amenities and economic inclusion of rural dwellers, provision of good market linkage and physical infrastructure will boast sustainable economic development in Nigeria.

Keywords: agribusiness value chain, mismatch between education and employment, economic exclusion

INTRODUCTION
Agribusiness value chain is the paradigm for sustainable economic development worldwide. Agribusiness value chain which comprises of industrial experts, agribusiness managers and other parties namely producers, processors, marketers, government agents till the final consumers. In recent time, the concept of agribusiness value chain is associated with agricultural development practitioners in development countries and there is no commonly accepted definition of agribusiness value chain. Several authors have described value chain from different perspectives, Kaplinsky and Morris (2001) emphasized that value chain involves several activities or services from conception throughout different stages of production or services thereby add value to the various links till it is delivery to final consumer and its final disposal after use. Similarly, International Finance Corporation (IFC, 2013) concedes that agribusiness refers to the business activities that start from the farm to conversion of agricultural products and their supply to the final consumers.

The IFC (International Finance Corporation, 2013) further classified sustainable agribusiness to involve stable financial, social and environmental issues that certify regular supply chain of business. Basically, agribusiness value chain successions are complex and involve growers, input providers, government agencies, processors packagers, distribution companies, exporters and various agents who work as a team to increase product value and improve competitiveness and profits (International Finance Corporation, 2013; Keshelashvili, 2018).

Nevertheless, it has been a worrisome situation for some decades that the standard of living of the rural dwellers remain very poor particularly those from developing economies and there have been series of initiatives by different governmental bodies, and organizations on strategies to help rural dwellers worldwide. Ibuathu and Kubaison, (2013) admit that youth population estimated to 1.2 billion and above 80 percent of the global youths exist in Africa, Asia, Oceania where agriculture provide approximately 35 percent of employment. Besides, Nigeria is blessed in vast wealth of natural resources, favourable climate and rare minerals, growing market opportunities yet have highly under-utilized labour force in agribusiness mainly resident in the rural areas (Manuemelula, 2013).

The massive youth unemployment has negative financial cost burden on families, both in terms of reduction of human and social capital, loss of opportunities for economic growth for present and future generations and increase in social evils in society (Ibuathu and Kubaison, 2013; Afande *et al*., 2015). Thus, the employees and the agribusiness practitioners would pay taxes, thereby contributing to government revenue. Furthermore, FAO (Food and Agriculture Organization, 2014) posits that agribusiness value chain adds value to five outstanding components in economic development: i) salaries for workers; 2) return to assets (profits) to entrepreneurs and asset owners; 3) tax revenue to the government; 4) better food supply to consumers, and 5) net impact on the environment, positive or negative.

In response to the clarion-call on the devastating state of rural dwellers, on 6th March 1973, the Federal Government of Nigeria (FGN) established Nigeria Agricultural and Cooperative Bank as Nigeria Agricultural Bank limited and in 2000, following merger of National Agricultural Cooperative Bank, People's Bank and Risk Assets of the Family-Economic Advance Programme (FEAP), Nigeria Agricultural Cooperative and Rural Development Bank (NACRDB) came into existence wholly owned by the FGN, funded with capital base of #50 billion, have six zonal offices and 200 branches in the federation. The bank is mandated to finance and credit facilities to agricultural and agro-allied industries, issue loans to farmers, agricultural institutions, organizations and cooperatives, provision of guarantees to viable agricultural and agro-allied and rural saving scheme (Bureau of Public Enterprises (BPE) 2018). The NACRDB lending channels are through cooperatives financing, non-government programme, investment and special project, usually in collaboration with international financial institutions and donor agencies such as International Fund for Agricultural Development (IFAD), International Labour Organization (ILO) and Economic (ECOWAS). Since, 2012 the Federal Government of Nigeria in collaboration with IFAD has taken a holistic and demand-driven method to addressing hindrances along cassava and rice value chains adopted an inclusive strategy, strengthening the capacity of actors which include producers, processors, service providers, police-makers and regulator from six states Anambra, Benue, Eboyi, Niger, Ogun and Taraba and in 2016, another poverty alleviation programme was started in the Northern refers to as Community-Base Agricultural and Rural Development Programme (CBARDP) aim to improve the livelihoods and living conditions of the poor rural communities in Nigeria (FGN/IFAD/VCDP 2016).

Statement of problem

The rural dwellers despite their dependence on agribusiness, live in abject poverty, and are malnourished. The phenomenon is associated to poor social amenities and economic exclusion, lack amenities and infrastructure, inadequate technological expertise, mismatch between education and employment, lateness in input disbursement, poor storage and processes facilities, lack professionalism and training in agribusiness value chain, inadequate market linkage and physical infrastructure. This study therefore, bring into focus agribusiness as indispensable option for sustainable economic development in Nigeria.

Purpose of the Study

The study examines agribusiness value chain leverage on sustainable economic development in Nigeria. In addition, the study intends to identify possible problems and making the necessary recommendations.

Study Objectives

The objectives of this study is

i) To examine five constraints militating against agribusiness value chain leverage on sustainable economic development: whether inadequate technological expertise; whether mismatch between education and employment; whether inadequate market linkage and physical infrastructure; poor social amenities and economic exclusion and whether lateness in input disbursement.
ii) To find ways through which International Organizations, the government of Nigeria, the public versus private partnership can intervene particularly to the situation of the rural dweller engaged in agribusiness for improvement of their livelihood, thereby reduce poverty level, malnutrition as well other issues.

METHODOLOGY

The study employed descriptive survey, utilize both primary and secondary sources of data collection: Imo State, Anambra State and Abia State. The research instrument adopted for the study is questionnaire administered randomly by hand to one hundred respondents from the selected states which captured opinions of youths, farmers and those engaged in other services resident in the rural areas. The respondents comprise of the producers, processors, marketers, input providers, government agencies, agro-based industries and various agents that work on produce till it get to final consumers. The respondents were asked to indicate their agreement in respect of each structured statement contained therein in five categories. Personal interviews were conducted along with the questionnaire. One hundred completed questionnaires were retrieved. The questionnaires were the primary data collection instrument because it is the most commonly used tool to obtain facts and opinion about a phenomenon. Several authors have credited the use of questionnaire (De Vos *et al.,* 2002; Nyanga, 2013; Manuemelula, *et al*., 2013). Furthermore, large samples (100) provide us with more confidence to obtain more accurate result (Gabrenya, 2003). The earlier works of Nyanga (2013) as well as Awojobi and Adeokun (2012) model a methodology that worth emulation, the prototype of this research process.

The study employed Likert five-point scales which measures the perception of respondents from different points of view in the study objectives. The study adopted multiple regression approach using Statistical Packages for Social Science (SPSS) to analyze the collected data. Simple descriptive statistics such as percentage, mean and standard deviation were used to describe most of the data collected from respondents. An alpha level of .05 was used for the study, with statistical significance accepted, where P-Value was <0.05.

RESULTS AND DISCUSSION

Correlation coefficient is significant at the 0.05 level. A significant model emerged, F4,40 = 60.325, p< 0.05. Adjusted R square 84% (R^2 = .846). Analysis of the respondents' answers from 100 questionnaires was carried out with the aid of Statistical Package for Social Science (SPSS) and employed multiple regression statistical technique to predict the degree of relationship between the power sector and agricultural productivity. A significant model emerged, $F_{4,40}$=60.325, P-Value of 0.000 is less than 0.05. The model accounts for 84% (R^2 =0.846) of variance between agribusiness value chain and sustainable economic development. The model is well fitted. Significant variables are shown below:

Table 1 Predictor and Criterion Variable Results

Predictor Variable	Criterion Variable	
	Beta	**P-Value**
i) Inadequate technological expertise	1.078	0.000*
ii) Mismatch between education and employment	0.776	0.000*
iii) Inadequate market linkage and physical infrastructure	0.241	0.002*
iv) Poor social amenities and economic exclusion	0.341	0.002*
v) Lateness in input disbursement	0.235	0.002*

Source: Analysis of Data, 2021 * significant

Table 1 shows that among the five variables the Standardized Beta coefficient between inadequate technological expertise is 1.078 and the Pearson correlation value (P-Value) is 0.000 which is smaller than 0.05 levels. A big absolute t value and small p value suggests that a predictor variable is having a large impact on the criterion variable. This is the highest score among the variables, showing perfect relationship between inadequate technological expertise and sustainable economic development in Nigeria. This suggests that for every unit increase in technological expertise in agribusiness value chain, holding all other variables constant will lead to increase in sustainable economic development in Nigeria.

Respondents overwhelmingly agree that inadequate technological expertise play critical constraints in sustainable economic development in agribusiness value chain in Nigeria. This finding corroborates with earlier work of Ibuathu and Kubaison (2013), lack of agribusiness skills are among the obstacles militating against employment in agribusiness. Mismatch between education and employment is another vital factor with coefficient 0.776 and a P-value of 0.000, which is significant at 0.05 level implying strong relationship with sustainable economic development in Nigeria. This suggests if education is directed towards the needs of the industrial sector for employment (inclusive agribusiness sector) it will promote sustainable economic development in Nigeria, holding other variables constant. Similarly, United Nations Economic Commission for Africa (UNECA) admits that mismatch between education and relevant skills are among the factors that causes massive youths unemployment.

Inadequate market linkage and physical infrastructure correlation is .241 with a P-value of 0.002 is significant at 0.05 level implying a relationship with sustainable economic development. This suggests that improved market linkage and physical infrastructure will boast sustainable economic development in Nigeria. Poor social amenities and economic exclusion is .0341 with the P-Value of 0.000. This suggests that increase in social amenities and economic inclusion of rural dwellers has positive effect on sustainable economic development in Nigeria. Again, lateness in input disbursement yield 0.235 with P-Value of 0.002 which is smaller than 0.05 levels. This suggests lateness in input disbursement also militates against sustainable economic development in Nigeria.

CONCLUSION

This study shows that in agribusiness value chain, inadequate technological expertise is the key antecedent to sustainable economic development in Nigeria. The second ranking among the variables is mismatch between education and employment which has significant relationship with sustainable economic development in Nigeria. The third ranking variable is poor social amenities and economic exclusion of the rural dwellers. The fourth variable is inadequate market linkage and physical infrastructure also is a constraint militating against sustainable economic development in Nigeria. Finally, the last variable is lateness in input disbursement is another factor militating against sustainable economic development in Nigeria.

The study, therefore, strongly recommend that agribusiness value chain to function effectively requires technological expertise, and the mismatch between education and employment need to be reviewed positively to enhance faster sustainable economic development in Nigeria. More so, the government has to minimize lateness to input disbursement to rural dweller, provision of social amenities and economic inclusion of rural dwellers as well as provision of good market linkage and physical infrastructure will boast sustainable economic development in Nigeria.

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Economics of Cassava Marketing among the Small-Scale Farmers in Ivo L.G.A of Ebonyi State, Nigeria

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ABSTRACT

The study investigated the economics of cassava marketing in IVO Local Government Area of Ebonyi State. Data for the study were collected using structured questionnaire administered to randomly selected 120 respondents. Data collected were analyzed using descriptive statistics, marketing margin analysis, marketing efficiency analysis and multiple regression analysis. The result of the socio-economics variables showed that 87.5% of the respondents were within the highly productive age-range of 21-50 years. Both males and females were involved in the marketing of cassava products in the study area; even though females dominated. Also, 78.3% of the married couples were involved in cassava products marketing. Similarly, the study equally showed that 65.8% of the respondents had formal education. The multiple regression analysis revealed that the coefficients for marketing experience, access to credit, cooperative membership and annual income had direct relationship with cassava products marketing; while the coefficients for age, gender, marital status and cost of marketing had inverse relationship with cassava products marketed. However, they were all significant at varied probability levels. The dominant constraints identified were, inadequate capital; poor supporting infrastructure and high perishability of the products. It is recommended that the Government should come to the aid of these resource-poor cassava product marketers by provision of infrastructural facilities to them so as to reduce premature rots and distress sales to enable them remain in the business, since it is very much rewarding and lucrative. This will not only enhance the efficiency of marketing activities, but also boost the income and the standard of living of the marketers in the study area.
Keywords: cassava marketing, cassava products, marketing efficiency, resource-poor

INTRODUCTION

Agriculture constitutes 70% of the principal livelihood of the world poor and it is the source of food security in most developing countries (Onwuemele, 2013). Nigeria is generally endowed with many natural and human resources. Its economy, although quite diversified relies more heavily on the petroleum and agricultural sector. Nigerian agriculture has been variously described as being characterized by low farm income level, low capacity to satisfy the food needs of the populace and low productivity level because of primitive production techniques are still being used by the farmers (Ohajianya and Onyenweaku, 2001.

The greatest challenge to the agricultural production in Nigeria is how to ensure increased food production and value addition of agricultural products. Thus, agricultural development focuses on credit and non-credit users to create a more effective, transformational approach that will achieve poverty alleviation, thereby hunger reduction for all, and also improve productivity between credit and non-credit users (World Food Programme, 2017). Cassava (*Manihot esculenta* Crantz) is one of the most productive and most important root crops in the tropics (Ezedinma and Oti, 2002). It derives its importance from the fact that it is starchy, thickened; tuberous roots are available, source of cheap calories, especially in developing countries where calorie deficiency and malnutrition are widespread (IITA, 2002). Over two-third of the total population of cassava is consumed in various forms by humans; and it is a major staple food crop for over 50 million Nigerians, providing more than 75% of their energy requirements in the cassava growing areas (Nweke, 2004). Cassava is a major staple food in the developing world, providing a basic diet for over half a billion people. It is one of the most drought-resistant crops, capable of growing on marginal soils. Nigeria is the world's largest producer of cassava, while Thailand is the largest exporter of dried cassava.

In Nigeria, cassava has moved from a food crop to a cash crop produced on an industrial scale and even exported (Obisesan, 2013). The introduction of a new high-yield cassava varieties and improved farming techniques has led to a boom in production. Cassava is produced largely by small-scale farmers using rudimentary farm implements, and most of the cassava produced is used for human consumption, with less than 5% being used in industries.

Cassava has many uses which gives the crop high potentials as a major foreign exchange earner in Nigeria. Products derived from cassava includes; garri, starch, tapioca, fufu, pellets, alcohol, flour, chips, glucose, and fuel (i.e. starch and gasoline), and can also be used as a livestock feed (IFAD, 2013). It has been eaten for centuries in various ways by indigenous people, and continues to be a staple food in local diets. The freshly harvested boiled tubers are eaten as the main starch in a meal, added to soup, and used as bases for other dishes or fried as chips or snack crisp (Abdul-Azeez), 2013).

Care (2004) described marketing as a tool that directs production along the line most suited to the consumer requirements. Thus, production is limited by the extent of marketing. Where the local markets are too small to absorb the increased output of the farmer, and the prospects for moving the local gluts to areas of scarcity are poor, then the producer incentives to production are likely to be dampened. However, where the local market with poor absorptive capacity is the only outlet, the farmers will be constrained to make their production decision or plan with the local market in view. Antonaci, Demeke, and Vezzani (2014) also asserted that a guaranteed market for farmers' produce was a risk averting measure and ready invitation to produce more. They further stressed that the marketing arrangement in any community should ensure that what is produced was either sold or stored.

Marketing channel is the sequence of intermediaries or middlemen and the marketers through which goods pass from the producers to the final consumers (Harris, 2007). Or it may refer to routes, avenues, or pathways through which goods flow from the producer to the final consumers (Ekerete, 2005). The marketing channel may be zero or multi-stage channels. The zero channel consists of the flow from the producer to the consumers directly, without any intermediary. The multi-stage channels consist of the middlemen through which it passes.
That is from the producer to the urban and rural wholesalers and the retailers (major flow). However, all these categories may not be exclusive because the producer can decide to sell directly to the wholesalers and the retailers (minor flow link).

Marketing margin refers to the price of cassava roots or its products received by both the wholesalers and the retailers (including day-to-day variations) in prices, grade differences, price variations over seasons and price differences in consumption and marketing areas (Kotter & Keller, 2009).

Marketing efficiency refers to the total estimated cost incurred by the marketing agencies, divided by the value of products sold and expressed in percentage (Arene, 1998). It is against this backdrop that this study sought to examine the economics of cassava marketing among the small-scale farmers in Ivo L.G.A. of Ebonyi state, Nigeria. Specifically, the objectives were to: (i) describe the socio-economic characteristics of small-scale farmers on the marketing of cassava, (ii) identify the marketing channels for the marketing of cassava, (iii) determine the factors affecting cassava marketing in the area, (iv) determine the marketing margin for cassava output in the area, (v) determine the marketing efficiency for cassava output in the area, (v) identify the problems associated with cassava marketing in the study area.

METHODOLOGY

Study area

The study was carried out in Ivo L.G.A. of Ebonyi state, Nigeria. It lies between latitudes 5°56' and 6°59' North of the Equator and longitudes 7°24' and 7°33' East of the Greenwich Meridian. It has its headquarters at Isiaka; and it is one of the thirteen Local Government Areas that make up Ebonyi state.

It has an annual rainfall range of between 1,500mm-2,500mm and an annual temperature range of between 28°C-30°C, with a relative humidity of 65%. It has a population of 220, 919 persons, and a large area of 3,506 km^2; most of which are fertile (NPC, 2006). It has two distinct seasons; the dry season which starts from November till March; and the rainy season which starts from April till October, with a short break in the month of August called "August break" (NPC, 2006). Its inhabitants are mostly farmers, petty traders, craftsmen, and civil servants. Among the crops grown in the area are cassava, yam, rice, okra, maize, sweet potatoes, and vegetables. They also raise some animals like sheep, goat, poultry, etc. Crush rock and SETRACO are the two major industries located in the area, which helps to boost economic activities through their stone quarrying. Ivo river and Ikwo river are the two main sources of water in the area.

Sampling procedure

Multi-stage sampling technique was used to select respondents for the study. Firstly, four (4) communities were selected randomly out of five (5) communities that make up the L.G.A , using simple random sampling technique. Secondly, three (3) markets were randomly selected from each of the four (4) communities already chosen in stage I. This gave a total of twelve (12) markets. Thirdly, ten (10) cassava marketers were randomly selected from each of the twelve (12) markets already chosen in stage II. Thereby giving a grand total of one hundred and twenty (120) respondents, made up of sixty (60) cassava wholesalers and sixty (60) cassava retailers which were used for a detailed study.

Analytical techniques

Data collected were analyzed using descriptive statistics, marketing margin analysis, marketing efficiency analysis, and multiple regression analysis.

Marketing Margin Analysis

This was used to determine the profitability of cassava marketing among the small-scale farmers, using Kotter & Keller's model. The model is expressed as:

$$\text{Marketing Margin} = \frac{SELLING\ PRICE - PURCHASE\ PRICE}{SELLING\ PRICE} \text{ X } \frac{100}{1}$$

Marketing efficiency analysis was used to calculate the efficiency in marketing; using **Shephered Futrel** model as captured by Arene (1998). The model is specified as:

$$\text{M.E.} = \frac{TC}{TR} \text{ X } \frac{100}{1}$$

Where,
M.E. = Marketing efficiency
T.C. = (purchase cost + marketing cost)
T.R = Total revenue

Multiple regression analysis
This was used to determine the influence of factors affecting cassava marketing in Ivo L.G.A. of Ebonyi state, Nigeria. Linear, exponential, semi-log, and double-log functional forms were fitted and tried; and on the basis of the magnitude of the R^2 value, the high number of significant variables and signs of the regression coefficients; linear functional form was chosen as the lead equation. The explicit form of the model is presented as thus:

$$Y=b_o+b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_5+b_6x_6+b_7x_7+\ldots b_nx_n+e_i = \text{equation (1)}$$

Where,
Y= output of cassava in tons/ha
X_1= age of the farmer (years)
X_2= gender (male=1; female=0)
X_3= marital status (married=1; single (0)
X_4= household size (numbers)
X_5= educational level (years)
X_6= marketing experience (years)
X_7= cost of marketing (₦)
X_8= annual income from marketing (₦)
X_9= cooperative membership (member=1, non-member=0)
X_{10}= access to credit (access=1, otherwise=0)
b_o= constant term
b_1-b_{10}= coefficients to be estimated
e_i= error term

RESULTS AND DISCUSSION
Analysis of the socio-economic variables of the respondents (Table I) revealed that the majority (87.5%) of them were within the age range of 21-50 years. This means that they are still in their active productive ages. The study also showed that 65.8% of the respondents had formal education. Thus, Onyeweaku and Nwaru, 2005) reported that education enhances one's readiness to understand and evaluate new production techniques. The study also revealed that both male and female were involved in the marketing of cassava in the study area; even though females dominated males in this case. It equally showed that 78.3% of the married couples were involved in cassava marketing, which emphasizes the importance of cassava as a source of food and income to the households. In the same vein, greater number of them (83.3%) had long years of experience in cassava marketing, but with a mean of 12.5.

The result of the estimated parameters is presented in Table II. Of the four functional forms that were fitted and tried with the production function models, the linear functional form was chosen as the lead equation based on the established economic theory.

The coefficients for marketing experience, access to credit, cooperative membership and annual income had direct relationships with cassava products marketing; while the coefficients for age, gender, marital status, and cost of marketing had inverse relationship with cassava products marketing. However, they were all significant at varied probability levels. In fact, these were all expected and are in accordance with a priori expectations.

CONCLUSION
The study revealed that there were males and females; including married people involved in cassava marketing in the area. Cassava output marketing activities involve a lot of intermediaries which invariably increases cost and purchase prices. Problems identified include; inadequate capital, poor supporting infrastructure, high perishability of products, inadequate processing facilities, inadequate marketing information, among others. It is recommended that the government should come to the aid of these resource-poor cassava product marketers in the study area.

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Table 1: Socioeconomic characteristics of Respondents

Variables	Frequency	Percentages (%)
Age in years		
21-30	10	8.30
31-40	35	29.20
41-50	60	50.00
51-60	15	12.50
Total	**120**	**100.~~00~~**
Gender		
Male	37	30.8
Female	83	69.2
Total	**120**	**100.~~00~~**
Marital status		
Single	21	17.5
Married	81	67.5
Widow(er)	13	10.8
Divorced (separated)	8	4.2
Total	**120**	**100.~~00~~**
Household size (No)		
1-5	37	30.8
6-10	58	48.3
11-15	17	14.2
16-20	8	6.7
Total	**120**	**100.~~00~~**
Education Level (years)		
No formal education	41	34.2
Primary education	51	42.5
Secondary education	19	15.8
Tertiary education	9	7.5
Total	**120**	**100.~~00~~**
Marketing experience(years)		
1-5	27	22.5
6-10	73	60.8
11-15	11	9.2
16-20	9	7.5
Total	**120**	**100.~~00~~**
Cooperation Membership		
Member	97	80.8
Non-Member	23	19.2
Total	**120**	**100.~~00~~**
Access to Credit		
Access	35	43.3
Non-Access	85	76.7
Total	**120**	**100.~~00~~**
Annual Income (₦)		
50,000-100,000	48	40.00
150,000-200,000	60	50.00
250,000-300,000	10	8.3
350,000-400,000	2	1.7
Total	**120**	**100.~~00~~**

Source: Computed from the field survey data, 2019.

Table 3. Constraints facing cassava marketers in the area

Constraints	Frequency	Percentage (%)	Ranking
Inadequate capital	95	79.2	1st
Poor supporting infrastructure	91	76.8	2nd
Inadequate processing facilities	77	64.2	4th
Inadequate market information	76	63.2	5th
Inadequate storage facilities	69	57.5	6th
High Perishability of the product	87	70.0	3rd
Unstable Government policies	65	54.2	7th
Lack of specified cassava market	63	52.0	9th
Poor communication network	54	45.0	11th
Inadequate power supply	65	54.2	8th
Low productivity	55	45.8	10th
Commission Agents		35.2	12th

Source: Computed from the field survey data, 2019. Multiple responses recorded.
Those factors as shown in the table above with average constraints above 50% were the major challenges that needed to be addressed in order to increase profits, as well as make the business more attractive and conducive for the cassava marketers in the study area.

Table 2: Results of Regression Analysis of the Factors Affecting Cassava Marketing in the Study Area

Variables	Linear (+)	Exponential	Double log	Semi-log
Constant	0.3156	-0.29817	0.0917	1.0798
	(0.83)	(-1.51)	(0.59)	(3.41)***
Age	-0.133	0.157	-1.78	0.009
	(-2.94)**	(-2.674)**	(0.986)	(3.054)***
Gender	-1.22	-0.094	-0.128	0.110
	(-1.808)*	(-2.945)**	(-1.286)	(-1.901)**
Marital status	-1.196	-0.034	0.687	0.475
	(-1.94)**	(-0.328)	(1.830)*	(1.875)**
H- hold Size	-0.006	-o.188	-0.006	-0.005
	(0.037)	(-0.124)	(-3.033)***	(-2.029)**
Educational	-0.010	0.193	-0.643	-0.550
Level	(-0.111)	(2.015)**	(-2.629)***	(-1.915)**
Marketing	0.048	-0.069	0.123	0.099
Experience	(2.544)**	(-0.709)	(1.865)**	(2.108)**
Cooperative	0.249	0.110	-0.o17	-0.033
Membership	(2.879)**	(1.85)**	(-2.169)**	(0.361)
Access to	0.0521	0.033	-0.147	0.102
Credit	(6.047)***	(0.340)	(-0.069)	(2.052)**
Cost of	0.1666	-0.0667	0.1625	0.3867
Marketing	(2.47)**	(1.91)*	(2.29)**	(2.78)**
Annual	0.2948	0.1500	0.316	0.6144
Income	(4.21)***	(4.14)***	(4.03)***	(4.000)***
R^2	0.834	0.761	0.413	0.411
F-Ratio	6.048***	0.989	12.844***	3.017***

Source: Computed from the field survey data, 2019
Note that: ***;** and * implies significant at1%,5% and 10% levels of probability respectively.
Figures in bracket represent t-values.

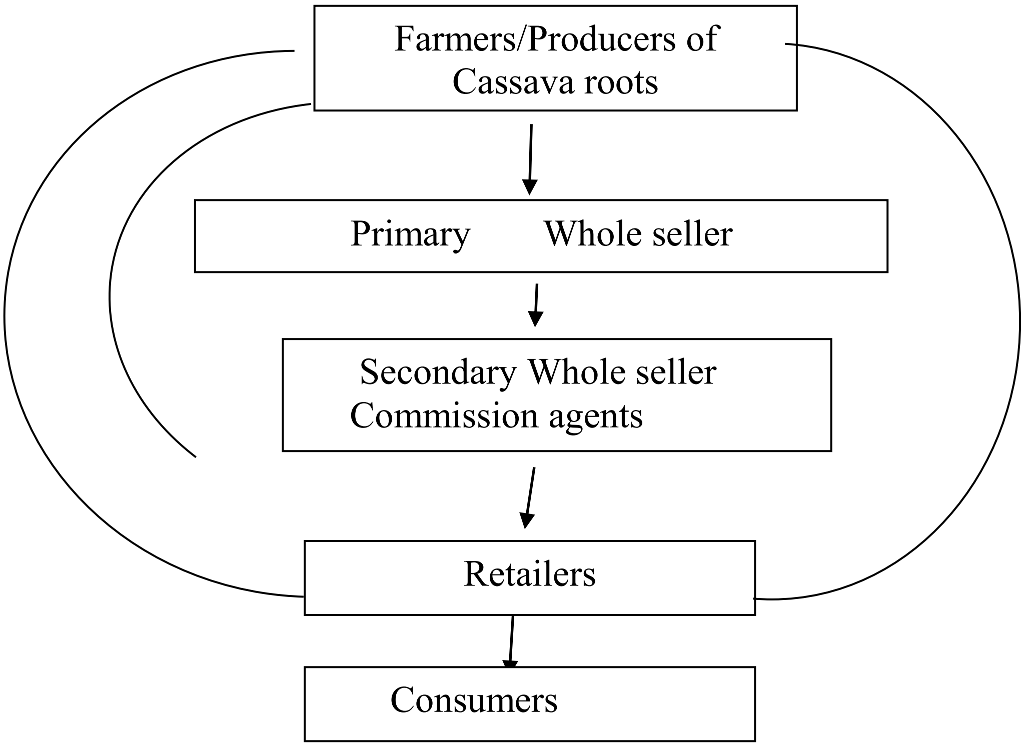

Figure1: Major marketing channels for cassava products in the area

Marketing margin for Cassava products in the area:

$$\frac{\text{Selling Price- purchase price}}{\text{Selling price}} \times \frac{100}{1}$$

$$= \frac{11{,}009.80-4{,}012.78}{} \times \frac{100}{1} = \frac{6{,}997.02}{11{,}009.80} \times \frac{100}{1} = ₦\,63.55.$$

Marketing Margin for Cassava Products =₦ 63.55

Marketing efficiency for cassava products in the study area:

$$\text{Marketing efficiency} \quad \frac{\text{Total Cost}}{\text{Total Revenue}} \times \frac{100}{1}$$

$$\text{M.E} \quad \frac{756{,}731.30}{1{,}321{,}176.70} \times \frac{100}{1} = 57.28\%$$

Marketing Efficiency for Cassava products =57.28%

Economics of Selected Derivatives of Cassava Marketing among Small-Scale Farmers in Ivo LGA of Ebonyi State, Nigeria

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ABSTRACT

The study was carried out in Ivo L.G.A of Ebonyi State to examine the economics of selected derivatives of cassava. Data were collected using structured questionnaire administered randomly to selected 120 respondents. Data collected were analyzed using descriptive statistics, marketing margin analysis, marketing efficiency analysis and multiple regression analysis. The result of the socio-economic variables showed that 87.5% of the respondents were within the highly productive age-range of 21-50 years. Both males and females were involved in the marketing of cassava and its derivatives in the area; even though females dominated. Also 78.3% of the married couples were involved in cassava related marketing. In the same vein, the study showed that 68.5% of the respondents had formal education. The multiple regression analysis revealed that the coefficients for marketing experience, access to credit, cooperative membership and annual income had direct relationship with the cassava derivatives marketed, while the coefficients for age, gender, marital status and cost of marketing had inverse relationship with the cassava derivatives marketed. However, they were all significant at varied probability levels. The dominant constraints identified were low returns to investments, poor access to market and bulkiness of the products. It is recommended that the government should come to the aid of these resource poor cassava derivatives marketers in the study area.

Keywords: cassava derivatives, cost of marketing, marketing experience, marketing margin

INTRODUCTION

Cassava (*Manihot esculenta* crantz) is a popular food crop in most part of Nigeria, with expanding acceptability (Adeyemo *et al*., 2010) and a wide range of derivatives (Akpan *et al*., 2014). In Nigeria, the crop is widely cultivated by resource poor small-scale farmers. In Ebonyi State for instance, cassava is considered as a cultural crop and is grown in almost all the rural households (Nweke, 2014). The crop and its chain of derivatives constitute one of the fundamental sources of calorie intake of most Nigerians (Ani, 2010). The utilization of the crop has extended to the industrial sector, export and feed industry; among others (Akpan *et al*., 2016).

Currently, Nigeria is the largest producer of cassava tubers in the world, with average annual production of about 35 million metric tonnes. Cassava roots store well in the ground for months after maturity (Ope-Ewe *et al*., 2011). Its production industry in Nigeria is increasing at 3% every year, but Nigeria continues to import starch, flour, sweeteners that can be made from cassava. This paradox is due to how cassava is produced, processed, marketed and consumed in Nigeria (that is in a largely subsistence to semi-commercial manner).

In Nigeria, cassava has moved from a food crop to cash crop produced on an industrial scale and even exported (Obisesan, 2013). The introduction of new high-yield cassava varieties and improved farming techniques has led to a booms in production. Cassava is produced largely by small scales. famers using rudimentary farm implements and most of the cassava produced are used for human consumption, with less than 5% being used in industries.

Cassava has many uses which gives the crop high potential as a major foreign exchange earner in Nigeria. Products derived from cassava include Garri, starch, tapioca, fufu, pellets, alcohol, flour, chips, glucose and fuel (i.e. starch and gasoline) and can also be used as a livestock feed (Abdul-Azeez, 2013). It has been eaten for centuries in various ways by indigenous people and continues to be a staple food in local diet. The freshly harvested boiled tubers are eaten as the main starch at a meal, added to soup, and used as bases for other dishes or fried as chip or snack crisps (IFAD, 2013).

This paper will however, concentrates on the products derived directly from cassava roots which include; garri, chips and flour. Garri is a cassava derivative which is cream-white granular flour with slightly fermented and slightly sour taste, made from fermented gelatinized fried cassava tubers. Its processing involves certain units of operation. Cassava chip is another product from cassava, which is widely consumed in the south-eastern part of Nigeria. The chips can either be consumed after it has been sliced and left to ferment for few days or be consumed after mixture with palm oil, some spices and vegetables. Cassava flour is yet another derivative which results after cassava chips are grounded and either used for mixing fufu or used in bakeries as flour in making bread, and other snacks for consumption (FAO, 2013).

Marketing Channel: is the sequence of intermediates or middlemen and the marketers through which goods pass from the producers to the final consumers (Harris, 2007). Or it may refer to the routes avenues or pathways through which goods flow from the producer to the final consumers (Ekerete, 2005).

The marketing channel may be zero or multi-stage channels. The zero channel consists of the flow from the producer to the consumer directly, without any intermediary. The multi-stage channels consist of the middleman through which it pass. That is from the producer to the Urban and rural wholesalers and the retailers (major flow). However, all these categories may not be exclusive because the producer can decide to sell directly to the wholesalers and the retailers (minor flow link).

Marketing Margin of a product or services is the difference between the retail or selling price of the product and the actual cost it took to produce that product. The production costs take into account the average unit cost in terms of operating expenses, manufacturing and packaging (Morello, 2002). The retail price or selling price reflects the mark-up on the cost of producing that product. In some cases, business owners do not calculate appropriate production costs or enough marketing margins, thereby causing them to lose money or break-even over the long-run.

Marketing Efficiency is the nature and character in which various market intermediaries and related institutions arrange and organize the movement of commodities from the point of initial production to the ultimate consumers are very crucial for the efficiency of the marketing system. Therefore, an efficient marketing system is that which locates where there are surpluses of produce and bring them to where there are shortages (Hays, 2005).

It is with this knowledge in mind that the study attempts to examine the economics of cassava derivatives marketing among small-scale farmers in Ivo L.G.A of Ebonyi State, Nigeria. The specific objectives of the study are to:

i. describ the socio-economic characteristics of small-scale farmers on the selected derivatives of cassava marketing;
ii. identify the marketing channels for marketing of selected derivatives of cassava;

iii. determine the effects of small-scale famer's socio-economic characteristics on the marketing of selected derivatives of cassava;
iv. determine the marketing margin for selected derivatives of cassava.
v. determine the marketing efficiency for selected derivatives of cassava; and
vi. identify the problems associated with marketing of selected derivatives of cassava by the small-scale farmers in the study area.

METHODOLOGY

Study Area

The study was conducted in Ivo Local Government Area of Ebonyi State Nigeria. It lies between latitudes 5^0 56^1 and 6^0 59^1 North of the equator, and longitude 7^0 24^1 and 7^0 33^1 East of the greenish meridian. It has its headquarters at Isiaka, and it is one of the thirteen local Government areas that make up Ebonyi State.

It has an annual rainfall range of between 1500mm-2500mm, and an annual temperature range of between 28^0c-30^0c; with a relative humidity of 65%. It has a population of 220,919 persons, and a land area of 3506km^2 areas of 3506km^2, most of which are fertile (NPC, 2006). It has two distinct seasons; the dry seasons which starts from November to March; and the rainy season which starts from April to October, with a short break normally in the month of August, called "August break: (NPC, 2006). Its inhabitants are mostly farmers, petty traders, craftsmen and civil servants; Among the crops grown in the area include: cassava, yam, rice, maize, sweet potatoes, Okro, and Vegetables. They also raise some animals like sheep, goats, poultry etc. Crush rock and SETRACO are the two major industries located in the area, which help to boost economics activities through their stone quarrying. Ivo River and Ikwo River are the two main sources of water in the area.

Sampling Procedure

Multi-stage random sampling technique was used to select respondents for the study. Firstly, four (4) communities were selected out of five (5) that make up the L.G.A., using simple random sampling technique. Secondly, three (3) markets were randomly selected from each of the four (4) communities already chosen in stage I. This gave a total of twelve (12) markets. Thirdly ten (10) cassava marketers were randomly selected from each of the twelve (12) markets already chosen in stage II. Thereby giving a grand total of one hundred and twenty (120) respondents that was made up 60 cassava derivative wholesalers and 60 cassava derivative retailers which were for a detailed study.

Analytical Techniques

Data collected were analyzed using descriptive statistics, marketing margin analysis, marketing efficiency analysis and multiple regression analysis.

Marketing Margin Analysis: This was used to determine the profitability of selected derivatives of cassava marketing among the small scale famers, using Morello's model. The model is expressed as:

$$\text{Marketing Margin} = \text{Selling Price} - \text{Cost per Unit}$$

Where,

$$\text{Cost per Unit} = \frac{\text{total cost of production}}{\text{Total Number of units produced}}$$

Marketing Efficiency analysis: was used to calculate the efficiency in marketing; using Shepherded Futrel model as captured by Arene (1998). The model is specified as:

$$M.E = \frac{TC}{TR} X \frac{100}{1}$$

Where,
M.E = Marketing Efficiency
T.C = Purchase cost + marketing costs
T.R = Total Revenue

Multiple Regressions Analysis

This was used to determine the influence of the socio-economics characteristics of selected derivaltives of cassava marketers on the output of cassava Linear, exponential, semi-log and double leg functional forms were fitted and Tried, and on the basis of the magnitude of R^2 value, the high number of significant variables and signs of the regression coefficients; linear functional form was chosen as the lead equation. The explicit form of the model is presented below:

$$Y = B_c + B_1 X_1 + b_2X_2 + b_2 + b_3X_3 + b_4X_4 + b_5 + b_6X_6 + \ldots b_nX_n + e \quad (1)$$

Where:
Y= Output of cassava in tons/ha
X_1= Age of the farmer (years)
X_2= Gender(male, 1 female =0)
X_3= Marital Status (married =1, otherwise =0)
X_4= Household size (numbers)
X_5= Educational level (years)
X_6= Marketing experience (years)
X_7= Cost of marketing (₦)
X_8= Annual income from marketing (₦)
X_9= Cooperative membership (member =1 non-member =0)
X9= Access to credit (Access =1, otherwise= 0)
b_0= Constant term
b_1b_{10}= Coefficient to be estimated
ei= Error term

RESULTS AND DISCUSSION

Analysis of the socio-economic variables of the respondents (Table 1) revealed that majority (87.5%) of them were within the age-range of 21-50 years. This means that they are still in their active productive ages. The study also showed that both male and female were involved in the marketing of cassava and its derivatives in the study area, even though females dominated in this case. It equally revealed that 78.3% of the married couples were involved in cassava related marketing which emphasizes the importance of food and income to the households. The study also showcased that 65.8% of the respondents had formal education. Hence, Onyenweaku and Nwaru, (2005) reported that education enhances one's readiness to understand and evaluate new production techniques. Similarly, greater number of them (83.3%) had long years of marketing experience, but with a mean of 12.5.

The result of the estimated parameters is presented in table 2. Of the functional forms that were fitted and tried with the production function models, the liner functional forms were chosen as the lead equation based on the established economic theory; The coefficients for marketing experiences, access to credit, cooperative membership and annual income had direct relationship with the cassava derivaties marketed; while the coefficient for age, gender, marital status and cost of marketing had inverse relationship with the cassava derivates marketed. However, they were all significant at varied probability levels. Thus, these were all expected and are in accordance with a priori expectations.

CONCLUSION

The study revealed that there were males and females including married people involved in cassava derivatives marketing in the area. It involves a lot of intermediaries, which invariably increase costs and purchase prices. Problems identified include, low returns on investment, poor access to market, bulkiness of the products, low storability, etc. It is recommended that the Government should come to the aid of these resources poor cassava derivative marketers in the study area.

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150,000-200,000	60	50.00
250-300,000	10	8.3
350,000-400,000	2	1.7
Total	**120**	**100.~~00~~**

Table 3: Constraints to cassava derivatives marketing among the small-scale farmers in the study area.

Constraints Point	Mean scores(x) ‾	Decision
Low returns on investment	3.80	Accepted
Lack of storage equipment	2.99	Rejected
Cost of processing	2.62	Rejected
Poor market access	3.66	Accepted
Weather condition (climate change)	3.2	Accepted
Cost of transportation/distribution	2.96	Rejected
Sources of the products	3.60	Accepted
Poor packaging	2.61	Rejected
Bulkiness of the products	3.44	Accepted
Seasonality of the products	3.64	Accepted
Excessiveness of the products	2.51	Rejected

Decision rule ≥ 3.0 is accepted; ≤ 3.0 is rejected
Source: computed from the field surely data, 2019.
Key: VGE = very great extent/; GE= great extent; NE=No extent LE=Low extent and VLE = Very low Extent

Table 2: Results of Regression Analysis on the Effects of the Socio-Economic Characteristics of the Respondents on Cassava Derivatives Marketing in the Study Area.

Variable	Linear (+)	Exponential	Double-log	semi-log
Constant	0.3156	0.29817	0.0917	1.0798
	(0.83)	(-1.51)	(0.59)	(3.41)***
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	(-1.808)*	(-2.945)**	(-1.286)	(-1.901)**
Marital	-1.196	-0.34	0.687	0.475
Status	(-1.94)**	(-0.328)	(1.830)*	(1.875)**
Household	-0.006	-0.188	-0.006	-0.005
Size	(0.037)	(-0.124)	(-3.033)	(-2.029)**
Educational	0.010	0.193	-0.643	-0.550
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Marketing	0.048	-0.069	0.123	0.099
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Cost of	0.1660	-0.0667	0.1625	0.3867
Marketing	(-2.47)**	(1.91)*	(2.29)**	(2.78)**
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R^2	0.834	0.761	0.413	0.411
F-ratio	6.048**	0.989	12.844***	30.17***

Sources: Computed from the field survey data, 2019
Note that: ***; ** and * implies significant at 1%, 5% and 10% levels of probability respectively. Figures in parenthesis represent t-values.

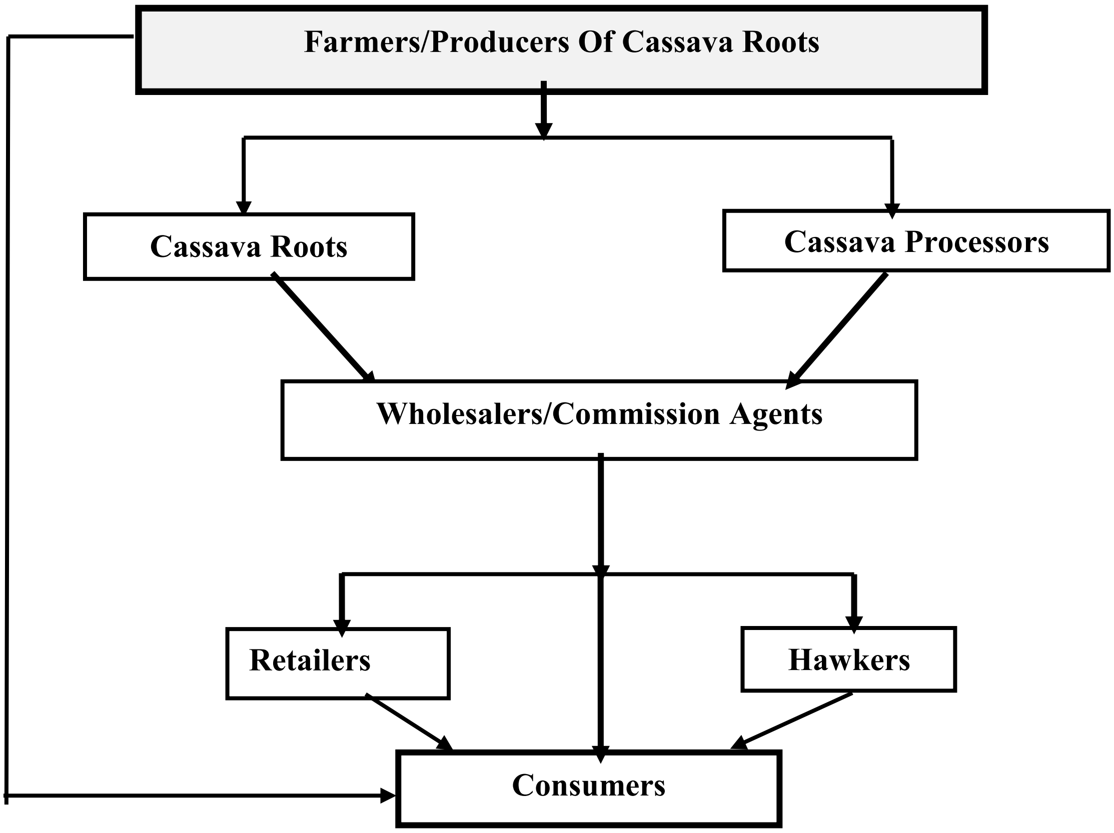

Figure: Marketing channels for cassava roots and its derivatives in the study area.

Marketing Margin for cassava derivatives marketing in the study area =

$$M.E = \frac{\text{Total Cost}}{\text{Total Revenue}} \times \frac{100}{1} = \frac{756,731.30}{1,321,176.70} \times \frac{100}{1}$$

$$M.E = \frac{756,731.30}{1,321,176.70} \times \frac{100}{1} = 57.28\%$$

Marketing Efficiency for cassava derivatives = 57.28%

Marketing efficiency = 57.28%

Marketing efficiency for cassava derivatives marketing in the study area:-

$$\frac{\text{Selling price} - \text{purchase price}}{\text{Selling price}} \times \frac{100}{1}$$

$$= \frac{11,009.80-4,012.78}{11,009.80} \times \frac{100}{1} = \frac{6,997.02}{11,009.80} \times \frac{100}{1}$$

Marketing Margin for cassava derivatives =₦63.55

A Survey of the Effect of Covid-19 on Nigerian Farmers

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ABSTRACT
The agriculture sector has been undermined following the outbreak of COVID-19 in Nigeria. COVID-19 which has had far-reaching consequences beyond the health sector on which policy makers and governments across different levels had placed major focus on. The pandemic led to varying ranges and degrees of restrictions and measures set out by both state and federal governments to forestall the spread of the virus. Some of these restrictions came in the form of night-time curfew, travel bans, closure of land borders, closure of schools, ban on public gathering and others. Beyond belief, these restrictive measures compounded the woes of the pandemic on the people as they led to severe economic, cultural and social consequences. In agriculture, farmers in Nigeria were plagued by income loss, reduction in agricultural productivity and disruption of food supply chains. Very importantly, the pandemic caused serious food security crisis for rural/urban dwellers and as well the Nigerian farmer and his household. Interestingly, there were efforts on the part of the government to cushion the effect of the pandemic on agriculture and the economy.
Keywords: COVID-19, Farmers, Food security, Agricultural production

INTRODUCTION
On the 11th March 2020, COVID-19 was declared a pandemic by the World Health Organization (Ilesanmi, et al, 2020). This would institute a reawakening in global health systems that would stretch health facilities and personnel world beyond their elastic limits. The disease is believed to be caused by the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) and has since its advent had catastrophic consequences on various corridors of life, including the educational, health, economic, and agriculture sectors (Ilesanmi and Afolabi, 2020). The World Bank predicted that globally, the pandemic was likely to push 49 million people into extreme poverty in 2020 (World Bank, 2020a). Beyond public health, the menace the pandemic pose has gone as far as eliminating or disrupting countless jobs, and as of December 2020, it placed nearly half of the world's 3.3 billion workforce at verge of losing their source of living (Yazdanpa *et al.*, 2021). From what is currently known, the worst of these threats is the global economic recession causing many to lose income and leaving many vulnerable people unable to afford the food they need. Unless immediate action is taken, we could see a global food emergency.

In the longer term, the combined effects of COVID-19 itself, as well as corresponding mitigation measures and the emerging global recession could, without large-scale coordinated action, disrupt the functioning of food system (UN, 2020). Governments in Europe, the United States, and other high-income countries have taken unprecedented fiscal and monetary stimulus measures to compensate for the income losses of businesses and workers and contain an inevitable economic crisis. But the relief responses of low- and middle-income countries like Nigeria, have been more limited (Laborde *et al*., 2021).

Nigeria has equally received its own dose of shock from the pandemic ever since the first case of COVID-19 was recorded in the country on February 27, 2020 (NCDC, 2020). Several factors influence the spread of the COVID-19 in Nigeria, most notably the extremely congested living conditions associated with numerous poor neighbourhoods in several cities (Onyeaka *et al*., 2021). Also, the high prevalence of co-morbidities, including chronic malnutrition, endemic malaria coupled with current measles, cholera and Lassa fever outbreaks, can complicate efforts to effectively contain the pandemic and result in severe implications on the transmission pattern and health of the community (UNDP,2021). According to Amare et al., (2021) Nigeria's lockdown and mobility restrictions were mostly introduced by federal and state-level governments. Starting from March 29, 2020, federal and state governments announced lockdown measures and strict mobility restrictions for some states such as Abuja FCT, Lagos, Ogun, Kano, Delta, Ekiti, Kano, Kaduna, Kwara, and Taraba states.7 Lockdown measures in other states were introduced by state governments independently of the federal government, including in Akwa Ibom, Borno, Osun, and Rivers. In most cases, the lockdowns remained in force for about 5–8 weeks. These measures restricted movement of residents and led to the closure of business operations, and the closure of business operations, and the closure of regional borders linking lockdown areas with the rest of the country.

Recent estimates indicated that the economy will have contracted by 3.5 to 5 percent in 2020, during the period in which the government-imposed restrictions on economic activities and mobility (World Bank, 2020c; IMF, 2020). COVID-19 is an unprecedented challenge for Nigeria because of her large population and the economic dependence mainly on crude oil export (Obayelu et al., 2021). The contraction in the Nigerian economy could also be attributed to drop in oil revenues, this was because oil prices had plummeted across the globe as there was border closure and restriction in international trade in different parts of the world (IMF, 2020). An economic slowdown in 2020 from the plunge in oil prices alone would have been damaging, but it is now clear that the continued spread of the COVID-19 pandemic and the associated policy responses across the globe, and within Nigeria, are likely to have devastating consequences for Nigeria's economy (Andam et al., 2020). Even though oil forms the fulcrum of the Nigeria's economy, the importance of the agricultural sector cannot be over emphasized as the sector provides employment for over 70% of the economically active population (NBS 2006).

Agriculture is the single largest contributor to the well-being of the rural poor in Nigeria, sustaining about 86 percent of rural households in the country. The sector has the greatest potential for reducing poverty in Nigeria (Fabunmi and Agbonlahor, 2012). Oyetoro *et al* (2020) added that the sector is a stable source of growth to the national economy. In the face of COVID-19, the agricultural sector has recorded some setbacks and Nigerian farmers who are the pioneers of this broad sector of the economy have equally been adversely affected (Obayelu *et al*., 2021). Nigerians generally have had to deal with the measures undertaken by governments to control COVID-19 have affected the livelihoods and the food security of communities. Some of these measures include; border closures, quarantines, social distancing, curfews, and trade restrictions which for the farmer, prevents him from accessing the farm and market—including the purchase of inputs and the sale of their products (Yazdanpanah *et al*., 2021).

Furthermore, these controls also prevent workers from harvesting agricultural products, triggering significant socio-economic consequences for people's livelihoods. While these restrictions are crucial for limiting the spread of the disease, they often disrupt chain markets and trade in agricultural and nonagricultural products, thus affecting the nutrition and food security of all (WHO, 2021). Ouma and Brown (2020) added that Quarantine measures could further limit farmers' access to their land and limit their access to essential agricultural inputs. As a result, crop production is likely to be below average, leading to more severe food insecurity and malnutrition in the medium to long term. COVID-19, and the measures established by policy makers and government to forestall its spread may have serious effect on the Nigerian farmer; thus, the study was aimed at examining the effect of COVID-19 on Nigerian farmers and the responses to these effects. These aims were largely dependent on literature from other studies.

The Effect of COVID-19 on farm output

Owing to COVID-19 the agriculture sector, which serves as the primary means of livelihoods for most Nigerians and accounts for a 70 percent share of the labour force, suffered about a 13.1 percent loss in output, around USD 1.2 billion Balana *et al* (2020). Agricultural production is known to be a sector with a high-risk rate compared to other sectors, even in pre-pandemic times (Topçu, 2008). So, it is likely that farmers will experience heavy economic consequences of the pandemic period. Agricultural production in 2021 is likely going to suffer from a high probability of having an internal food demand crisis as food demand may not likely going to be met. It follows that Covid-19 has caused a devastating labor shortage in terms of a decrease in the labour supply by the number in most states in Nigeria. Furthermore, a delay in one activity such as land preparation, seeds supply, feeds, fertilizers, pesticides, required in production process will undermine yields and output (Obayelu *et al*., 2021). In cases where farmer's cropping timetable have been interrupted, this may lead to a buildup of water demand for irrigation and in certain areas, strengthen dangers and pressures related to water shortage and inadvertently affecting agricultural yield (CGIAR 2020).

This COVID-19 crisis started during the cropping season making most farming households to abandon their existing farms and the ones in the process of cultivation (Ofuoku *et al*., 2021). Signs of the reduced availability of agricultural produce, such as rice, maize, groundnut, yam, millet, sorghum, and cassava, were evident from the third quarter of 2020 (PwC, 2020). This can be attributed to the late start of the farming season, which was caused by movement restrictions order as well as the September floods, which affected 16 states in Northern Nigeria (FAO. 2021). Restrictions on the movement of people between regions have reduced the availability of hired labour for farming. For example, many workers hired during the planting season in Ogun State come from other states (FAO, 2021). Agricultural output will be low in an atmosphere where geographical mobility of labour is hampered by mounting restrictions from the government. Balana *et al* (2020) added that, in most parts of Nigeria, the planting of the two main staples crops (rice and maize) starts either in April or May (which may extend up to June in Northern Nigeria), with follow-up activities of weeding and harvesting. With the COVID-19 pandemic, the disruptions of these activities, especially planting and supply chains due to lockdown measures, affected agricultural activities and is expected to lower agricultural output later in the year.

Livestock farmers were equally hit by the tempest of the pandemic as Oyetoro *et al* (2020) observed that COVID-19 pandemic has however resulted in a reduction of livestock production both in small and large scales. This event primarily stems from the reduced money in circulation during the COVID-19 pandemic, and reduced earning among many individuals. Thus, the purchase of livestock feeds and drugs seemed unrealistic. For this cause, household savings in the pre-COVID-19 period in Nigeria was expended on basic food items which could assure of survival (Ilesanmi *et al*., 2021).

Balana *et al* (2020) showed in their study on the effects of COVID-19 policies on livelihoods and food security of smallholder farm households in Nigeria that about 29 percent of the respondents reported they planted fewer crops, 24 percent reduced cropping area cultivated, 24 percent reduced fertilizer application rates, and 14 percent increased their use of family labor. A national-level COVID-19 impact monitoring survey in Nigeria (World Bank and NBS, 2020b) also found that of the households engaged in agricultural activity, 38 percent reported having to modify their farming due to COVID-19, of whom 25 percent reported delaying planting time, 52 percent reported reducing the area they planted, and 30 percent reported planting crops that take less time to mature. Developments of this nature can have significant shock on national food security. What is more worrying being that, when restrictions of movement impede farmers from cultivating their crops, the extent of the harm to the economy and population may not be felt in the current farming season but in the next when the amount of stored produce has diminished (Balana *et al*., 2020).

The Effect of COVID-19 on Farmers' Income

The recent national-level finding conducted by the NBS, showed that 79 percent of the respondents reported that their households' total income has decreased since the outbreak of the pandemic (World Bank and NBS, 2020). In response to the loss in income, respondents adjusted their household expenditure to suit their limited resources. This adjustment is also driven by the rising cost of both food and non-food items because of the rising logistical and distribution costs incurred in making these goods available to the consumers. the reduction of both the quality and quantity of food items may aggravate the situation of food and nutrition insecurity in farming households (Amare *et al*., 2020; Akseer *et al*., 2020; Headey *et al*., 2020). Income decline for the farmer will not only reduce demand for food but also induce shifts in the mix of products consumed, notably resulting in less consumption of more nutrient-rich foods (like fruits, vegetables, and animal-sourced foods) and relatively more of calorie-rich foods (like basic grains and sugar) (Laborde *et al*., 2021).

The nation's weak and inefficient early warning system has put Nigeria in a state of unpreparedness, causing untold hardship for farmers. This hardship by and large, has can undermine the income of farmers. Balana *et al* (2020) reported in their study (the effects of COVID-19 policies on livelihoods and food security of smallholder farm households in Nigeria) Income loss was one of the major challenges for most of the households. They observed that 78 percent of the respondents dipped into their savings, while 50 percent borrowed the additional income from alternative sources. When inquiring about these financial sources, 40 percent of respondents received funds from friends and relatives, 30 percent from local lenders, 10 percent from the non-commercial banks, and only 4 percent from commercial banks. The income and price changes associated with the pandemic are likely to result in some quite substantial changes in patterns of food consumption, with adverse nutritional consequences (Laborde *et al*., 2021). Furthermore, Amare et al., (2020) in their study on "COVID-19 and food security: panel data evidence from Nigeria" reported when asked about major sources of livelihood in the last 12 months and changes in associated income since the outbreak of COVID-19. 72 percent of households reported reduction in farming income.

The Effect of COVID-19 on Food Security

Most measures undertaken by governments to control COVID-19 have affected the livelihoods and the food security of communities (Van Bodegom and Koopmanschap, 2020). A household is only food secure if everyone has unrestricted access to food that allows them to satisfy their basic needs (Rosales and Mercado 2020). Controls also prevent workers from harvesting agricultural products, triggering significant socio-economic consequences for people's livelihoods a step which may further undermine food security (WHO, 2020). It follows that individuals who were previously vulnerable (e.g., farmers living in poverty) appear to be disproportionately affected by COVID-19 (Defeyter *et al*., 2021). Thus, the COVID-19 shock highlights existing vulnerabilities and creates an additional layer of complexity to farmers' livelihoods and food security (Guido *et al*., 2020). Amare *et al*., (2020) argued that lockdown measures are associated with 6–15 percentage points increase in households' experience of food insecurity and that reduction in household income is one of the most important mechanisms through which the COVID-19 pandemic can affect food insecurity. This position establishes a link between farmers income and food security. Furthermore, it is estimated that two-thirds of Nigeria's population is involved in one form of agriculture or the other, thus serving as a source of livelihood for the people (FAO, 2020). According to Onyeaka *et al* (2021). This important source of income has been severely affected due to the crash in the global economy, with a resultant loss in individuals' livelihood. This has led to a decrease in gross household income which will indirectly lead to malnutrition cases as food cannot be afforded by people, especially in the rural areas of the country where majority of the inhabitants are farmers. With the look of events, it seems to the eyes, that a health crisis is becoming a livelihood and employment crisis that is becoming a food crisis (UN, 2020).

The Effect of COVID-19 on Food Supply Chain

The Food and Agricultural Organization (FAO) of the United Nations has highlighted that the effects of the pandemic on the entire food supply chain can be disastrous and lead to a collapse in food security and nutrition globally (FAO, 2020). Moreover, Welsh (2020) explains that the pandemic is affecting food systems directly by distorting supply and demand internationally; and indirectly by degrading the purchasing power of the population and by undermining the capacity to produce and distribute food.

The restriction caused by COVID-19 has led to remarkable losses in farm produce (especially perishable products) because there was disruption supply chain (UN, 2020). Ouma and Brown (2020) supported this view as the asserted that food supply especially of labor-intensive agricultural production like fruits, vegetable and meat: transport interruptions and quarantine measures limiting farmers' access to input and output markets; and an increase in food loss and waste resulting from food supply chain disruptions. When milk and dairy products, fruits and vegetables, meat and fish fail to reach wholesale and retail markets, farmers, pastoralist households, fisherfolks and traders suffer major income losses. This leaves fewer resources for preparing for the next season's planting, fish catches or livestock raising and slaughter (UN, 2020). In Nigeria, the markets for perishable food items were unfavorably affected by workplace closure at the processing and packaging departments of food companies. The transportation of these perishable produce to the market were hindered as a result of travel restrictions put in place, and this resulted in an increase wastage of food items (FAO, 2020). Furthermore, using data collected from sample households from four Nigerian states, Balana *et al* (2020) investigated the effects of COVID-19 pandemic policies on the incomes, employment, and food security situation of smallholder farming households in Nigeria. Their findings show that travel and movement restrictions from COVID-19 caused disruptions in agricultural activities and supply chains.

Responses to Effects of COVID-19

Policy responses to the pandemic also play a major role in the outcome (Laborde *et al* 2021). Some of the responses by government and private sector on the effect of COVID-19 in Nigeria are:

i. One of the most robust farm policies implemented by the Nigerian government in response to COVID-19 was the mass agriculture component of the Nigeria Economic Sustainability Plan (NESP), officially launched in May 2020. The plan, with a total budget of N2.3 trillion (USD 6 billion), has three components: a mass agriculture programme, a mass housing programme, and a solar connection programme. The agriculture program is structured with a guaranteed offtake scheme for food crops, sanitisers, and face masks (FAO, 2021);
ii. Regarding farm input subsidies, the government issued intra-state movement permits for seed conveyance throughout the period of the lockdown and price subsidies for seeds for farmers to ensure the continuity of agricultural activities during the lockdown (GAIN. 2020);
iii. CBN unveiled guidelines for non-interest financial institutions under its Agri-Business, Small and Medium Enterprise Investment Scheme (AGSMEIS), Micro, Small and Medium Enterprises Development Fund (MSMEDF), and Accelerated Agricultural Development Scheme (AADS). The MSMEDF for NIFIs guidelines are aimed to channel lo- return funds to the MSME sub-sector of the Nigerian economy through participating Financial Institutions to enhance MSMEs' access to financial services (GAIN. 2020);
iv. The Mastercard Foundation provided a $20.4 million grant for 65,000 Nigerian farmers who will have access to tractors, seeds, fertiliser, and finance. They teamed up with Alluvial Agriculture, a farming collective, to provide some 200 tractors, 330,000

kilograms of seeds, climate advisories, and digital payment systems to farmers. The initiative is aimed at supporting agriculture to recover from the pandemic in a way that will help it to withstand future crises such as climate change (GAIN. 2020);

v. As parts of policy response of the Nigeria government, the Central Bank of Nigeria (CBN) masterminded a financial improvement bundle, including a N50 billion ($138.89 million) credit facility to family units, small and medium ventures generally influenced by the pandemic; a N100 billion ($277.78 million) advance to the health sector and a trillion naira ($2.78 billion) to the manufacturing sector (CBN 2020);

vi. interest rates on all CBN interventions have been revised downwards from 9 to 5%, and a one-year moratorium on CBN intervention facilities has been introduced, effective from March 1, 2020 (CBN 2020).

vii. The Central Bank of Nigeria (CBN) disbursed USD 1.1 billion in non-interest loans to farmers nationwide through its Anchor Borrower's Programme (ABP) and Targeted Credit Facility (TCF) to support households and small and medium enterprises (SME) affected by COVID-19. The CBN specified that the funds would be used to fund the value chains of nine commodities, including rice, maize, livestock, fish, oil palm, cowpea, poultry, yam and cassava (CBN, 2020).

viii. On 13 May, the National Agricultural Seed Council (NASC) provided 81 000 tonnes of certified seeds to farmers (Ewepu, 2020) to ensure the continuity of agricultural activities during the lockdown period and ensure that farmers would have enough seeds for the 2020 planting season (FAO, 2021).

CONCLUSION

The outbreak of COVID-19 has led to health and socio-economic disruptions. It has equally brought about untold hardship to a significant part of the population. This has come on the form of death from the pandemic, hunger, loss of jobs, and restriction of human and economic activities. Nigerian farmers have suffered losses on output and income, also the disruption of food supply chain had an effect on the marketing of their commodities, plus they have had to suffer consequences of food insecurities under the lockdown measures by government. Although, there are existing responses on COVID-19, policy makers should enhance the early warning system as COVID-19 is still present and is now noted to be occurring in waves. Farmers who suffered severe losses from the pandemic should be given grants to recover from their losses and participate fully in national production.

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Analysis of Credit Access and Poverty Status of Women Entrepreneurs in Ondo State, Nigeria

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ABSTRACT
The study analyzed credit access and poverty status of women entrepreneurs in Ondo State, Nigeria. Primary data were collected from 100 randomly selected woman entrepreneurs. Data were analyzed using Descriptive Statistics, Foster, Greer and Thorbecke (FGT) index and Gini coefficients. The study found that 52.0% of the respondents were within the age range of 25 and 35 years with mean age 39 and 56.0% of the respondents had primary school education while, greater percentage (87.0%) of the respondents were married with medium household size of between 4 and 5. The result also indicated that 30.0% of the sampled respondents reported inadequate collateral security in sourcing for loan. The Poverty index analysis revealed that most (67.0%) of the sampled respondents were poor while the result of the Gini coefficient revealed a very high income inequality among the respondents.
Keywords: Access, Credit, Collateral, Entrepreneur, Poverty

INTRODUCTION
Nigerians are currently experiencing high poverty level and income inequality despite her huge amount of available human and material resources (Clement and Dickson, 2019). This daily rise in poverty can be attributed to government policies and programmes that are in most cases wrongly targeted at reducing poverty. Akinlade *et al.,* (2015) observed that income inequality and poverty are problems affecting every nation of the world and that they are part of the greatest challenges facing mankind today.

According to World Bank (2001), out of about 6 billion people in the world; 2.8 billion lived on less than US$2 per day and 1.2 billion on less than US$1 a day. Of the latter, 24.3 per cent were in sub-Saharan Africa (SSA) increasing to 28.3 per cent in 2010. It was estimated that 1.4 billion people had consumption levels below $1.25 a day in 2010, while SSA of which Nigeria is one, accounted for 388 million of this number (Global Monitoring Report, 2012). While virtually all other regions of the world have been able to achieve the MDG1 of reducing poverty by 2015, South Asia met the target up to about 25% and SSA failed to meet the target (World Bank Group, 2015).

The official statistics released by National Bureau of Statistics (NBS) shows that the national poverty rate is 69 per cent while sectoral disaggregation shows urban poverty rate of 61.8 per cent and rural poverty rate of 73.2 percent (NBS, 2012). Poverty has become an object of cynosure to all Nigerian government that require an urgent attention. One important ways to reduce this menace of poverty is to encourage every Nigerian to participate in entrepreneurial development. More importantly women because, the role of women in enterprise development as a means of eradicating poverty cannot be over emphasized. However, an issue of concern is that most of the women entrepreneurs do not have access to credit facilities which limit the growth of their enterprise.

Though, several researchers such as Amao *et al.* (2009); Idowu *et al.* (2011); Adeyonu *et al.* (2012); Igbalajobi *et al.* (2013); Mailumo *et al.* (2015) and Akinlade *et al*. (2015) have worked on income inequality and poverty determination in Nigeria, however, few concentrate on the effect of credit access on poverty reduction among women entrepreneurs in Ondo State. Hence the need to:
(i) assess the women entrepreneur's poverty status
(ii) determine the income inequality of the women entrepreneurs in the study area.

METHODOLOGY

The study was conducted in Ondo State, South West Nigeria. A multistage sampling techniques was adopted for the selection of the respondents. The first stage involves the simple random selection of four (LGAs) in the state, namely; Akure-South, Owo, Akure-North and Ose. The second stage involves a purposive selection of two communities each from the four Local Government Areas. In the third stage, Snowball method was used in the selection of thirteen (13) women entrepreneurs, who made use of different credit sources as a means to poverty reduction in the study area, making a total of one hundred and four respondents (104) in the study area. Only one hundred questionnaires were adequately filled and retrieved.

Analytical Techniques

Data collected were subjected to descriptive statistics, Gini coefficient and Foster- Greer- Thorbecke. Descriptive statistics such as frequency count, percentages and mean were used to analyze the socio – economic characteristics of the respondents, sources of credit and volume of credit received from each source. Gini coefficient was applied to determine the degree of respondents' inequality in the distribution of income while Foster- Greer and Thorbecke (1984) class of poverty measures (FGT) including the Head count ratio was used to analyze the poverty status of the respondents. Regression analysis was used to analyze the determinant factors influencing women entrepreneurs' access to credit loan.

The computation of the Gini coefficient is presented as:

$$G = 1 - \sum_{t=0}^{n-1}(A_i + 1 - A_i)(B_i + 1 - B_i) \quad (1)$$

Which reduced to G = 1-∑AB.

Where,
G = Gini Coefficient
A = Percentage of entrepreneurs
B = Cumulative percentage of income from enterprise.
According to Evelyn and David (2015) The Gini coefficient measures income inequality based on the Lorenz curve and has values between 0 and 1 (0 and 1 inclusive) as the value approaches unity, it implies high rate of income inequality while value closer to 0 signifies more equality in the distribution and 0 signifies absolute equality in the distribution.

The Foster- Greer and Thorbecke is expressed as follow:

$$P_\alpha = \frac{1}{N}\sum_{i=1}^{q}\left[\frac{Z-Y}{Z}\right]^{\alpha} \quad (2)$$

Where $\alpha \geq 0$.

The parameter α reflect poverty aversion. Larger values of α put higher weight on the poverty gaps of the poorest people. By setting $\alpha = 0$, eqation 2 reduces to a head count index (P_o) , if

α = 1 equation 2 becomes a poverty gap index. Aggregating the proportionate poverty gap shows the shortfall of the poor's income from the poverty line, expressed as an average over the whole population.
P1 = non-negative parameter (0, 1 or 2) reflecting social valuation of different degree of poverty. It takes on a value of 0 for poverty incidence, 1 for poverty depth, and 2 for severity of poverty.
Yi = per capita expenditure (₦/person/day)
q = Number of households with per capital consumption
Z = The poverty line
N = number of households in the sample.

RESULTS AND DISCUSSION

The age distribution of respondents is presented in Table 1. The result showed that most (52.0%) of the respondents were between age (26-35) years with mean age of 39. The mean age of the respondents showed that most of the respondents were young and agile entrepreneurs. Majority (85.0%) of the respondents had little or no formal education. The marital status of the respondents as indicated on Table 1 showed that majority (81.0%) of the respondents are married. The Table also revealed that most (61.0%) of the respondents have at least 4-5 household members. Seventy-two percent (72.0%) of the respondents operates a medium scale enterprise.

Table 1. Showing the Distribution of Respondents by Socioeconomic Characteristics

Description	Frequency	Percentage
Age		
18-25	9	9.0
26-35	52	52.0
36-45	23	23.0
45 above	16	16.0
Mean age	**38.6**	
Education		
No formal education	18	18.0
Primary	11	11.0
Secondary	56	56.0
Tertiary	15	15.0
Marital Status		
Single	13	13.0
Married	81	81.0
Divorced	4	4.0
Widow	2	2.0
Household Size		
≤3	12	12.0
4-5	61	61.0
6-7	22	22.0
7 above	5	5.0
Size of Enterprise		
Small	14	14.0
Medium	72	72.0
Large	14	14.0

Source: Field Survey 2019

Distribution of Respondents According to Sources of Credit

Table 2, showed the distribution of respondents according to various credit sources in the study area. The table revealed that, the most common sources of credit in the study area are cooperative society, friends and family. About 47.0% of respondents' source credit from cooperative societies while 36.0% of the respondents source credit from friends and family. Majority (84.0%) of the respondents had access to credit, though their major constraint was inadequate collateral security or equity capital. This also corroborate the reports of Emefesi and Yusuf, (2014); Ilavbarhe and Izekor, (2015) and Oladayo, (2019).

Table 2. Showing the Distribution of Respondents by sources of credit

Description	Frequency	Percentage
Friend and relative		
Yes	36	36.0
No	64	64.0
Co-operative Society		
Yes	47	47.0
No	53	53.0
Bank /financial institution		
Yes	1	1.0
No	99	99.0
Constraint in Sourcing Credit Loan		
Interest rate	22	22.0
Administrative Charges	16	16.0
Inadequate collateral	30	30.0
Lack of surety	22	22.0
Delay in disbursement	10	10.0
Access to Credit		
Yes	84	84.0
No	16	16.0

Source: Field Survey 2019

Determination of Poverty Status Among Respondents

Poverty line of ₦16,539 was estimated using mean per capital household income. Respondents that have their income below this were classified poor while those with income above ₦16,539 were considered not poor. As presented in Table 3, majority (67.0%) of the respondents fall below the poverty line while only (33%) of the respondents were above the poverty line. This is an indication that women entrepreneurs surveyed for the study were very poor. Akinlade *et al* (2015) reported in their research work on income inequality and poverty among farming households in Southwest, Nigeria, that Poverty incidence was higher during the dry season than rainy season.

The table also revealed the computed head count index and the poverty gap index of 0.67 and 0.485 respectively. The headcount index of 0.67 showed that 67% of the respondents fall below the poverty line while the poverty gap index of 0.485 showed the extent to which individual fall below the poverty line as a proportion of the poverty line. This means that individual will need 49% of ₦16,539 to get to the poverty line.

Table3: Showing Income Distribution of respondents

Income Level	Frequency	Percentage
≤50,000	46	46.0
51,000-60,000	8	8.0
61,000-70,000	5	5.0
71,000-80,000	7	7.0
≥81,000	34	34.0
Means income	16538.97	
Below mean income (poor)	**69**	**69.0**
Above mean income (not poor)	**33**	**33.0**
Head count Index	**0.67**	
Poverty Gap Index	0.485	

Source: Field Survey 2019

Analysis of Respondents Income Inequality

Table 4 presents the analysis of income inequality among the respondents in the study area. The result shows that income inequality among the respondents was high with the value of the Gini Coefficient as high as 0.69. This value showed that most of the entrepreneur's experience income inequality in the study area. This result is in line with the findings of Igbalajobi *et al.* (2013), who reported a Gini Coefficient value of about 0.492 in their research work on the determinant of poverty incidence among rural farmers in Ondo State Nigeria.

Table 4. Analysis of Respondents Income Inequality

Category of Total Income From Entrepreneurs	NOR	A(POR)	CPOR	TEI	B(POTEI)	CPOTEI	AB
≤ 50000	46	0.46	0.46	1051500	0.1295	0.1295	0.060
51000 – 60000	8	0.08	0.54	451000	0.0556	0.1851	0.004
61000 – 70000	5	0.05	0.59	350000	0.0431	0.2285	0.002
71000 – 80000	7	0.07	0.66	555000	0.0684	0.2969	0.005
≥ 81000	34	0.34	1.00	5710000	0.7034	1.0003	0.239
Total	**100**	**1**	**1**	**8117500**	**1**	**0**	**∑AB = 0.31**
Gini Coefficient = 1- ∑AB, GC = 1 – 0.31 = 0.69.							

Note: NOR = Number of Respondents, A(POR) = Proportion of respondents, CPOR = Cumulative proportion of respondents, TEI = Total Enterprise Income, POTEI = Proportion of total enterprise income, CPOTEI = Cumulative proportion of total enterprise Income, AB = (POR * POTEI).

Probit Regression Analysis of Factors Determining Entrepreneurs Access to Credit

Table 5. presents the results of the Probit regression analysis of socio-economics characteristic affecting entrepreneurs' access to credit. The regression estimate showed that the coefficient of the variables of collateral security, size of enterprise and income were positive and statistically significant at (1% and 5%) p-value while the coefficients of age was statistically significant but negative, indicating that increase in age decreases entrepreneurs' access to credit facility. Other variables (education and household size) were negatively related to access to credit but not statistically significant. The coefficient of the variable of collateral security was positively related to access to credit. This implies that, as the amount of collateral increases, the probability of an entrepreneurs obtaining loan through credit source also increases. The coefficient of the variable of income was positive and significant, it implies that increase in income increases the probability of entrepreneurs to sourcing more loan. The coefficient of the size of enterprise was positive and significant, suggesting that increase in size of enterprise, increases the probability of entrepreneurs in sourcing for loan.

Table 5: Probit Regression Analysis of factors determining Entrepreneurs' Accesses to Credit

Variable	Regression coefficients	P-Value
Constant	2.1435	1.8711
Age	-0.0244	-1.9117
Education	-0.0314	-0.9016
Collateral security	0.6433	3.8864
Household size	-0.0279	-0.3939
Size of enterprise	0.0179	2.5062
Income	0.7957	2.3923
Likelihood Ratio test	10.5795	
McFadden R-Square	0.12031	
Percentage of Right Prediction	0.84000	

Field Survey 2019

CONCLUSION

The study analysed access to credit and poverty status of women entrepreneurs in Ondo State, Nigeria. Based on the findings, most of the respondents were poor and constraint with inadequate collateral security. Besides, there is high income inequality among the respondents. The Probit regression analysis reveals that age decreased the probability of an entrepreneur in sourcing for loan while collateral security, income and size of enterprise increased the probability of an entrepreneur in sourcing for loan. The study recommended that government should reduce the stringent condition needed to obtain loan from banks and financial institutions and provide soft loans to young and existing entrepreneurs to encourage enterprise creation as well as increasing the size of their enterprise. The existing entrepreneurs should be sensitized on radio and market days on the importance of adequate record keeping to increase their chances of securing loan in other to reduce poverty.

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Perception of Vegetable Farmers to Diseases Management Using Mobile Phones in Osun State, Nigeria

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ABSTRACT
The destruction caused by crop diseases has negative effects on food security and production in Nigeria. Mobile Phone based technologies have been successfully integrated into extension and advisory services to farmers in developed countries. This study was conducted to assess the perception of vegetable farmers to diseases management using mobile phones in Osun State, Nigeria. mobile phones in crop disease management as an implication for e-extension and advisory system in Nigeria. A structured interview schedule was used to elicit information from 120 respondents. Descriptive statistics was used to analyse the data. The study reveals that vegetable farmers are aware that mobile phones can be used to enhance information from with expert's/extension professionals. There was a positive perception to the use of mobile phone for crop disease management among majority (80%) of vegetable farmers in the study area. This implies The study concluded that, there is availability of enabling environment for the integration of mobile phones-based technologies for effective crop disease management among extension professionals and farmers in Nigeria.
Keywords: Perception, Mobile phone, Technologies, Crop diseases management, extension and advisory services

INTRODUCTION
Vegetables is vital in human nutrition. Most vegetables have little fat and calories but are bulky and filling (Centres for disease control and prevention, CDCP, 2017). They are important sources of essential vitamins, minerals and trace elements such as antioxidant vitamins A, C and E. Inclusion of vegetables in human diet decreases the incidence of cancer, stroke, cardiovascular disease and other chronic ailments (Oguntibeju, *et al.,* 2013). The role of fruits and vegetables consumption in human health is beneficial to the human body as they boost the immune system, heart, nervous system and the muscles. The anti-oxidants in Vegetables are powerful enough to fight cancer and inflammatory diseases, lower the risk of heart diseases, blood clots, high blood pressure, high cholesterol and diabetes with different cholesterol having different effects in the body. They prevent anaemia and stimulate the metabolism of the body. (Bruso and Jessica, 2018).

Farmers faced many problems as a result of diseases caused by environmental changes and pathogens, hence the need for competent advice from agricultural extension and advisory experts is one of the ways to combat the vegetable crop diseases. Infested crops can have caused direct and severe pathological effects on humans and animals when consumed. Farmers do face a lot of problems as a result of diseases caused by environmental changes and pathogens. They need satisfactory and timely advice from agricultural experts as a way to combat these diseases. The naked eye observation of experts is the main approach adopted in practice for detection and identification of plant diseases (Weizheng *et al.*, 2008). A single picture can replace a thousand words; thus, image is an easy way of communication without any limitation of languages (Yiyi and Ying 2019).

Countries like Russia, United States, Japan, China, Israel, Estonia, India, etc. have been extremely successful in the usage of artificial intelligence through mobile phones (West and Allen 2018). Recent advances in mobile phone technology, data storage and transmission, as well as network coverage allow smart phone users to communicate almost any kind of information in real time from anywhere, such as images taken with built-in camera. In addition, efficient and accurate pattern recognition approaches are able to extract and process information encoded in image data in order to retrieve information about its content in real time (Vinh Loc Cu 2019). According Hughes and Salathe (2015), the current spread of smart phones usage among farmers around the world provides a prospective for transforming the smartphone into a valuable tool in several communities that are involved in food crop production. One of such potential is the development of mobile disease diagnostic machine learning and crowd sourcing. Jaji, Abanigbe and Abass (2017) opined that extension services, especially those in rural areas of developing countries, have been turning to Smartphone as an important tool to aid the diffusion and collection of information. According to Qiang *et al.*, (2012), several applications have been developed to allow subsistence farmers access information. Hence, the assessment on perception of vegetables farmers to mobile phones for crop disease identification and management is very germane as a result of the digital revolution in this digital technology age.

METHODOLOGY

This study was conducted in Osun state. The state was created on 27th August, 1991. The state shares boundaries with Kwara State in the North, Oyo State in the west, Ogun State in the South, Ondo and Ekiti State in the East. It comprises 30 local government areas. According to the 2006 census reports, the population of Osun State stood at about 4.14 million consisting mainly of the Yoruba ethnic group. Over ninety per cent (90%) of the rural people are involved in farming (which farming). Major vegetables grown in the study area include; pepper, tomato, amaranthus, Fluted pumpkin, okra, melon, water leaf, bitter leaf, eggplant, jute mallow, Sokoyokoto (*Celosia argenta*) (Taleat, and Aknfe, 2015).

Osun state is classified into three agro-ecological zones by the Osun State Agricultural Development Project (OSSADEP). The apex of administrative structure is the State headquarters, Osogbo. Vegetable farmers in Osun State were the target of this study. The state was divided into three agro-ecological zones namely Iwo, Ife/Ijesa and Osogbo under the Osun State Agricultural Development Programme (OSSADEP). A random sampling procedure was used to select two of the zones namely: Ife/Ijesa Zone and Osogbo Zone from which respondents were sampled for the study. Sixty respondents were selected from each zone to make total of 120 respondents. Structured interview schedule was used for collection of quantitative data. Descriptive statistics such as percentages, mean and frequency distribution were used to analyse the data.

RESULTS AND DISCUSSION

Results in Table 1 showed that mean age of the respondents was 50 years with a standard deviation of 12 years (50 ± 12 years). These results indicated that larger proportion of the respondents were tending towards their inactive age of productivity while very few of the respondents (5.0%) were in their active age of productivity. The implication is that, majority of the respondents are already tending towards their old age. Majority (73.3%) of the respondents were male while 26.7 percentage of the respondents were female. This implies that, there are more males' respondents involved in the use of mobile phone in vegetable crop diseases identification and management in the study area than the females. Results in Table 1 showed that 60.0 percent of the respondents had secondary education and above. The mean years of formal education was 10.90 years with standard deviation of 5.03. It may be inferred from the results that majority of the respondents had secondary education or less in the study area, thus, they were literate. The findings indicated that majority of the respondents had some literacy level which may be necessary to access and make use of their mobile phones in crop diseases identification and management in the study area. Results in Table 1 showed that slightly more than half 51.7 percent of the respondents had household size of between 6 and10 with mean household size of 7.20 and standard deviation of 3.44. This result conforms with the findings of Garner and Ana (2014) that farm families in rural communities have a reasonably large family size which may provide more family labour in agricultural production.

Results in Table 2 showed that mobile phones can be used to enhance information delivery system with (mean = 1.68), ranked the highest of all the awareness statement by the respondents in the usage of mobile phone in identifying and managing vegetable crop diseases. However, the grand mean score for the awareness statement was 1.42. This implies that respondents were moderately aware of mobile phone potentials for vegetable crop diseases identification and management in the study area. Results in Table 3 shows the perceptions of the respondents in crop diseases management using mobile phone. It revealed that, the statement searching for agricultural information to aid identification of common vegetable diseases will help the farmers, (mean = 3.63) ranked the highest of all the statements. The findings showed that the grand perception mean is 2.86 which show that the majority of the respondents have positive perception in crop diseases management using mobile phone in the study area.

Table 1: Distribution of respondents according to personal and socioeconomic characteristics n= 120

Variables	Frequency	Percentage	Mean	Standard Deviation
Age (years)				
10-30	6	5.0	50.10	11.66
31-50	50	41.7		
51-70	62	51.7		
Above 70	2	1.7		
Sex				
Male	88	73.3		
Female	32	26.7		
Years of formal education				
≤ 5	20	16.7	10.90	5.03
6-10	28	23.3		
< 10	72	60.0		
Household size				
≤ 5	40	33.3	7.20	3.44
6-10	62	51.7		
11-20	18	15.0		

Source: Field Survey, 2019

Table 2: Farmers Awareness of Mobile Phone Potentials for Crop Diseases Identification and Management

Awareness variables	NA Freq(%)	M Freq(%)	VW Freq(%)	Mean Score	Rank
Mobile phones can be used to enhance information delivery system	–	19(31.7)	41(68.3)	1.68	1st
Alert farm families of intending diseases	5(8.3)	12(20.0)	43(71.7)	1.63	2nd
For providing information's on farm enterprises	5(8.3)	23(38.3)	32(53.3)	1.45	3rd
To access current information on specific crop diseases	–	34(56.7)	26(43.3)	1.43	4th
To facilitate interaction between researchers, extension experts and the farmers	7(11.7)	20(33.3)	33(55.0)	1.43	4th
Used to reduce cost and risk of frequent travelling	2(3.3)	31(51.7)	27(45.0)	1.42	6th
Used in efficient crop diseases identification and management	15(25.0)	12(20.0)	33(55.0)	1.30	7th
Used for question-and-answer services in which agricultural workers respond to	15(25.50)	14(23.3)	31(51.7)	1.27	8th
Information and diagnoses crop diseases	22(36.7)	6(10.0)	32(53.3)	1.17	9th

Grand mean = 1.42
Source: Field Survey, 2019

Table 3: Distribution of Respondents based on their perception in crop diseases management using mobile phone.
n=120

Perception Statements	UD Freq(%)	SD Freq(%)	D Freq(%)	A Freq(%)	SA Freq(%)	Mean	Rank
Searching for agricultural information to aid identification of common vegetable diseases will help the farmers	–	–	1(1.7)	20(33.3)	39(65.0)	3.63	1st
Advertisement of crop diseases management will improve marketability and profit making	3(5.0)	–	6(10.0)	33(55.0)	18(30.0)	3.05	2nd
Taking pictures of diseases after spreading will not solve any problem	4(6.7)	19(31.7)	26(43.3)	5(8.3)	6(10.0)	2.83	3rd
Calling other farmers to investigate diseases identification will reduce crop losses	7(11.7)	1(1.7)	5(8.3)	33(55.0)	14(23.3)	2.77	4th
Contacting expert to help in diseases identification and management using mobile phone is expensive	–	11(18.3)	29(48.3)	8(13.3)	12(20.0)	2.65	5th
Purchase of mobile phone that could be used in diseases identification and management is not solving any problem	–	16(26.7)	11(18.3)	7(11.7)	26(43.3)	2.28	6th

Grand mean = 2.86
Source: Field Survey, 2019

CONCLUSION

The objective of this paper is to assess the perception of vegetables farmers to mobile phones in identifying and managing crop diseases in the study area. The study revealed that farmers indicated positive/ favourable perception to mobile phones in identifying and managing crop diseases. Hence, extension agents should leverage on the use of mobile phones by the farmers to disseminate agricultural innovation and advisory services. There should be more sensitization and creation of awareness about the agricultural benefit of mobile phone usage by government through extension agents to farmers apart from communication which most farmers are familiar with.

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Costs and Returns Analysis of Maize *(Zea mays L.)* Processing in Imo State

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ABSTRACT
A study of costs and returns analysis of maize (Zea mays L,) processing was carried out in Imo State of Nigeria. The study revealed the socio-economic characteristics of the maize processors, the source of harvested maize as well as disposableness of processed maize, the types of processing technology used, average costs and returns analysis of each processing technology used per week. A multiatge sampling procedure was used to select 150 respondents using a well-structured questionnaire/interview schedule. Data were analyzed using D descriptive statistics and gross margin analysis. Majority of the respondents sold their various processed maize products to earn income for sustaining their standard of living in which the Coronavirus (Covid-19) Pandemic brought serious havoc to the growth and development of the economy nationwide as well as worldwide. It is recommended that Mechanized Maize Processing Center should be encouraged and established by Federal and State Governments specifically in each of the three agricultural zones of the state to increase the scale of operations and ease of processing. Also, maize processors should have access to credit facilities and loans from banks, co-operatives and international organizations.
Keywords: Costs, Returns, Maize Processing, Gross Margin.

INTRODUCTION
Maize *(Zea mays L.)* is also known as corn. Maize is a cereal grain that was originated from Southern Mexico about 10,000 years ago. It is the most widely grown grain that has become a staple food in various parts of the world with its total production surpassing that of wheat and rice (FAO, 2014). It is ranked the fifth largest in land area cultivation, the third largest in yield and the fourth largest in output (Surinder, 2011). Maize is a major cereal food crop in West Africa that is cultivated in Sub-Saharan Africa thus, it is one of the most important grains in Nigeria. It provides food, animal feeds and raw materials for some agro-based industries in Nigeria. About 65% of maize consumed by man and animals while 35% is utilized in various industrial processes (Igbokwuwe, 2015).

Processing implies a change in form of the original produce. That is, it is the treatment given to agricultural produce after harvesting which adds value to the produce for consumption and satisfaction (Igbokwuwe, 2015). Maize is processed into different products by efficient processing methods which includes sweet corn, flint corn, pod corn, pop corn, dent corn, field corn, corn meal, corn flakes, corn oil e.t.c. This efficient processing methods is regarded as Processing Technology that comprises of three types:-Traditional Processing Technology (TPT),Modern Processing Technology (MPT) andTraditional and Modern Processing Technology (TMPT) combined (Igbokwuwe, 2015).

Traditional Processing Technology (TPT) implies processing for consumption only in which family basis is attained. Modern Processing Technology (MPT) implies processing for market sales for profit maximization. While Traditional and Modern Processing Technology (TMPT) implies processing of large quantity for consumption and market sales for profit maximizatiom combined (Igbokwuwe, 2015). State the problem identified to be solved and motivation for carrying out this study. Re state your broad objective and specific objectives to address the main objectives.

METHODOLOGY

The study area was Imo State with a tropical climate of two distinct seasons. The annual rainfall ranges between 1,000mm and 1,500mm, temperature of about 30°c to 35°c and humidity of 35% to 60%. A three stage random sampling technique was used in selecting the sample for the study. The first stage involved random selection of the three agricultural zones (Owerri, Okigwe and Orlu) as delineated by State Agricultural Development Programme (ADP). The second stage involved a random selection of five (15) villages from each of the zones using the State Agricultural Development Programme (ADP) listing as sampling frame and thus giving a total of 15 villages altogether. In the third stage, twelve household heads were randomly selected from each village of the three state's agricultural zones . A total of 180 farming households were chosen but only 150 farming households were finally used for this study as some of the other households did not engage in maize processing. Primary data collected using a well-structured questionnaire/Interview Schedule was administered with the help of Agricultural Extension Agents working in each of the selected areas. Data analysis for this study was carried out using descriptive statistics and gross margin analysis.

Gross Margin Analysis

The Gross Margin Analysis (GMA) is a method of estimating the costs, returns, profitability or negativity of cassava processing (source and date). The total revenue (TR) represents the value of output of cassava processing from the farm/processing machine or processing industries (ie physical quantity of the crop multiplied by the unit price). The total cost, on the other hand, is made up of the "Variable and Fixed" components. Variable Cost (VC) also known as specific cost varies directly with the level of processing and include expenditure on peeling, grating, frying e.t.c. Fixed costs (FC) are known as overhead cost that do not vary with the level of output and consist of cash expenses (on repairs and maintenance e.t.c) and non cash adjustment (depreciation on farm/processing tools, equipment and machinery).
The Gross Margin Analysis of Cassava Processing in Anambra state was expressed as ;

$$GM = TR - TVC \quad (1)$$

Where,
GM = Gross Margin
TR = Total Revenue
TVC = Total Variable Cost.

RESULTS AND DISCUSSION

Table 1 shows the socio-economic characteristics of the respondents. It reveals that 89.4% of the respondents are still within their productive ages and production is mainly in the hands of females (78%). Less than half of the respondents are married (42%) with 11-15 years of experience (34%) and more than half of them were educated (56.7%). Result shows that most (87%) of the farmers (processors) were full-time farmers (processors) that can make positive contribution to agricultural production and also, depends on farming for livelihood as well as processing raw maize.

Table 1: Socio-economic characteristics of Respondents.

Variable	Frequency	Percentages
Age (in years)		
< 30	34	22.7
31 – 40	42	28.0
41 – 50	58	38.7
>50	16	10.6
Total	150	100.0
Sex		
Male	33	22.0
Female	117	78.0
Total	150	100.0
Marital Status		
Single	41	27.3
Married	63	42.0
Widowed	36	24.0
Divorced	10	6.7
Total	150	100.0
Experience (in years)		
< 5	21	14.0
6 – 10	44	29.3
11 – 15	51	34.0
>15	34	22.7
Total	150	100.0
Status of Farmers		
Full-time	87	58.0
Part-time	63	42.0
Total	150	100.0
Education		
No formal education	65	43.3
Primary	43	28.7
Secondary	24	16.0
Tertiary	18	12.0
Total	150	100.0
Occupation		
Farming	64	42.7
Civil servant	54	36.0
Trading	22	15.0
Artisan	10	6.3
Total	150	100.0

Source: Field Survey, 2020

Table 2 shows that 53.3% of the respondents get harvested maize from their personal farm, 28% purchased harvested maize from purchased/leased farm and 18.7% acquire harvested maize from co-operative farm. This implies that majority of the respondents own their harvested maize in which they get their benefits. Also, the table shows that 21.3% of the respondents offer their various processed maize products for their home consumption, 52% of the respondents offer their various processed maize products for market sales and finally, 26.7% of the respondents offer their various processed maize products for both home consumption and market sales. This implies that majority of the respondents sell their various processed maize products to earn income for sustaining their standard of living in which the Coronavirus (Covid-19) Pandemic brought serious havoc to the growth and development of the economy nationwide as well as worldwide.

Table 2: Distribution of Respondents according to Source of Harvested Maize and Sales of Processed Maize

Source	Frequency	Percentage
Personal Farm	80	53.3
Purchased/Leased Farm	42	28.0
Cooperative Farm	28	18.7
Total	150	100.0
Disposable		
Home Consumption only	32	21.3
Market Sales only	78	52.0
Both Combined	40	26.7
Total	150	100.0

Source: Field Survey, 2020

Table 3: Distribution of Respondents according to Processing Technology used

Types	Frequency	Percentages
Traditional Technology only	23	15.3
Modern Technology only	39	26.0
Traditional & Modern Technology combined.	88	58.7
Total	**150**	**100.0**

Source: Field Survey, 2020

Table 3 shows that 15.3% of the respondents use Traditional Processing Technology (TPT) only in processing maize, 26% of the respondents use Modern Processing Technology (MPT) only in processing maize and 58.7% of the respondents use both Traditional and Modern Processing Technology (TMPT) in processing maize. This implies that majority of the respondents in the study area combine bothe the use of Traditional and Modern Processing Equipment.

Table 4 shows the Costs and Returns of the various Processing Technology used per week. The Traditional Processing Technology (TPT) only has an average cost of ₦17,430 and ₦35,280 as an average returns per week. While the Modern Processing Technology (MPT) only has an average cost of ₦42,190 and ₦89,100 as an average returns per week. The Traditional and Modern Processing Technology (TMPT) combined has an average cost of ₦83,850.00K and ₦176,720 as an average returns per week. Therefore, Total Cost (TC) per week is ₦143,470 and Total Returns (TR) per week is ₦301,100.

Table 4: Average Costs and Returns Analysis of the Processing Technology used per week

Types	Costs (₦)	Returns (₦)
Traditional Technology only	17,430.00	35,280.00
Modern Technology only	42,190.00	89,100.00
Traditional & Modern Technology combined.	83,850.00	176,720.00
Total	**143,470.00**	**301,100.00**

Source: Field Survey, 2020

Table 5 shows the Gross Margin of the Processing Technology used per week. The result revealed that Costs of production (TC) accounted 12.1% which is ₦17,430 per week for Traditional Processing Technology (TPT) only, 29.4% which is ₦42,190 per week for Modern Processing Technology (MPT) only and 58.5% which is ₦83,850 per week for both Traditional and Modern Processing Technology (TMPT) combined.

Table 5: Gross Margin Analysis of the Processing Technology Used Per Week

Types	Cost (₦)	Percentages	Returns (₦)	Percentages	Gross Margin	Percentages
Traditional Technology only	17,430.00	12.1	35,280.00	11.7	17,850.00	11.3
Modern Technology only	42,190.00	29.4	89,100.00	29.6	46,910.00	29.7
Traditional & Modern Technology combined	83,850.00	58.5	176,720.00	58.7	92,870.00	59.0
Total	143,470.00	100.0	301,100.00	100.0	157,650.00	100.0

Source: Field Survey, 2020

Also, it shows that Gross Returns (GR) accounted for 11.7% (which is ₦35,280.00K) per week for Traditional Processing Technology (TPT) only, 29.6% which is ₦89,100 per week for Modern Processing Technology (MPT) only and 58.7% which is ₦176,720 per week for both Traditional and Modern Processing Technology (TMPT) combined. Therefore, Gross Margin (GM) revealed 11.3% (which is ₦17,850 profitable per week for Traditional Processing Technology (TPT) only, 29.7% which is ₦46,910 profitable per week for Modern Processing Technology (MPT) only and 59.0% which is ₦92,870 profitable per week for both Traditional and Modern Processing Technology (TMPT) combined.

CONCLUSION

From the above results, majority of the respondents are still within the active ages and maize processing was mainly in the hands of married and experienced processors. However, the total returns (TR) for the processing technology used was ₦301,100. while the total cost (TC) for the Processing Technology used was ₦143,470. Therefore, the Gross Margin for the processing technology used was ₦157,630 which implies that maize processing is highly profitable in the study area. Also, it implies that the best technology for maize processing in the study area is combined Traditional and Modern Processing Technology (TMPT) that guarantee efficient viability of available resources with optimum outputs.

Despite the climatic conditions and constraints that affect maize processing especially the Coronavirus (Convid-19) Pandemic, maize processing is profitable and attainable. Therefore, it is recommended that increase in processors to focus on the use of both Traditional and Modern Processing Technology (TMPT) and formation/establishment of a union/cooperatives society should be encouraged in the state. Also, it is recommended that Mechanized Maize Processing Centers should be established specifically in each of the agricultural zones of the state by Federal and State Governments to increase scale of operations and outputs. Finally, it is recommended that maize processors should have access to credit facilities from banks and international organizations.

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Profitability Analysis of Oil Palm Seedling Production in Ondo State, Nigeria

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ABSTRACT

This Study empirically investigated the profitability of oil palm seedlings production in Ondo state, Nigeria. In order to achieve the broad objective, four specific objectives were raised to guide the study. Data were randomly collected from 60 respondents using a multi stage sampling procedure, Data collected were sorted, organized and processed using Cobb Douglas multiple regression. The result of the findings revealed that the mean age of respondents was 40 years and 90% of the farmers were males while female accounted for only 10%. The mean farming experience was 10 years and the result further showed that 65% of the farmers financed their farming operations through personal savings. Farmers mostly relied on borehole water as source of water in their nurseries and about 73.3% of them were actually making use of inorganic fertilizer in their nurseries. The study also showed that the total revenue (TR) of the farmers was #3,183,204.00 and the total variable cost (TVC) was #195,392.20. While the gross margin (GM) of the farmers was #2,987,811.80 per annum, their average gross margin (AGM) was #49,796.86 per month/farmer. The regression result showed that all variables except gender and miscellaneous operating cost had positive and significant influence on the profitability of oil palm seedlings production. The study concluded that production of oil palm seedlings is profitable. Following the major findings in this study, it was recommended that financial aid should be provided for oil palm seedling farmers through soft loan to be able to expand their farm sizes and there should be regular extension visits to the farmers to keep farmers constantly abreast of emerging innovations is oil palm seedling production.

Keywords: Oil Palm Seedling, Production, Profitability Analysis, Ondo State.

INTRODUCTION

There has been a rapid global development of the oil palm industry since the early sixties, majorly due to the ever-increasing world demand for oils and fats, upsurge in the potential profitability of the crop, imperative of diversification of the sources of income by the oil palm growing nations and most significantly, ability of the rural workers and smallholders to adapt to new changing patterns of agricultural development and effective adoption of the emerging innovation in the oil palm industry world-wide. The contribution of the Nigerian oil palm industry was quite remarkable at the early stages of Nigerian economic growth. The significance of the oil palm production to the Nigerian economy arises from two factors. Firstly, the contribution of the industry to export earnings, and secondly, the fact that production of palm produce for export is a major source of income to a substantial proportion of the oil palm farmers in the southern Nigeria. Ehicheoya and Joseph (2016) stated that the oil palm industry was the engine of economic growth, contributing over 80% of the total Nigerian domestic export earnings annually during the first decade of the twentieth century. Nigeria indeed almost depended on palm produce for her export earnings during this period. Usoro (1994) reported that the value of oil palm produce as a percentage of total export earnings rose from 74.4% in 1906 to 86.1% in 1911. Udom (2019) recorded a steady decline of palm produce as an export earner as from 1920 which he opined was majorly due to almost absolute dependence on the proceeds from mineral oil particularly, since its first export in 1956 and the Nigerian civil war of 1967. Another critical reason for this downturn as noticed by Iwala (2005), was the sustained use of traditional and crude production methods by smallholder oil palm farmers that account for about 70% of the oil palm industry and its attendant persistent low yield per hectare. The oil palm sector in Nigeria has since continued cascading with the contribution of palm oil and palm kernels being mere 15% to 20% of the country's total exports. The global market share of Nigerian oil palm produces stands at a meagre 1.4% as at 2018 according to data from the United State Department of Agriculture (USDA). Oil palm production just like any other agricultural venture cannot enjoy sustainable development if the venture is perceived not to be profitable. One of the major ways of breaking the jinx of recession in oil palm industry and enhancing international competitiveness is to critically examine the specific socio-economic characteristics of farms and farmers that influence profitability of oil palm production. This study is therefore conceptualized to examine the profitability of a very crucial aspect of oil palm production, which is oil palm seedling production.

The broad objective of the study is to economically analyze the profitability of oil palm seedlings production in the study area. The specific objectives are to: describe the socio-economic characteristics of the producers of oil palm seedlings in the study area; compute the cost and returns on oil palm seedlings production; identify the factors affecting the level of income generated in the production of oil palm seedlings; and identity the constraints militating against profitable production of oil palm seedlings.

METHODOLOGY

The study was conducted in Ese-Odo, Irele and Okitipupa Local Government Areas of Ondo State, Nigeria. The 3 LGAs were purposively selected because oil palm is the main permanent crop grown and it plays a dominant role in the socio-economic activities of the people in particular and the state in general. Selection of the study area was also influenced by the presence of two big oil palm companies in the area, namely: Okitipupa Oil Palm Pic, Okitipupa and Ode-Irele Oil Palm Company Ltd, with oil palm plantations totaling about 18,743 hectares in both companies. The activities of both companies over the years have influenced the small-scale farmers to adopt the cultivation of oil palm as their main permanent crop. Other agricultural activities in the area include yam, cassava, plantain and fish farming.

The study area constitutes three (3) of the eighteen Local Government Areas that make up Ondo state and situated in the Southern Senatorial District of the state. The 3 LGAs lie between longitudes 4° 57/ and 6° 40/ Greenwich meridian and latitudes 4° 43/ and 6° 31/ North of the Equator. The area lies within the tropical rainforest zone of Nigeria with the annual rainfall which often exceeds 2000mm and the temperature ranges between 27^{0}C and 28^{0}C. The 3 LGAs generally enjoy luxuriant vegetation which is highly favourable to oil palm production. The study area covers a total land area of 2,528sq.km and has an estimated population of 724,300 people. The study area was bounded in the east by Edo state while to its west lies part of Osun State and the Atlantic Ocean by the south. The inhabitants of the study area are mainly Yoruba of Ikale ethnic group, Apoi and Ijaw. The area is mainly agrarian in nature, with the cultivation of cash and food crops, while the Ijaws of Ese-odo are mainly fisher men and women.

A multistage sampling technique was used to select respondents for this study. In the first stage, 3 Local Government Areas (Okitipupa, Irele and Ese-Odo) were purposively selected from Ondo State because of the predominance of oil palm production in the area. In the second stage, 2 communities were randomly selected from each of the LGAs, (Ode-Ayeka and Ilu-titun in Okitipupa LGA), (Ode-Irele and Iyansan in Irele LGA) and (Igbekebo and Sabome in Ese-Odo LGA), making a total of 6 communities from the 3 Local Government Areas. Finally, 10 farmers were randomly selected from each of the selected communities to obtain 60 respondents as sample size. Primary data were mainly used for this study. These data were collected with the aid of detailed and well-structured questionnaires on socio-economic characteristics of oil palm seedling farmers such as age, gender, household size, level of education, etc. The data collected were subjected to descriptive and inferential statistical analysis, such as frequency distribution, mean scores and tables. Gross margin was used to measure the profitability level of oil palm seedling farmers. It is mathematically represented as:

$$GM = TR - TVC$$

Where,

GM = Gross margin accrued to oil palm seedling farmers
TR = Total revenue accrued to oil palm seedling farmer
TVC = Total variable cost incurred by oil palm seedling farmers
TC = Total cost incurred by oil palm seedling farmers
TFC = Total fixed cost incurred by oil palm seedling farmers

Regression analysis was used to ascertain the independent variables that significantly contributed to the profitability of oil palm seedling production as an enterprise in the study area. The ordinary least square multiple regression model was used. This model has equally been used by many researchers such as Alabi and Adebayo (2008). The explicit form of the model can be stated as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + e_i \quad (1)$$

Y = Gross margin
X_1 = Vector of independent variable in the model
β_0 = Constant
$\beta_1 - \beta_n$ = Vector of unknown parameters to be estimated

Double log functional form

$$Y = \log \beta_0 + \beta_1 \log X_1 \, ei \quad (2)$$

Log = Logarithm
Y = Gross margin
Semi log:

$$Y = \log \beta_0 + \beta_1 \log X_1 \, ei \quad (3)$$

Exponential log functional:

$$\log Y = e\,(\beta_0 + \beta_1 + \log X_1 + e) \quad (4)$$

e = error term

Four functional forms were tried using Ordinary Least Square (OLS) estimation for each seedling farmers. Linear, semi-log, double-log and exponential log was proposed, others were dropped for reason of their being unstable. Besides, in production studies, the Cobb – Douglas production seems to be the preferred.

RESULTS AND DISCUSSION

Table 1 shows the socio-economic characteristics of the respondents. The table revealed that 78.3% of the respondents were between 20 and 50 years of age. This age structure implies that the respondents are mostly within the economically active age which would make them productive and innovative in oil palm seedling production. The gender distribution of the respondents showed that 90% of the respondents were male. This finding is in agreement with the submission of Baiyewa (2017) that gender inequality remains an issue in oil palm farming as land grabbing and obnoxious tradition seem to have taken away women's rights to permanent lands. They are more or less able to practice subsistence farming and help their male counterparts in palm oil processing. The educational status of the respondents revealed that 83.3% of respondents had primary education and above.

Table 1: Socio-economic characteristics of respondents (N=60)

Characteristics	Frequency	Percentage (%)
Age (Years)		
< 20	01	1.7
20 – 30	11	18.3
31 – 40	14	23.3
41 – 50	22	36.7
50 and above	12	20
Gender		
Male	54	90
Female	6	10
Educational Status		
Non-Formal education	2	16.7
Primary School	10	33.3
Secondary	27	30
Tertiary	21	20
Farming Experience (Years)		
1 – 5	10	16.7
6 – 10	20	33.3
11 – 15	18	30
16 and above	12	20
Sources of funds for seedling production		
Personal savings	39	65
Family savings	04	6.7
Loan through friends/associates	10	16.7
Loan from banks/other credit institutions	02	1.7
Loan from cooperative/thrift societies	05	8.4
Nursery Land Area (Size)		
< 0.3 acre	29	48.3
0.4 – 0.6 acre	22	36.7
0.7 – 0.9 acre	05	8.3
1 acre and above	04	6.7
Source of oil palm seeds nursed		
Direct from NIFOR	21	35
Direct from ADP	18	30
Randomly supplied	14	23.3
Picked from existing plantations	07	11.7

Source: Field Survey, 2020

This shows that oil palm seedlings producers in the study area had relatively high level of education which should be an advantage in making the farmers accessible to the prevalent inputs and innovations in oil palm nursery techniques. This is in agreement with the positions of Akinola (1983) and Yustus et al (2014) that educated farmers would understand the need to source for vital information on their farming enterprises from the right source. The study also revealed that only 16.7% of the respondents had less than six years' oil palm seedling production experience. This implies that farmers had stayed long enough in the enterprise which ought to have made them well-experienced in oil palm seedling production.

The table further revealed that 65% of the respondents depended on their personal savings while 23.4% relied on loans from family members and friends/associates. The implication of this is that only 10.1% of the respondents had access to loans from cooperative societies and conventional credit institutions. This finding is in congruent with the position of Agbelekale (2020), that though billions of naira are allotted to the agricultural sector in Nigeria every year, farmers are still unable to access government loans to expand due to government bureaucracy. An insignificant proportion (6.7%) had nursery land area (size) over 1 acre. This could be as a result of lack of access to sufficient fund to purchase or lease more land for expansion. Adegeye and Dittoh (1985) had submitted that small farmers are poor because they cultivate small areas and hence, sell only a very small amount which in turn cannot help in expanding their farms. Majority of the respondents (65%) procured their sprouted nuts directly from either Nigerian Institute for Oil Palm Research (NIFOR) or the Zonal Agricultural Development Projects (ADP) offices. While 23.3% who procured from random suppliers of the nuts with the believe that such nuts were genuine from either NIFOR or ADP, only 11.7% of them admitted that they picked and processed their planting nuts from the established government plantations around them. The implication of this is that majority of the seedling producers were in the knowledge of improved oil palm seeds and the benefits of planting them in their nurseries.

Table 2 revealed the percentage distribution of cost and returns of oil palm seedling farming in the study area. The total variable cost (TVC) of producing oil palm seedlings per annum was ₦195,392.20. The average variable cost of procuring sprouted seeds per year was ₦54,028.5 representing 27.65% of the total variable cost. About 8.08 % of the total variable cost was expended on hired labour while average of ₦13,863.9 was spent on cost of herbicides representing 7.10% of the total variable cost. Cost of fertilizers used by the farmers was ₦9,910 which was about 5.037% of the TVC. About ₦20,248.80 and ₦25,872.40 were spent on nursery materials and transportation, representing 10.36% and 13.24% respectively. The cost of generating power for watering the nursery was ₦55,685.30 representing about 28.5% of TVC which is very significant. The total revenue was ₦3,183,204.00, the oil palm seedlings farmers realized an average gross margin of ₦2,987,811.80 translating to ₦49,796.86 per month/farmer. The result indicates that oil palm seedlings production is highly profitable in the study area.

Table 2: Revenue/Cost structure for oil palm seedling production in the study area.

Parameter	Amount (₦)/ha	Percentage (%)
Total Revenue (TR)	**3,183,204.00**	
Variables Cost (VC)		
Cost of sprouted nuts (seeds)	54,028.30	27.65
Cost of labour	15,783.50	8.08
Cost of herbicides	13,863.90	7.10
Cost of fertilizers	9,910.00	5.07
Cost of materials (nylon, nets, etc.)	20,248.80	10.36
Cost of transportation	25,872.40	13.24
Cost of diesel/generator maintenance	55,685.30	28.50
Total Variable Cost	**195,392.20**	

Source: Field Survey, 2020

Therefore, Gross Margin = Total Revenue – Total Variable Cost
GM = TR – TVC
= ₦3,183,204.00 – ₦195,392.20
= ₦2,987,811.80 per month

$$\text{Average Gross Margin} = \frac{2{,}987{,}811.80}{60} = ₦49{,}796.86$$

Table 3: presents the results of regression analysis of the Cobb Douglas production function for oil palm seedlings production in the study area. The Cobb Douglas production was chosen on the basis of economic, statistical and econometric criteria on one hand, and on the other

hand, the elasticity of input can be ready directly as the co-efficient. The value of R2 was 0.40 which implies that 40% of the total variation in the level of income generated from oil palm seedlings was accounted for by all the explanatory variables in the regression model. Also, the significance of F-value of 8.850 at (p> 0.05) is that all the variable in the model jointly exerted a significant influence on the income level of the farmers. To further diagnose the validity of the regression model, the Durbin Watson test was conducted and the value was 2.0 which implies that there was absence of autocorrelation in the sampled parameters. In the model, five variables were found to be significant out of six.

The variables that were significant include costs of sprouted nuts (seeds), labour and herbicide, generator/diesel interaction. These variables are discussed as follows: The cost of sprouted nuts had a negative influence on the level of income realized from the production of oil palm seedlings at the 1% level of significance. This result implies that a one unit increase in the price of sprouted seed would lead to a decrease in the income generated by the farmer by 56%. This result agrees with a prior expectation. Cost of labour had its expected sign, with a negative relationship with the income generated from the oil palm seedlings. It was significant at 1%. The result revealed that a one unit increase in the cost of labour, holding other variables in the model constant, the level of income generated on the production of oil palm seedlings would decrease by 48%. The study also revealed that cost of herbicides was negatively and statistically related with the level of income generated from the production of oil palm seedlings at the 1% level.

This result indicates that a unit increase in the cost of labour hired, ceteris paribus, would decrease income by about 62%. The results as shown in Table 3 further revealed that the cost of fertilizer is positively significant. It is also statistically related with productivity and profitability. The result implies that a unit increase in application of fertilizer in the production of oil palm seedlings will lead to about 22% increase in productivity and profitability of the enterprise. As for cost of generator maintenance and diesel for pumping water to wet the seedlings, it is negatively significant at 1% level. This implies that any unit increase in the cost of this variable will reduce the profitability by about 63%.

Table 3: Cobb Douglas multiple results and estimates for oil palm seedling production.

Variables	Coefficient	Standard Error	P-value
Intercept	21.659	7.207	0.004
Sprouted seed cost	-0.568	0.131	0.000**
Labour cost	-4.806	1.71	0.007**
Herbicides cost	-6.188	2.125	0.005**
Cost of fertilizer	0.223	0.065	0.731**
Generator maintenance and diesel cost	- 6.354	0.082	0.063**
R-squared	0.46		
Adjusted R2	0.40		
F-statistics	8.850		
Sig.	0.000		
DW	2.00		

Source: Field survey, 2020

Table 4 shows the distribution of respondents by constraints faced in oil palm seedling production. These ranged from high transportation to lack of fund, vagaries in climatic conditions, pests infestation, lack of extension visits, insufficient water supply, poor soil, expensive materials, arduousness of nursery operations, poor seed viability and scarcity of labour. Lack of fund and pests infestation which ranked highest as constraints are (15.0% at par, followed by insufficient water supply (11.8%), poor soil, lack of extension visits and expensive nursery materials were 10.0% at par. While scarcity of labour is 5.1%, high transportation and vagaries in climatic conditions are 3.3% at par.

Table 4: Friedman and Kendall's mean rank of constraints faced by oil palm seedling farmers

Constraints	Position of Constraints	Mean Rank	Percent
Lack of credit facilities	9	15.0	1st
Pests' infestation	9	15.0	1st
Insufficient water supply	7	11.8	3rd
Lack of extension visits	6	10.0	4th
Poor soil	6	10.0	4th
Expensive nursery materials	6	10.0	4th
Arduousness of nursery operations	5	8.3	7th
Poor seed viability	5	8.3	7th
Scarcity of labour	3	5.0	9th
Vagaries in climatic conditions	2	3.3	10th
High transportation	2	3.3	10th
Total	60	100	

Source: Field survey, 2020

CONCLUSION

The study concludes that oil palm seedlings production is very profitable as the average gross margin was ₦49,796.86/month/farmer. Forty percent of the total variations in the level of income generated from oil palm seedlings was accounted for by all the explanatory variables in the regression model. The study further concludes that out of all the variables, only labour cost, cost of herbicides and cost of generator maintenance was negatively and statistically related to the level of income generated from oil palm seedlings production at 1% level. The implication of this is that further increase in a unit of each of these variables, holding other variables constant would decrease the income generated by the farmers by 48%, 62% and 63% respectively. The most critical of the constraints militating against profitability of oil palm seedling production as an enterprise are: lack of credit facilities, pests' infestation in the nursery, insufficient source of water supply, lack of extension visits, poor soil and relatively expensive nursery materials. Based on the findings of the study, the following recommendations are made to enhance profitability of oil palm seedlings production.

1. Access to soft loans by farmers from financial institutions with little or no rigidities and encumbrances.
2. Oil palm seedling farmers should strive hard to increase their nursery land sizes to be able to garner more profits through economy of scale.
3. Farmers must have access to extension workers for regular information on modern nursery techniques and improved inputs. Extension departments must be adequately funded and strengthened to achieve this.
4. Investment in oil palm seedling production by agripreneurs with sufficient funds should be encouraged. Oil Palm seedling production is highly profitable as an enterprise and could help to provide jobs for the teaming jobless rural youth.

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Investigating the Constraints Militating Against Microcredit Use by Ginger Processors in South East, Nigeria

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ABSTRACT
This study examined the constraints militating against microcredit use of ginger processors in south east, Nigeria. A multi-stage sampling procedure was used in selecting one hundred and twenty (120) respondents for the study. A well-structured questionnaire was used in collecting data from the respondents and the data collected were analysed using frequency distribution and mean. The result shows that majority of the marketers were female and are married, they are still in their active age of 31-50 years which had the highest representatives (65.83%). The result of the Constraints militating against microcredit use of ginger processing shows that majority of the respondents had overbearing bottleneck during the process of obtaining microcredit and it was also reported that microcredit is for the poor. It is therefore recommended that male counterparts should be encouraged since it is source income for household and livelihood. Cost of getting microcredit is should be reduced to encourage ginger processers in the management of the business and ginger processers should be encouraged to engage in seminars that will provide information on easy access to micro-credit.

Keywords: Ginger, Processers, Microcredit and Constraints

Introduction
Ginger is one of the principal cash crops in Nigeria. Nigeria is one of the major producers, and it is an important export commodity of Nigeria (Ojiako *et al.,* 2007). Ginger powder is fast becoming a household kitchen item in Nigeria. In the market, ginger is available in various forms; fresh ginger rhizome, powder ginger and dry ginger rhizome (Brian, 2014). About 10% of the produce is consumed locally as fresh ginger while the remaining 90% is dried for both local consumption and export. According to Ezeagu (2006), 20% of the dried ginger is consumed locally for various uses, and 80% is exported. The crop is an essential spice with real potential for employment creation and income generation. It is a low-volume, high-value tropical crop. In the foods and beverages industry, ginger is used as an additive for its aroma and pungency. It is one of the oldest rhizomes widely domesticated with spice. The crop is highly cherished in the international market because of its aroma pungency and high oil with oleoresin content called gingerin.

Ginger is a seasonal and perishable crop (USAID 2017). It is an export crop because of its high demand in advanced for medical and confectionery industries. Due to the lack of storage facilities, traders are forced to sell the product immediately after collection from farmers. The functioning of food markets in many developing countries is hampered by the high costs involved in market exchange and differences in technology to a large degree, account for observed lower marketing activity of the poor. Ginger markets in Nigeria are unorganized like many other food markets and participants assume different roles at different points. Prices of food items have been fluctuating partly on account of low productivity and irregular supplies. In developing economies, marketers face so many problems and these problems inhibit effective performance of the marketing system. This study therefore examined the socioeconomic characteristics by ginger processors and the constraints militating against microcredit use of ginger processors.

MATERIALS AND METHODS

Study area

The study was conducted in South east states of Abia, Ebonyi and Imo of Nigeria. The area lies between Latitude 5^0 29^1, 5^0 32^1, and 6^0 20^1 N of equator and 7^0 01^1, 7^0 29^1, and 8^0 06^1 E Longitude of Greenwich meridian respectively. The states have a total land mass of 10,952,400ha. The zone has over 16 million resident's populations (NPC, 2016). The zone is made up of five states, namely: Abia, Anambra, Ebonyi, Enugu, and the Imo States. It also has a rural population density of 173 persons per square kilometer (Iloka and Anuebunwa, 1995). About 60-70% of the inhabitants are engaged in agriculture, mainly crop farming, animal rearing, food processing, and marketing of farm produce. The climate can be described as tropical with two clear, identifiable seasons namely, the wet and dry seasons. Farming, processing, and marketing are the predominant occupations of the people. The economy of the zone primarily depends on agriculture and commerce.

Data Collection

A multi-stage sampling procedure was used in selecting the respondents for this study. The target population was ginger processors. The first stage involved purposive selection of three states, namely Abia, Imo, and Ebonyi out of the five states in the South east geo-political zone. These states were chosen based on their high-level activities in ginger processing.

In the second stage, two agricultural zones were purposively selected from each of the selected states, giving a total of six agricultural zones. The agrarian zones selected are Aba and Umuahia from Abia State, Ebonyi North and Ebonyi South from Ebonyi State and Owerri and Okigwe from Imo State. In the third stage, two LGAs were purposively chosen from each of the two agricultural zones, giving a total of twelve LGAs.

In the fourth stage, two (2) communities were purposively selected from each LGA based on the use of microcredit facility, giving a sample of 24 communities. In the fifth stage, one market was purposively selected from each community to give a total of 24 markets was chosen from each of the selected communities. In the sixth stage, a random sampling technique of five (5) ginger processors was selected and informative community resident, extension agents, and ginger marketing association in the areas. This gave 120 ginger processors in the areas.
Data collected from the ginger processors were analyzed using descriptive statistics such as frequencies distributions and mean. Socioeconomic characteristics of ginger processors and Constraints militating against microcredit users in the study areas, was achieved using descriptive statistics.

RESULTS AND DISCUSSION

The socio-economic characteristics of ginger processors such as gender, age, marital status, level of education, processing experience, marketing experience, household size, membership of cooperatives, and extension visits were discussed under this section. The results of the socio-economic characteristics of ginger processors for microcredit users are presented in Table.1.

Table 1: Socio-economic characteristics of ginger processors that used microcredit.

Variables	Freq	Percentage
Gender		
Male	25	21.0
Female	95	79.0
Total	120	100.0
Age (years)		
21-30	23	19.17
31-40	45	37.5
41-50	32	26.67
51-60	15	12.5
61-70	5	4.17
Total	120	100.0
Mean		43.38
Marital status		
Married	70	58.33
Single	19	15.83
Divorced	10	8.33
Widow	21	17.5
Total	120	100.0
Education level (years)		
No formal Education	3	2.5
Primary Education(1-6)	20	16.67
Secondary Education(7-13)	58	48.33
Tertiary Education(14-19)	39	32.5
Total	120	100.0
Experience (Years)		
1-5	24	20
6-10	25	20.83
11-15	20	16.67
16-20	19	15.83
21-25	18	15
26-30	14	11.67
Total	120	100.0
Mean	10.84	10.66
Household size		
1-3	28	23.33
4-6	41	34.17
7-9	40	33.33
10-12	11	9.17
Total	120	100.0
Mean		
Cooperatives		
None members	40	33.33
Members	80	66.67
Total	120	100.0
Extension visits		
No	61	50.83
1-2	42	35
3-4	17	14.17
Total	120	100.0
Mean		1.37

Source: Field Survey Data, 2018

The result in Table1 shows that majority (71.43%) of the ginger processors who used microcredit were females and (28.57%) of processors are male. This could be that processing of ginger requires less effort and not tedious for women to engage in. This is in line with the findings of Ezra *et al* (2017) which indicated that the domination of women in ginger processing is due to low demands of time and efforts required to work in the enterprise.

The result shows that the mean age of microcredit users of ginger processors was 43.4 years. It was observed that the majority (66.67%) of the microcredit users of ginger processing are in the age bracket of 31-50 years. This implies that ginger processors are within the active working bracket. They are young people who can withstand stress involved in the processing of ginger, and they are matured to take credit decisions that sustain the business.

The results obtained are in line with the findings of Kantiok (2007) who opined that the majority of the agricultural enterprise actors are in their working age. Also, this is in line with the results of Udoh and Nyienakuma (2008). They both opined that agriculturist within the active age groups would be able to withstand stress and put more time in various agricultural operations.

The result also shows that the majority (58.33%) of microcredit users of ginger processors were married. This result indicates that ginger processing can be used to sustain the basic needs of families involved in the processing. This result agrees with Ojo and Jibowa (2008) that reported that married people being responsible, their views are likely to be respected within the rural communities as they decide on the use of agricultural inputs.

Most (97.50%) of the ginger processors of microcredit users had one form of formal education or the other. This will enhance the management of ginger processing in the study area. In processing, formal education allows the ginger processors to understand the proper management of resources in processing. This finding agrees with the fact that high literacy level, western education facilitates the adoption of modern technologies and improved practices (Shehu *et al.*, 2014; Offor and Nse-Nelson, 2015).

Farming experience is expected to have a significant positive impact on the managerial ability of the processors. The result in Table.1 shows the years of experience the processors had acquired over the years. The mean years of experience of ginger processors who use microcredit is 10.84 years. This result is an indication that the ginger processors have been in processing over a long period and can be said that there are experienced. This implies that the more experience, the more committed and confidence they have in the processing. The finding also shows that the processors were aware of the merits and demerits associated with the business because of the long years of experience.

The study also shows that the majority of the processors in the study area had a household size less than seven (7) persons. This means that the processors in the study area have a large household size. This implies that the processors have the advantage of family labour. Higher household size is advantageous in processing as the members of the household aid in the processing activities (Effiong, 2005 and Idiong, 2005). However, higher family size does not necessarily translate to higher use of family labour, because some of the able young men may prefer other jobs. The result in Table.1 shows that majority (66.67%) of microcredit users of the processors belong to cooperatives. This implies that they can easily relate among themselves and coordinate as a group on information sharing.

The result in Table 2 shows the constraints of microcredit use of ginger processors in the study area as thus;

Table2: Constraints militating against microcredit use of ginger processors.

Perception	Frequency	Percentages
Cost of getting microcredit is high	20	6.94
Only members in the cooperative assess microcredit	27	9.38
Microcredit takes a lot of time to process	33	11.46
Bureaucratic bottleneck for credit	35	12.15
Microcredit is for the rich	15	5.21
Microcredit is too hard to understand	32	11.11
Availability of microcredit to market is too hard	32	11.11
Microcredit operation is similar to other borrowing methods	35	12.15
Microcredit is for the poor only	34	11.81
The culture of your community tolerate microcredit	25	8.68

Source: Field Survey Data, 2018

These constraints are as a result of the multiples responses of the processors. The constraints militating against the use of microcredit by ginger processors in the study area was investigated using descriptive statistics. The result in Table 2 shows that majority of the respondents, 12.15% had overbearing bottleneck during the process of obtaining microcredit. The result also indicates that 11.81% reported that microcredit is for the poor and this agrees that microcredit increase per capita household income (Imai and Azam, 2012). It also enhances households' multidimensional well-being and improves the living standards of rural dwellers (Adjei *et al.,* 2009 and Imai *et al.,* 2010). The result shows that 6. 94% indicated that Cost of getting microcredit is high. This means that the impression people have about getting microcredit is not true. The number that agreed that the cost of getting microcredit is low compares other variables.

CONCLUSION

The study examined the Constraints militating against microcredit use of ginger processing in South east, Nigeria. The result of socio-economic characteristics of ginger processors, the majority of processors are females and (58.33%) are married. The literacy levels is high among the respondents and could enhance processing technology. The result also shows that majority of the respondents, 12.20% had overbearing bottleneck during the process of obtaining microcredit and 11.80% reported that microcredit is for the poor It is therefore recommended that male counterparts should be encourage since it is source income for household and livelihood. Cost of getting microcredit is should be reduced to encourage ginger processers in the management of the business and ginger processers should be encouraged to engage in seminars that will provide information on easy access to micro-credit.

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Assessment of Farm Succession Plans among Cattle Farmers in Igabi Local Government Area of Kaduna State Nigeria

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ABSTRACT
Farm succession planning is essential to the process of passing a farm on to the next generation as smoothly and successfully as possible. Despite the importance of succession planning, farmers do not deal with it effectively. The study was designed to assess farm succession plans among cattle farmers in Igabi Local Government Area of Kaduna State, Kaduna. Multi stage sampling technique was used for the study. A total of Eighty (80) cattle farmers were randomly selected and interviewed using structured questionnaires. Descriptive statistics was used to analyze the data. The result showed that farmers' age between 41-50 years (31.25%) with 6-11 members was dominant in the study area. Majority (50.00%) had no formal education with 16 -20 years (37.50%) experience and most (68.75%) depending on their family/inheritance as source of their capital. The study showed that among the benefits of succession plans included provision of food and financial security, enables business to survive, ensuring peace among heirs and attracting investors. The study also revealed that inheritance (43.75%), family retainment (31.25%), selling off business enterprise (18.75%) and transfer of ownership (6.25%) were the major method of succession among cattle farmers in the study area. The study further revealed that leadership failure (41.25%), lack of knowledge (37.50%), sudden death (12.50%) and dispute among family as constraints faced on successful implementation of succession plans. It is recommended among others that succession planning should now be one of the major focus areas in agricultural extension, more education and communication by extension officers is required in order to deal effectively with issues that may arise from succession planning.
Keywords: succession, plan, cattle, household, farm

INTRODUCTION
Despite the knowledge of the diminishing effect of age on farm productivity, farming remains a largely inherited occupation and one in which the transfer of business control and ownership to the next generation is arguably one of the most critical stages in the development of the business (Uchiyama *et al*., 2008). Farmers support local economies and communities, protect natural resources and sources of food, fiber, and feed and provide industrial components. The ageing of the farm population, and the consequent importance of succession, appear to be issues that are common throughout the world (Conway *et al*., 2016, Fasina and Inegbedion, 2014). In some countries it has resulted in specific policies designed to encourage farmers to retire in their mid-fifties to mid-sixties, but the assessment of such policies has concluded that they have achieved only moderate success with outcomes little different from what might have been expected from traditional succession patterns in the absence of the policies (Bika, 2007). Without a smooth transition of business to next generation, rural communities will find it difficult to attracting new businesses and supporting population growth. Contrary to the significant concern on succession planning, business owner and managers rarely outline their future succession (Astrachan and Kolenko, 1994). Successful succession will require a balance

of economic and social values (Grubbstrom *et al*., 2014). Ibrahim *et al*., 2020 submitted that the cattle rearing industry in Nigeria is a vital sub sector in the agricultural sector.

The cattle production industry has become a security threat; this is because of over dependence of its value chain on a network of nomadic herdsmen (Ibrahim *et al*., 2020) hence it is imperative to ensuring that rearing is done on a basis devoid of crisis and ensure sustainability. Most farming enterprise does not adequately prepare for succession nor plan their succession. Farm succession is essential to the process of passing a farm on to the next generation as smoothly and successfully as possible. Succession planning involves the transfer of ownership and control of farming assets to the next generation charged with the responsibility of continuing the business. The absence of a succession plan can cause serious management problems, even leading to a business failure. The reasons for the demise of this family business are many. However, Ward (1987) indicates that inability to plan strategically for the business future is a major cause. Sharma *et al*., (2001) and Morris *et al*., (1997), suggests that well developed succession plans can increase the likelihood of co-operation among stakeholders in businesses, thereby enhancing the chance of a smooth and effective succession.

MATERIALS AND METHODS

Study Area

Igabi is a local government area in Kaduna State with administrative headquarters in the town of Turuku. It has latitude of 10^0 47' 0'' N and longitude 7^0 47' 0'' E. It covers an area of 3727km2 with a projected population of 581, 500 as at 2016 from the 2006 national population census. It is the largest local government area by population in Kaduna State. Igabi LG is bounded to the north by Giwa and Zaria local government areas, to the east by Soba and Kauru local government areas, to the south by Kajuru, Kaduna North, Kaduna South and Chikun local government area, and to the west Chikun and Birnin Gwari local government areas. It comprises about sixteen districts which are, Amaza, Audi, Bargu, Dunki, Dusten Mai, Eadan Gayan, Faro Kwai, Garda, Gehehu, Igabi, Kerawa, Mangi, Pumbi Dutse, Turunku, Yelwa and Zangon Aya districts. The people of Igabi Local Government Area are predominantly Adara by tribe and speak two other languages like Hausa and Gbagyi. (NPC, 2010). The climate is marked by rainy season and long dry season. The average rainfall is 1025mm/ annum, falling between May to October which last for about 4 - 5 months a year. The climatic condition of the area is characterized by hot and wet season as in the tropical areas with the months of November to January as harmattan period. Annual temperature ranges between 35°C to 39°C (Ariyo, 2019). Multistage sampling technique was used for the study. Out of the sixteen (16) districts in Igabi local government area, four (4) districts namely; Turunku, Gehehu, Zango aya and Kerawa were purposively selected as a result of high population of cattle farmers, twenty (20) respondents were randomly selected from each districts and were administered the questionnaire making a total of eighty (80) respondents.

RESULTS AND DISCUSSIONS

The result of socio-economic characteristics of the cattle farmers on table 1 showed that 31.25% of the respondents were between the age ranges of 41-50 years and 6.25% from 61 years and above. The result further showed that those within the age brackets of 10-20 years, 21-30 years and 31-40 years accounted for 6.25%, 13.75% and 23.75% respectively. The challenge of the ageing farmer population is not only a third world phenomenon and according to Wiley *et al*., (2009) the average age of U.S farmer today is nearing 60, up from 50 in 1978. The finding from the study shows that the youth in the study area does not constitute the majority of cattle rearer's in the study area. Youth migration into urban areas for white collar jobs must have been responsible for this. Ntshangase *et al*., (2016) submitted that youth migration into urban areas is an important feature of rural youth and unless young people remain active in agriculture, which is the main economic driver in these areas, they will migrate to big cities and the situation in rural areas will remain worse off.

Table 1: Socio – economic characteristics of the respondents in the study area

Age	Frequency	Percentage (%)
10-20	05	6.25
21-30	11	13.75
31-40	19	23.75
41-50	25	31.25
51-60	15	18.75
61-above	05	6.25
Household size		
0 - 5	10	12.50
6- 10	38	47.50
11-15	20	25.00
16-20	12	15.00
Educational level		
Non-formal education	40	50.00
Primary education	23	28.75
Secondary education	10	12.50
Tertiary education	07	8.75
Source of Capital		
Personal savings	20	25.00
Loan Facility	05	6.25
Family / Inheritance	55	68.75
Years of experience		
1-5	03	3.75
6-10	15	18.75
11 - 15	20	25.00
16-20	30	37.50
21- above	12	15.00
Total	**80**	**100**

The study showed the household size of respondents in the study area to include majority (47.50%) having between 6-10 individuals, 0-5 individuals, 11-15 individual and 16-20 individuals with 12.50%, 25.00% and 15.00% respectively. Majority (50.00%) of the respondents had Non-formal education while minority (8.75%) had tertiary education. Those with primary and secondary education accounted for 28.75% and 12.50% respectively.

Majority (68.75%) of the farmers had their source of capital from family inheritance while the minority (6.25%) secured loan to run their cattle rearing enterprise. It was obvious that cattle farmers in the study area do not have cooperative societies that can give them loan as a lower interest rate and give them a sense of belonging.

Experience in cattle rearing is a measure of the period an individual has been involved in the business. Majority of the respondents (37.50%) had between 16-20 years of experience in cattle rearing while 3.75%, 18.75%, 25.00% and 15.00% had between 1-5, 6-10, 11-15, 21 years and above respectively. Furthermore, the advantage inherent in this is that if the successor is a child of the principal, in addition to the physical assets inherited, intangible asset (tacit knowledge) are also transferred to the new business (Uchiyama *et al*., 2008).

Table 2: Benefits of Succession Plan among Cattle Farmers in Igabi LGA of Kaduna State

Benefit of succession plan	Frequency	Percentage (%)
Attract income from investors	06	7.50
Ensure peace among heirs	21	26.25
Enable business survive for generations	20	25.00
Provide food and financial security	33	41.25

Table 2 indicates the benefits of succession plan among respondents. Majority (41.25%) of the respondents stated that one perceived benefit of succession plan is the guarantee of the provision of food and financial security while 26.25%, 25.00% and 7.50% indicated ensuring peace among heirs, enables business survive for generations and that it attracts income from investors respectively.

Table 3: Major Method of Succession Plan adopted by Cattle Farmers in Igabi LGA of Kaduna State

Method of succession plans	Frequency	Percentage (%)
Selling off Business	15	18.75
Transfer of ownership	05	6.25
Inheritance	35	43.75
Family / Friends	25	31.25
Total	**80**	**100**

The result showed in Table 3 that majority (43.75%) of the respondents said one major succession plan in the study area is by inheritance from parents while (6.25%) of the respondents attributed succession through the transfer of ownership plan in the study area. The finding is in line with that of Colli (2003) that the most prevalent form of business in the world is family business. The result further shows that other succession plans by respondents included selling off of enterprise and retaining of the enterprise by members of an extended family with 18.75%, 31.25% respectively. Aldrich and Cliff (2003) argued in their widely referenced article that families and businesses are inextricably intertwined.

Table 4: Constraints Faced on Successful Implementation of Succession Plans among Cattle Farmers in Igabi LGA of Kaduna State

Succession Plan	Frequency	Percentage (%)
Dispute among family	7	8.75
Sudden death	10	12.50
Leadership Failure	33	41.25
Lack of Knowledge	30	37.50
Total	**80**	**100**

The result of the constraints faced on successful implementation of succession on table 4 showed that majority (41.25%) attributed leadership failure as a major constraint faced on successful implementation of succession plan. Most of the cattle rearer's do not make provision for continuity in their enterprise. Minority (8.75%) of the respondents affirmed that disputes among family members are one of the constraints faced on successful implementation of a succession plan. This corroborates the findings of Garcia Alvarez and Lopez-Sintas (2001) that problems will arise if families and their business do not share same values and beliefs. Other constraints identified are lack of knowledge of the need for a succession plan and sudden death of owners of the cattle enterprise with 37.50% and 12.50% respectively. This finding brings to fore the submission of Fasina and Inegbedion (2014) that the transfer of business control and ownership to the next generation is arguably one of the critical stages in development of the business, thus prompting the need for a proper understanding and knowledge of the values of succession plan.

CONCLUSION

Conclusively, it was observed from the study that succession planning is essential to the process of passing a farm on to the next generation as smoothly as possible. Cattle farmers lack the adequate knowledge and understanding of the need for a succession plan in the study area. It is thus recommended among others that succession planning should now be one of the major focus areas of agricultural extension, more education and communication by extension officers is required in order to deal effectively with succession planning.

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Factors Influencing Households' Consumption Preference for Locally Produced Rice Brands in Ijero Local Government Area of Ekiti State

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ABSTRACT
This study seeks to examine factors influencing household consumption preference for locally produced rice brands in Ijero Local Government Area of Ekiti State. Primary data was collected using a multi-stage sampling technique from 120 respondents using a structured questionnaire. The data was analyzed using descriptive statistics. Result shows that majority (58.3%) of the respondents were female. They were quite in their active age with (43.2%) of the respondents between the ages of 41-50 years and they were mainly married (90%). Also it was revealed that majority (52.5%) of the respondents had primary education. In the same vein, majority (66.6%) had a household size of 6-10 and they were majorly farmers (55%) and traders (52%), above average (56.7%) of the respondents had a monthly income of ₦5000- 10,000.00. It was also observed that less than average (47.5%) spent ₦2,250-3,400 monthly on rice consumption and all the respondents (100%) had rice as part of their diet regularly, while a sizeable number (31.7%) ate rice once a week and twice weekly respectively, with majority (78.3%) consuming 1-5kg of local rice per time, majority (54.2%) of the respondents source their local rice from the open market and a whooping number of the respondents (98.3%) consumed the local rice. It was shown that a whooping number (98.3%) of the respondents identified Ofada and Igbemo rice (94.2%) as their most consumed locally produced rice in the study area. In the same vein, majority of the respondents (99.2%) preferred local rice consumption based on how stone and sand free it is, majority (89.2%) based on the price, (72.5%) on its availability, (66.7%) on its swelling capacity. Also, enormous number (92.5%) preferred local rice consumption. Furthermore, it was shown that income level (75%) had the highest influence on the respondents' preference for local rice; this was followed by perception/ age long beliefs (74.2%) and high cost of imported rice (52.9%). It was recommended that rice value chain actors should capitalize on improving local rice attributes other than price so as to expand its production and wider adoption. The production and processing technologies should also be enhanced to increase its market standard both locally and in the international market.
Keywords: Rice, Household consumption preference, locally produced rice

INTRODUCTION
Rice (*Oryza Sativa*) is the major staple food crop in Nigeria. According to Johnson *et al* (2013) it is the most widely accepted and consumed staple food by both the urban and rural populace in Nigeria, with about 85% of households consuming rice and spending an average of 6% of its total income on rice consumption, the highest among all staples consumed in Nigeria. But then, it's no longer news that Nigeria is now the largest rice producing nation in West African sub-region but though the second largest importer of rice in the world. According to Obih and Baiyegunhi (2018), Nigeria is Africa's largest rice consuming and importing country, spending about an average annual import bill of USD of 300 million, this has been attributed to the poor quality of locally produced rice which could be due to poor production and processing

technologies. Though the Nigerian government has put up different policies and programmes to boost rice production and processing over the years, some meaningful impact has been made in this regards but the problems still persists. According to Obih and Baiyegunhi (2018), despite huge investments of over USD 1.65 billion made by government and private sectors in rice processing over the last six years – which has led to dramatic improvements in the quality of local rice brands –the consumers' preference for imported rice brands persists. They opined that carrying out consumer demand focused marketing is the key to ascertain the way forward. This study is therefore being carried out to ascertain factors influencing household consumption preference for locally produced rice Ijero local government area of Ekiti State.

Objectives of the study: The general objective is to ascertain factors influencing household consumption preference for locally produced brands of rice in Ijero local government area of Ekiti State.

Specifically, the study was designed to:

i. describe the socio economic characteristics of the household in the study area;
ii. identify the types of locally produced rice consumed by households in the study area;
iii. identify the households' criteria for selection of locally produced rice in the study area;
iv. determine the households' preference between locally produced rice and imported rice in the study area;
v. determine the factors influencing households' consumption of locally produced rice in the study area.

METHODOLOGY

This study was carried out in Ijero local government area of Ekiti state Nigeria because it is a prominent area for rice production in Ekiti State. A multi-stage sampling technique was employed to select the households for the study. The first stage involved a purposive selection of Ijero Local Government based on its prominence in rice production and high concentration of rice consumers. The second stage is the random selection of 3 towns out of six towns under Ijero local government area of Ekiti state. The third stage involved the random selection of two communities from each of the 3 selected towns of the local government area making a total of 6 communities. The fourth stage was selection of 20 households from each community to make a total of 120 respondents that was used for the study. A structured questionnaire was used to collect the data. Data was analysed using descriptive statistics.

RESULTS AND DISCUSSION

Socioeconomic characteristics of the respondents

Table 1 revealed that (41.7%) of the respondents were male and majority (58.3%) of the respondents were female. This implies that females were more in the study area. This could be because since they are responsible for deciding cooking of foods and making of any menu decision as is obtainable in any given African home and tradition. It was also revealed that (43.2%) of the respondents in the study area were between the ages of 41-50 years, (39.9%) were between the ages of 31-40 years. This implies that a good number of them were in their active age and can easily determine their preferences of consumption. Majority (90%) of the respondents were married. This means that cooking and its pertinent decisions remains the exclusive responsibility of married women in our society. Also it was revealed that majority (52.5%) of the respondents had primary education. This implies that these respondents are knowledgeable enough to make decisions on their rice preferences based on cogent reasons and not just based on their perception. In the same vein, majority (66.8%) had a household size of 6-10 members. It was also revealed that majority (55%) of the respondents were farmers, many were traders (52%). Above average (56.7%) of the respondents had a monthly income of ₦5000-10,000.00 and this means that price/cost could be a factor in making preference for rice to be consumed by the households. It was also observed that some (47.5%) spent ₦2,250-3,400 monthly on rice consumption. This means that majority of the respondents were poor and it could negatively influence their rice consumption pattern.

Table 4.1 socio-economic characteristics of the respondents N=120

Variable	Frequency	Percentage	Mean
Sex			
Male	50	41.7	
Female	70	58.3	
Age			
31-40	48	39.9	
41-50	52	43.2	44
51-60	12	10.0	
61-70	8	6.6	
Marital status			
Single	2	1.7	
Married	108	90.0	
Divorced	2	1.7	
Widow	8	6.7	
Educational status			
No formal	1	0.8	
Primary	63	52.5	
Secondary	54	45.0	
Tertiary	2	1.7	
Household size			
1-5	37	33.4	
6-10	80	66.8	6
Primary occupation			
Farming	55	45.8	
Trading	52	43.5	
Civil servant	13	10.8	
Household monthly income	(#)		
5000-10000	68	56.7	
11000-16000	35	29.1	12529.17
17000-27000	7	5.9	
28000-35000	5	4.1	
36000-40000	2	1.6	
41000-48000	3	2.5	
Monthly expenditure (#)			
200-2000	38	31.6	
2250-3400	57	47.5	2914.17
3750-8000	25	20.8	
Rice as a diet			
Yes	120	100	
Period of consumption of locally produced rice			
Everyday	4	3.3	
Once a week	38	31.7	
Once a month	2	1.7	
2 times a week	38	31.7	
3 times a week	29	24.2	
4 times a week	8	6.7	
7 times a month	1	0.8	
Brand of rice consumed			
Locally produced rice	118	98.3	
Imported rice	2	1.7	
Quantity of locally produced rice consumed			
1-5kg	109	78.3	3.47
6-12kg	11	21.6	
Source of locally produced rice			
Market	65.04	54.2	
Planted	54.96	45.8	

Source: Field survey, 2020

It was also observed that all the respondents (100%) had rice as part of their diet regularly. Majority of the respondents (98.3%) consumed the local rice, this could be due to its cheaper price since they were majorly poor or just due to their inherent perception. This negates the findings of Oyinbo et al., (2013) who stated that from the pooled sample of households, a larger proportion (75%) preferred consuming foreign rice brands to local rice brands. Also majority (78.3%) of the respondents consume 1-5kg of local rice. Majority (54.2%) of the respondents source their local rice from the open market. This implies that most of the respondents get their locally produced rice from the market, though a sizeable number are rice farmers and this implies more market demand for the producers.

Brands of locally produced rice consumed

Table 2 below showed that a majority number of the respondents identified Ofada rice as their most consumed locally produced rice in the study area, majority of them identified Igbemo rice as mostly consumed locally produce rice in the area. This implied that Ofada rice was the most preferred local rice consumed in the study area; this could be due to its test or just an old age perception to be the best among others.

Table 2: Brands of locally produced rice consumed

Brands of local rice	Frequency	Percentage
Ofada rice	118	98.3
Tomato rice	46	38.3
Mama’s pride	11	9.2
Igbemo rice	113	94.2
Gboko rice	82	68.3
Tapa rice	75	62.5

Source: Field survey, 2020

Criteria for selection of locally produced rice

Table 3 shows that the respondents majorly (99.2%) selected their preferred rice to be consumed based on how stone and sand free it is. Majority (89.2%) is based on the price, (72.5%) on its availability, (66.7%) on its swelling capacity. This implies that the attributes of the local rice are key determinants for their preference and purchasing decision of the consumers. This is an eye-opener for the stakeholders in rice value chain promotion as concentration in these areas will engineer a drastic change in meeting the rice demands of the Nigerian populace and beyond and sustainable measure to end rice importation in the country and preserve our foreign reserve. Consumers are attracted to cheaper price because they are poor peasant farmers.

Table 3: Criteria for selection of locally produced rice

Criteria for selection	Yes	No
Price	89.2	10.8
Taste	47.5	52.5
Cooking time	0.8	99.2
Cleanliness	3.3	96.7
Swelling capacity	66.7	33.3
Stone and sand free	99.2	0.8
Grain shape	0.8	99.2
Ostentation	5.0	95.0
Nutritional value	54.2	45.8
Availability	72.5	27.5

Source: Field survey 2020

Preference between locally produced rice and imported rice

Table 4 showed the percentage of the respondents (92.5%) who preferred local rice consumption to very few (7.5%) who preferred consuming imported rice. This could be due to its lower cost, taste, availability, nutritional value and swelling capacity compared to its imported rice counterpart as observed in Table 3. This negates the findings of Bamidele *et al*. (2010) who stated that households preferred imported rice to local rice, because the imported rice is of a higher quality and grade.

Table 4: Preference between locally produced rice and imported rice

Variable	Percentage
Imported rice	7.5
Local rice	92.5

Source: Field survey, 2020

Factors influencing consumption of locally produced rice

Table 5 showed that income level (75%) had the highest influence on the respondents' preference; this was followed by perception/ age long beliefs (74.2%), high cost of imported rice (52.9%) and milling quality (49.2%). This implies that they were majorly influenced to consume local rice because is cheaper, since they are majorly peasant farmers. Also it could be due to their age long believes that local rice is tastier, it swells faster and it has more nutritional values though they are still negatively influenced by its poor processing nature which affects its quality. This aligns with the findings of Oyinbo et al. (2013) who stated that rice quality (cleanliness, whiteness, shape and breakage of grain) was positively related to the households' consumption preference probability for foreign and local rice.

Table 5: Factors influencing consumption of locally produced rice

Factors influencing rice consumption	Very Severe	Severe	Not Severe	Mean	Rank
Price fluctuation	15.8	75.0	9.2	2.07	8
Quality processing	50.8	47.5	1.6	2.50	6
Adulteration	40.0	57.5	2.5	2.40	7
Income level	75.0	25.0	0	2.8	1
High rate of consumption	1.0	18.3	80.7	1.13	14
Nutritional value	45.0	52.5	2.5	2.7	3
Milling quality	49.2	48.3	2.5	2.5	5
Produce fast rate of deterioration	0.8	19.2	80.0	1.21	11
Inadequate market information	4.2	50.8	45.0	1.6	9
Perception/age long belief	74.2	24.2	1.6	2.7	2
Low patronage	0	3.3	96.7	1.03	15
Poor taste of product	0	15.0	85.0	1.15	15
Taste	0.8	14.2	85.0	1.16	12
Ease of preparation	1.0	2.5	96.5	1.03	13
Cleanliness	1.7	97.5	0.8	2.01	10
High cost of imported rice	59.2	40.0	0.8	2.6	4

Source: Field survey 2020

CONCLUSION

Based on the results obtained from the study, it is concluded that majority of the respondents were female of youthful age and married. They majorly had at least primary education, with a household size of 6-10 members. They were mainly farmers and traders with majority having a household monthly income of ₦5,000 -10,000. The respondents highly consumed local rice than its counterpart at about 1-5kg per time. The respondents most consumed brands of local rice were Ofada and Gboko rice. Furthermore, it was also observed that the respondent's major criteria for selection of locally produced rice were its price, stone and sand free nature, its readily availability and swelling capacity while being cooked. The respondents preferred local rice to its imported counterpart. The result further showed that the major factors influencing their local rice consumption were; their income level, perception/age-long beliefs, high cost of imported rice and the milling quality of the local rice. It can be adduced from this study that the respondents immensely preferred local rice to its imported counterpart based on its other attributes such as taste, nutritional value, perception/age long believes other than price. This means that rice value chain actors can capitalize on these attributes to expand their production and close the ever widening demand and supply gap of rice produce in the economy. Also, there is need to enhance the processing facilities so as to increase the local rice quality for both domestic and the international markets.

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Assessment of Improved Gum Arabic Production Technologies Adoption Levels Among Farmers in Jigawa State, Nigeria

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ABSTRACT
This study assessed levels of adoption of improved gum Arabic production technologies by farmers in Jigawa State, Nigeria. Using multistage sampling procedure, sample size of 60 farmers was selected. Information on farmers and farm characteristics were generated using structured questionnaire. Data analysis was carried out using descriptive statistics. Results of the study revealed that 70.0% of the farmers were over 50 years in age and over 90.0% had formal education. Adoption index analysis revealed that farmers adopted technologies on number of gum Arabic stands/ha at 91.6% and number of incisions/tree/year at 74.1% at high levels. It is concluded that adoption of improved gum Arabic production technologies have the potentials to increase farmer's gum yields if the farmers could adopt the technologies as recommended. Institutionalization of training programs in conjunction with farmer's association and increased farmer-extension agent's interaction were commended in order to achieve these goals.
Keywords: Adoption index, Adopted technologies, Farmer's Association, Gum Arabic

INTRODUCTION
Achieving increased agricultural productivity will require that farmers employ new ideas and methods in the cultivation of their farms, otherwise referred to as adoption of technologies. Akinbode and Bamire, (2015), posited that adoption of agricultural technologies refers to the decision to apply a technology and to continue with its use. In arriving at a decision to adopt or not to adopt a technology, farmers undergo three stages of acceptance, actual adoption and continued use.

It is for these reasons that Rubber Research Institute of Nigeria, (RRIN), the agency with the national mandate for research and development of rubber, gum Arabic and other latex producing plants, developed and distributed improved gum Arabic seedlings to farmers in Jigawa and other gum arabic producing States. Furthermore, the institute in conjunction with relevant federal agencies and the gum Arabic farmer's associations organized training programs for farmers on effective management of their farms. The goals of these trainings were to increase sizes and productivity of gum Arabic farms in order to ensure steady supply of raw materials to user industries, generation of employment and income for the farmers and foreign exchange earnings for the nation.

Farmers adopt technologies at different levels due largely, to differences in their social, economic and psychological characteristics. Others have access to institutional supports and technology characteristics. This study was informed by the need to ascertain the levels of adoption RRIN developed gum Arabic production technologies. Outcome of this study will shed

light on the extent of adoption of these technologies, thereby providing guide for future policy direction, particularly, as it relates to delivery of agricultural extension messages.
Specifically, the objectives of the study are to,

i. describe the socio-economic characteristics of gum Arabic farmers in the study area, and
ii. estimate the levels of adoption of improved gum Arabic production technologies by farmers.

MATERIALS AND METHODS

The study was conducted in Jigawa State, Northwest Nigeria. The state lies approximately between latitudes $11^0\,14^1$ N and $13^0\,09^1$ N and between longitudes $8^0\,00^1$ E and $10^0\,15^1$ E (Mikail, 2001). The state has an approximate population of 4, 361,002 (NPC, 2006). Jigawa State shares borders with Kano and Katsina States on the west, Bauchi State to the east and Yobe State to the northeast. Six (6) LGAs namely, Mallam Madori, Kiyawa, Birniwa, Ringim, Maigatari and Kaugama were purposively chosen because of the higher and active number of gum arabic farmers. Total of 60 farmers were selected through the use of simple random technique from a total of 120 registered gum Arabic farmers. Interview schedule was used to generate primary data on the farmer's socio-economic characteristics and levels of technology adoption among farmers. Secondary sources of information were also used during the study. Data for the study were analyzed using descriptive statistics namely, Frequency, Percentages and Means. Adoption index analysis was used to determine level or extent of adoption of improved gum Arabic production technologies by individual farmer as described by Tadesse (2008). Adoption index shows the extent and intensity of use of technology by the farmers.

RESULTS AND DISCUSSIONS

The result showed that majority (70.0%) of the gum Arabic farmers were between the age of 51- 60 years (Table 1). This implies that gum Arabic cultivation in the study area is mainly undertaken by the aged. Farmers' productivity is known to decline with increasing age due to reduced vigor, Uwagboe *et al* (2014). All the respondents (100.0%) were males (Table 1).

Table1: Distribution of Farmers based on Socio – economic Characteristics (n = 60)

Variable	Frequency	Percentage
Age (Years)		
31 - 40		10.0
41-50		15.0
51 – 60		70.0
61 and above		5.0
Sex		
Male		100.0
Female		0.0
Family size		
1 – 10		25.0
11 – 15		41.7
16 – 20		25.0
>20		8.3
Education		
Secondary school		8.3
National diploma/ NCE		46.7
HND/Degree		33.3
Postgraduate		11.7
Income(₦)		
Low (150,000 – 499,999)		15.0
Medium (500,000 – 999,999.00)		25.0
High (1,000,000.00 or more		60.0

This implies that gum Arabic cultivation in the study area is dominated by male farmers. Access to production inputs in most of Africa's societies are skewed to the advantage of males.

This agreed with findings of Ajala *et al* (2013). Table 1, further revealed that 41.7% of the farmers had between 11 – 15 family members. Farm families with large members could readily mobilize such human capital for adoption of labour intensive technologies. This position was supported by the work of Awotide *et al.* (2011). Educational status of the gum Arabic farmers (Table1) showed that majority (90.0%) of the farmers were educated. Educated farmers can easily access and interpret innovation messages leading to improved farming activities. The findings conformed to work the of Pereira (2011). Farmers' income distribution showed that majority of the farmers (60.0%) belongs to high income status. High income status may promote innovativeness among farmers. Farmers with high income will be able to pay for costs of adopting technologies (Awotide, 2011).

Levels of adoption of production technologies

Results (Table 2) revealed that more than half (70.0%) of the farmers belonged to high adoption category with respect RLPP. This implied there was substantial compliance with the RLPP by the farmers. A well prepared land will allow for better water and air percolations, promote early root establishment and attainment of early maturity. Mohammed *et al.* (2013) recorded similar findings. Also, Table 2 showed that majority (90.0%) of the farmers belonged to high adoption category in relation to DGS/ha. The high level of compliance could be attributed to subsidies the farmers enjoined under the federal government on the promotion of gum Arabic production. Analysis of compliance with the recommended weeding regime (Table 2) indicated that 46.7% of the farmers belonged to low adoption level. Weed management is capital intensive, especially in plantation crops.

Furthermore, (Table 2) showed that a good number, 45.0% of the farmers belonged to the medium adopter category with respect to adoption of ATFI practices. Above findings implied that majority of gum Arabic farmers in the study area viewed the gestation period of 5 years as rather too long. Early maturity has been found to be positively and significantly related with adoption (Idrisa *et al.,* 2012), further indicated that majority (66.7%) of the farmers belonged to the high adoption category in terms of compliance with recommendations on MGTT. This high compliance could be attributed to the fact that majority of the farmers were able to easily identify tree trunks and branches that have attained the required diameter thickness. When technology is simple to understand and comprehend, it is readily adopted because generally, they are user friendly. The 45cm diameter thickness recommended to farmers in this study agrees with that of Wekesa *et al.,* (2009). Results in Table 2 revealed also that recommendation on TCD was adopted by over half of the farmers (55.0%) at medium category. Openings that are too small may inhibit maximum gum exudation while very large openings may equally delay the healing process before next cropping season, thereby compromising the ability of the tree to continually yield gum on a sustainable basis.

The 3cm x 15cm recommended in this study agrees with that of Wekesa *et al* (2009). Farmers complied with recommendation of 7 numbers of openings on **NO/T/Y** as majority of the farmers (70.0%) belonged to high adoption category. Reason for this compliance could be because the openings represents outlet of gum exudation upon incision. Opening the trees as recommended could ensure maximum and sustainable gum exudation. A finding of this study is higher than the 55.30%reported by Mohammed *et al.* (2013). The results showed that half of the farmers (50.0%) belonged to the medium adopter category as it relates to NDBGC. The likely reason for this compliance could be because gum collection in undertaken during dry season when farmers are less busy with other farm activities. The 30 days recommended to farmers in this study was in line with 25 – 30 days recommended by Wekese *et al* (2009).

Table 2: Distribution of Respondents Based on the Level of Adoption of Improved Gum Arabic Production Technology (n = 60)

Adopter category	Index range	LPP	DGS/ha	WR	ATFI	MGTT	TCD	NOP/T/Y	NDBGC
Low adoption	0.01 - 0.33	2.0 (3.3)	3.00 (5.0)	28 (46.7)	20 (33.3)	7 (11.6)	13 (21.7)	9 (15.0)	12 (20.0)
Medium adoption	0.34 – 0.66	16.0 (26.7)	3.0 (5.0)	9.0 (15.0)	27 (45.0)	13 (21.7)	33 (55.0)	9.0 (15.0)	30 (50.0)
High adoption	0.67 – 1.00	42.0 (70.0)	54.0 (90.0)	23 (38.3)	13 (21.7)	40 (66.7)	14 (23.3)	42 (70.0)	18 (30.0)

The values outside the parenthesis = frequency, values in parenthesis = percentage. **LPP:** Land Preparation Practice; **DGS/ha:** Density of Gum Arabic Stands/ha; **WR:** Weeding Regime; **ATFI:** Age of Tree at First Incision; **MGTT:** Minimum Girth Thickness at Tapping; **TCD:** Tapping Cut Dimension; **NOPTY:** Number of Openings Per Tree Per Year; **NDBGC:** Number of Days Before Gum Collection.

CONCLUSION

The study reveals that there was adoption of gum Arabic production technologies by the farmers, though at different levels. While some of the recommended practices were wholly adopted, a number of others were adopted at levels lower than recommended by RRIN. Reasons for the observed differences in compliance with recommended practices could be traced to technological characteristics and differences in social, economic, institutional factors of the farmers. Farmers should be encouraged on the need to comply fully while adopting the technologies promoted by RRIN in order to enhance their productivity. This will require increased farmer-extension agents' interaction to enhance capacity of the gum Arabic farmers.

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Assessment of Borrowing Propensity of Poultry Farmers in Akinyele Local Government Area, Oyo State

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ABSTRACT

This study assessed the level of borrowing and conditions for obtaining credit facilities as well as the factors that determine the borrowing propensity of poultry farmers in Akinyele Local Government Area, Oyo State. A three-stage random sampling approach was adopted in selecting the respondents for the study. Simple descriptive statistics such as frequency counts and percentages were used to analyze the characteristics of loan borrowing propensity of poultry farmers. Likewise, Logit Model was used to determine the factors influencing the borrowing propensity while Likert Scale was used to analyze the level of borrowing of the respondents. The study concluded that interest rate and lack of guarantors were the main challenges facing the poultry farmers in obtaining loan facility while their inclination to demand for more loans would be increased provided the interest rate is reduced. The study therefore recommended that the financial institutions and other medium should reduce their interest rates so that poultry farmers would be able to pay back easily.

Keywords: poultry farmers, propensity, borrowing, credit, interest rate

INTRODUCTION

Poultry is one of the world's major and fastest growing sources of meat and egg (Yakubu *et al.,* 2018). Though, this business is money yielding but it has not been fully harnessed in Nigerian economy. Available literatures (Udoh and Etim, 2010) have reported that 90% of the rural population in Nigeria depends on poultry for food and income. In Nigeria, poultry farming contributes low to the export earnings compared to what they are expected to contribute. Poultry farming as a veritable tool for economic empowerment in Nigeria depends largely on the attractiveness of the agricultural credit facilities to thrive (Otunaiya *et al.,* 2014).

Credit has been considered not only as one of the critical inputs in agriculture, but also is regarded as an effective means of economic transformation and poverty alleviation. The performance of the agricultural sector depends to a large extent on the availability of credit. Credit affects the performance of agriculture by providing resources for the purchases of inputs and adoption of new technology. It also plays a crucial role in amplifying the development of agriculture and the rural economy (Nwankwo and Bokelmann, 2008).

However, there is a growing concern that credit flow from the financial institutions to farmers especially the livestock farmers in Nigeria is poor, leading to low output and consequently high prices of meat in their markets. This raises the question of the farmers' accessibility to formal loan which is accepted as the cheapest source of credit and their repayment performance of loans obtained from formal institutions.

However, the inability of borrowers to repay amount of loans collected is crucial for the long-term sustenance of the credit institutions. It is thus against this backdrop, emerge two main research objectives addressed in this study related to (i) the level of borrowing and conditions for obtaining credit facilities and (ii) the factors that determine the borrowing propensity of poultry farmers in the study area.

MATERIALS AND METHODS

The study was carried out in Akinyele Local Government (LGA), Oyo state, Nigeria. It is one of the eleven local government area that make up Ibadan metropolis. Akinyele LGA lies in the South – Western Zone of the State, which is roughly enclosed by latitude 7.53060 and 3.91100E north of the equator. The major occupation of the Akinyele LGA is farming. Akinyele Local Government Area was specifically selected for this study because of its contribution to the poultry industry in Oyo State and high concentration of poultry farmers within the area. Primary data was collected using structured questionnaire to elicit information from poultry farmers in the study area. A three-stage random sampling approach was adopted in selecting the respondents for the study. At first stage - Six wards were purposively selected from the twelve wards that make up the Akinyele LGA particularly those that fall within the outskirt (based on their potentials in poultry farming and concentration of poultry farmers in these wards). In the second stage - Three villages were randomly chosen in each of the above six purposively selected wards while seven poultry farmers were randomly selected from each village. A total of one hundred and twenty-six poultry farmers were interviewed in the eighteen selected villages. Simple descriptive statistics such as frequency counts and percentages were used to analyze the characteristics of borrowing propensity of obtaining loans. Likewise, Logit Model was used to determine the factors influencing the borrowing propensity of the respondents while Likert Scale was used to analyze the level of borrowing loans of the respondents.

RESULTS AND DISCUSSION

Table 1 shows that the rate at which money was being borrowed from banks is the highest with 59.7% followed by non-bank (thrift) with 20.9%. So, this result shows that poultry farmers in the study area still practice traditional methods of getting credit facility because thrift has been considered as non-formal means of borrowing money. The third medium of borrowing money adopted by the respondents was through family and friends with 16.1% while the least is through money lender with 3.3%.

Table 1: Levels of Borrowing Loans of the Respondents

Level	Very high	High	Moderate	Low	Very low	Total
Banks	21.9%	17.1%	10.1%	7.1%	3.5%	59.7%
Non-banks	6.7%	5.1%	4.3%	2.9%	1.9%	20.9%
Money lenders	1.4%	.9%	.6%	.3%	.1%	3.3%
Family & friends	6.1%	3.8%	3.2%	2.4%	.6%	16.1%

Source: Field survey, 2021

Table 2: Characteristics of Borrowing Propensity of Poultry Farmers

Variable	Frequency	Percentage
Types of Credit Source		
Bank	74	59.7
Family and Friends	20	16.1
Money Lenders	4	3.2
Thrift	26	21.0
Total	124	100.0
Collateral		
Land	26	21.0
Jewelry	1	.8
Promissory Note	7	5.6
None	9	7.3
Others (Guarantors)	81	65.3
Total	124	100.0
Frequency of obtaining credit		
Once in a Week	9	7.3
Once in a Month	10	8.1
Once in three Months	81	65.3
Once in six Months	21	16.9
Once in a Year	3	2.4
Total	124	100.0
Challenges of borrowing loan		
Paucity Of Fund	5	4.0
Bureaucracy	24	19.4
Insult	9	7.3
High Interest	25	20.2
Collaterl	8	6.5
Others	53	42.7
Total	124	100.0
How to solve the challenges		
Reduce Interest	58	46.8
Reduce the Procedure to Obtain Loan	30	24.2
Reduce the Collateral Requirement	10	8.1
Make Loan Frequent	2	1.6
Others	24	19.4
Total	124	100.0

Source: Field survey, 2021

Logit model analysis was used to determine factors that influence the borrowing propensity of poultry farmers in the study area (Table 3). The results showed that age, marital status, educational status, sex, family size were the policy driven variables that determines the borrowing propensity of the poultry farmers in the study area. It is therefore safe to posit that the explanatory power of the estimated logit regression model is satisfactory and can be used to explain the prospect of accessing loan by the poultry farmers in the study area. This result buttressed the findings of Osotimehin *et al* (2011) that found that age, gender, education level and household size were included in the explanatory variables that influenced credit accessibility in South-western Nigeria. Also, this outcome is in agreement with some previous literature on the subject matter that included such demographic variables to explain the dependent variable (Ashraf and Ibrahim, 2014; Obisesan and Akinlade, 2013; Balogun and Yusuf, 2011).

Table 3: Factors that Determine the Borrowing Propensity of Poultry Farmers

Variable	Co-efficient	Standard error	Marginal effect
Constant	-0.44816	0.2779	-
Age of respondents (X_1)	0.0061**	0.0056	0.1069
Marital status (X_3)	-0.0008***	0.00816	0.4496
Educational status (X_4	-0.0881*	0.04807	0.0666
Sex (X_5)	0.09259*	0.09049	0.5326
Family size (X_6)	0.05646 *	0.09049	0.5326
Log likelihood	-58.981		
Chi-Squared	28.64		

Source: Field Survey, 2021

*Significant at 10%; ** 5% and ***1% probability level

CONCLUSION

The study concluded that poultry farmers mostly have access to bank loan with the help of guarantor in the study area. Also, interest rate and lack of guarantors were the main challenges facing the poultry farmers in obtaining loan facility while their inclination to demand for more loans would be increased provided that the interest rate is reduced. Likewise, the results indicated that age, marital status, educational status, sex, family size were the policy driven variables that determine the borrowing propensity of the poultry farmers in the study area. Based on these findings, the study therefore recommended that the financial institutions and other related medium (Bank, thrift, family and friends, money lenders) should reduce their interest rates so that poultry farmers would be able to pay back easily. Also, Government should initiate credit borrowing friendly policies that will reduce bureaucratic bottleneck that is usually associated with credit access through banks and other related financial agencies in order to encourage easy access to credit by the farmers.

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Analysis of Food Security Among Rural Dwellers of Billiri Local Government Area of Gombe State, Nigeria

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ABSTRACT
This study was conducted to measure food security status of rural dwellers in Billiri Local Government Area of Gombe State, Nigeria. The study used questionnaire in collecting primary data from the respondents. Analysis was done using descriptive statistics and food status index. The result shows that the respondents were young with an average of 42 years of age, married, male, with long years of experience (average 14 years), large family size with mean household size of 8 people. It was found that 64% of the respondents were food in-secured with households consuming 36% less than their daily calorie requirements. Household coped mainly with food insecurity by eating food that are less preferred and less expensive, reduced portion of sizes of food and purchased food on credit. Therefore, it is recommended that extension services should be encouraged in the area to increase adoption of improved farming technologies which will result to yield increase vis-à-vis income; formal education should be encouraged in the area to increase knowledge on the need for food security and balanced diets for better health; and cooperative societies should be formed to enable farmers source for income with minimal interest rate.
Keywords: Billiri, Coping strategies, Food security, Gombe

INTRODUCTION
Agricultural production provides the means of livelihood and economic sustenance for the majority of Nigerians population (Yakubu *et al.*, 2021). Nigeria is an agrarian country with about 70 percent of the population who live in the rural communities engaged in agricultural production (Akinyele, 2009; Ugwu, 2011). Yet, Nigeria is not among the food secured countries in the world. Nigeria faces a crisis in terms of access to food and general food availability (Owoo, 2021). According to Akinyele (2009), the country is highly characterized by high reliance on food imports; malnutrition is widespread in the country and rural areas are especially vulnerable to chronic food shortages, malnutrition, unbalanced nutrition, erratic food supply, poor quality foods, high food costs, and even total lack of food. These shortages in food is common in the northern parts of the country. That is why Food and Agricultural Organization of the United Nations (FAO) reported that Sahel States in Northern Nigeria are faced with severe food insecurity. The statement clearly says that, "poor families have used up their food stocks and are facing high food prices awaiting the next harvest" (Food and Agricultural Organization (FAO), 2013). Crop and livestock farmers contribute significantly to the economic development and food security status of Nigerians. Food security is a broad concept which cuts across many magnitudes - access to adequate food for a healthy life (Eme *et al.*, 2014).

Different quarters have defined food security from diverse view points at different times, United States Agency for International Development (USAID) Bureau for Africa, cited by Eme *et al*., (2014) defined food security as a situation *"When all people at all times have physical, social and economic access to sufficient food to meet their dietary needs for a productive and healthy life"*. Yakubu *et al*. (2021) stated that "food security at the individual, household, national, regional and global levels is achieved when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs for active and healthy life." The inverse of this statement is known as food insecurity. Therefore, food insecurity exists when people do not have adequate physical and economic access to food, (FAO, 2015). This means food security is a combination of household agricultural production, food imports and donations, employment opportunities and income earnings, intra-household decision-making and resource allocation, health care utilization and caring practices (Eme *et al*., 2014).

According to World Bank (2001), food security is of three folds, these are food availability, food accessibility and food affordability. Food availability for farming households means ensuring sufficient food for the households through their own production or purchase from markets (Akinyele, 2009; Eme *et al*., 2014). Hence, food security connotes physical and economic access to adequate food for all household members, without undue risk of losing the access (Eme *et al*., 2014). The concept of food security has expanded beyond the strict biological requirements of sustenance for survival. Food security does include consuming at a level adequate for physical and mental health and also includes the right to cultural preferences.

Food insecurity and malnutrition have profound implications for health and development, and present major obstacles to attaining the Sustainable Development Goals (SDGs) (Sani, 2017). Recently the Nigeria Sustainable Development Goals (SDGs) reported in 2014 revealed that ending extreme poverty including hunger (SDG Goal 1) and achieving health and wellbeing at all ages (Goal 5) in rural area remain a key developmental challenge in the country (Oladimeji and Abdulsalam, 2014; Akinmulewo *et al*., 2017). Therefore, understanding smallholder farmers, who are mostly rural dwellers in Nigeria, how much they earn, what they eat, as well as broader questions about the function food security plays in the betterment of the peoples' health and wellbeing is crucial to designing sustainable strategies to reduce hunger, poverty, and illness. Considering that most (70 percent) Nigerians live in rural areas, an analysis of the food security status of rural dwellers will provide a clear picture of what needs to be done to assure food security in Nigeria.

Despite the high level of agricultural activities in the study area, little or inadequate information have been documented, in respect to food security of rural households considering the current trend of food price hike, insecurity and farmers-herders conflicts that has rendered some households deficient in food supply. It poses a key challenge and call for an in-depth scrutiny of food security situation among rural dwellers in the study area. Therefore, this study analyzed the food security status of the rural dwellers in Billiri Local Government Area; identified the socio-economic characteristics of the rural farmers; and identified coping strategies adopted by the farmers against food insecurity.

METHODOLOGY

The study was carried out in Billiri Local Government Area (LGA) of Gombe State, Nigeria. It is located at the north eastern part of the country between latitude 9°30 and 12°30°N, longitude 8°5 and 11°45 E. It is mainly an agrarian area within the Sudan Savannah zone, with a land area of 737km^2. The area has two distinct seasons (wet and dry) with an average rainfall of 850 mm. Billiri LGA has a population of 202,680 in 2006 Census (Yakubu *et al*., 2021; Sani *et al.*, 2017), the projected population was 300,559 people in 2020. Multistage sampling procedure was used in eliciting primary data, a total of 120 questionnaires were administered to the randomly selected respondents for the study. The elicited information was analyzed using descriptive statistics and food status index.

In assessing food security at the household level, the study adopted the Cost-Of-Calories (CoC) method profound by Foster *et al*. (1984) to determine the food insecurity line. This method yields a value that is usually close to the minimum calorie requirements for human survival. The process involves defining a minimum level of nutrition necessary to maintain healthy living. This minimum level is referred to as the “food insecurity line”, below which households are classified as food insecure. Calorie adequacy was estimated by dividing the estimated calorie supply for the households by the household size adjusted for adult equivalents using the consumption factor for age–sex categories (Sani *et al*., 2017). Therefore, using this method, the food insecurity line was determined as:

$$\text{Ln}X = a + bC \qquad (1)$$

Where X is the adult equivalent food expenditure (₦) and C is the actual calorie consumption/adult equivalent of a household (in kcal). The calorie content of the recommended minimum daily nutrient level (L) was used to determine the food insecurity line (S) using equation 2:

$$S = e^{(a+bL)} \qquad (2)$$

Where, S = food insecurity line, a and b = parameter estimates from equation 1, L = recommended minimum daily energy (calorie) level (2260 kcal). Based on the S calculated, households will be classified as food secured or food insecure, depending on which side of the line they fall.

RESULTS AND DISCUSSION

A total of 115 questionnaires were dully filled and retrieved. Hence, analysis was based on the retrieved data.

Socio-economic characteristics of the respondents

Farmers’ age is said to influence farmers’ maturity, agility and decision making ability (Sani *et al.,* 2014). Result in Table 1 indicates that most of the respondents were within the youthful age of between 20 and 49 years considered to be agile. This result collaborates the findings of Mbavai *et al* (2015). Majority (68%) of the respondents were male. This could be attributed to the cultural heritage of the people in the area where female is not allowed to own land due to predominant land tenure system, hence the female engage in processing of produce. The respondents were mainly married (86%). The high proportion of the respondents who were married was an indication that family labour could be available for farming. The mean household size was 8 persons. This finding is closely related to that of Bashir *et al* (2015) who reported large family size in their study. This is highly indicative of the extended family system in the study area where parents and other relation dwell together as a household. More family labour would also be readily available since relatively large household size is an obvious advantage in terms of labour supply. The result obtained from this finding, revealed that most of the respondents (60%) had acquired one form of formal education or the other. The respondents had long time experience in farming with an average of 14 years. The duration of experience in farming is probably an indicator of a farmer’s commitment to agriculture. Extension activities was noticed to be low. Averagely, respondents earned ₦620,000.00 annually from their agricultural activities.

Table 1: Distribution of Respondents based on Socio-economic Characteristics (n=115)

Socio-economic Variable	Frequency	Percentage (%)	Mean
Age			
20-29	20	17.39	42
30-39	42	36.52	
40-49	23	20.00	
50-59	17	14.78	
60-69	9	7.83	
70 and above	4	3.48	
Gender			
Male	78	67.83	
Female	37	32.17	
Marital status			
Married	99	86.09	
Single	14	12.17	
Widow(er)	2	1.74	
Household size			
1-6	26	22.61	8
7-12	37	32.17	
13-18	35	30.43	
19-24	9	7.83	
25-30	5	4.35	
above 30	3	2.61	
Educational Attainment			
Primary	22	40	
Secondary	38	47.83	
Tertiary	9	12.17	
Farming experience			
1-5	13	11.30	14
6-10	18	15.65	
11-15	35	30.43	
16-20	28	24.35	
21-25	12	10.43	
26-30	9	7.83	
Extension contact			
Yes	52	45.21	
No	63	54.78	
Annual income			
50,000-500,000	41	35.65	₦620,000.00
501,000 - 1,000,000	49	42.61	
1,100,000 - 1,500,000	20	17.39	
1,501,000 -2,000,000	5	4.35	

Source: Field survey, 2021

Food Security Status of respondents

Food security status of farming households is presented in Table 2. The result indicates that most (64%) of the rural households were food in-secured. The mean food security index of food secured and food in-secured households were 1.22 and 1.51 respectively. The food insecurity gap of 0.21 and 0.36 implies that on average the food in-secured households consumed 36% less than their daily calorie requirements meanwhile food secured households consumed 21% in excess of their daily calorie requirements. This contradicts the findings Sani *et al.* (2014 in their study which assessed household food security among sorghum farmers under agricultural transformation agenda in Gombe state.

Table 2: Food security status of respondents

Item description	Food secured	Food insecured
Cost-of-calories equation: LnX = a + bC		
Slope coefficient	0.5712	
Number of household	41	74
Percentage of household	35.7	64.3
Mean food security index	1.22	1. 51
Food insecurity gap/Surplus index	0.21	0.36
FAO recommended daily energy levels (L)	2,260 kcal	
Constant	0.4324	

Source: Field survey, 2021

Coping Strategies against food insecurity adopted by the respondents

From the findings in Table 3, it was found that farmers resort to employing coping strategies against food insecurity in their households. The result shows that 97%, 91% and 89% of the respondents eat food that are less preferred and less expensive, reduce portion of sizes of food and purchase food on credit respectively as their coping strategies for food insecurity. This could lead the respondent into ill-health, malnutrition and indebtedness which jeopardize their chances of alleviating poverty among the dwellers. Other coping strategies identified include: rationing consumption, maternal buffering, relying on help from relatives or friends outside household and begging were the least used coping strategies among the respondents. These strategies are employed by the farmers to keep them moving in life. Similar result was found by Agbola (2008) in the measurement of coping strategies as a food insecurity indicator among farming households in Osun area of Southwestern Nigeria.

Table 3: Coping strategies against food insecurity

Coping strategies	Frequency*	Percentage	Ranking
Eating food that are less preferred and less expensive	112	97.39	1st
Reducing portion sizes	105	91.30	2nd
Purchasing food on credit	102	88.70	3rd
Rationing consumption	99	86.09	4 th
Ate less than felt	96	83.48	5 th
Skipped meals	88	76.52	6 th
Borrowing money to buy food	87	75.65	7 th
Borrowing food	71	61.74	8 th
Hungry but did not eat	52	45.22	9 th
Maternal buffering	41	35.65	10 th
Relying on help from relatives or friends outside household	35	30.43	11 th
Begging	23	20.00	12 th

Source: Field survey, 2021. *Multiple response

CONCLUSION

This study analyzed the food security status of the rural dwellers in Billiri Local Government Area; identified the socio-economic characteristics of the rural farmers, and coping strategies adopted by the farmers against food insecurity. The result shows that the respondents were young, married, male, with long years of experience, large household sizes. It was found that 64% of the respondents were food insecured with households consuming 36% less than their daily calorie requirements. Household cope mainly with food insecurity by eating food that are less preferred and less expensive, reduce portion of sizes of food and purchase food on credit. Therefore, it is recommended that extension services should be encouraged in the area to increase adoption of improved farming technologies which will result to yield increase vis-à-vis income; formal education should be encouraged in the area to increase knowledge on the need for food security and taking balanced diets for better health; and cooperative societies should be formed to enable farmers source for income with minimal interest rate for input purchase.

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Using Cassava to Rehabilitate the Convict and Reintegrate the Ex-Convict in Nigeria

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ABSTRACT
There is a need for the Nigerian Prison Service to move away from the more punitive measure of rehabilitating convicts to a more reformative measure using cassava to rehabilitate the convict and reintegrate the ex-convict. This study assessed the inmates' awareness of improved cassava varieties and their willingness to adopt innovations in cassava farming. Deprivation theory of Ted Gurr, Rogers' diffusion theory of innovation and Theory of change were used to understand how some causal factors that leads to illegitimate activities in an individual can be reverted through the adoption of an innovation, thereby influencing a positive outcome. The materials used were the following cassava varieties; IITA-TMS-IBA101040, IBA011412, 1070593, IITA-TMS-IBA961089A, TMS-IBA000203, IITA-TMS-IBA912324, TMEB419. The study was carried out at the Nigerian Prison Service Farm Centre, Ogbomosho, Oyo State and a total of 20 inmates and 3 prison staff available where interviewed. Data were collected through primary and secondary sources; the primary sources include Focus Group Discussions (FGD) and non-participant observation method. The secondary source of data included prison records. It was discovered that the inmates were not aware of improved cassava varieties and that they were still practising traditional farming methods. From the non-participant observation, it was shown that the inmates were willing to adopt the innovation. Hence, there is a need to expand this research to study ways of further empowering the inmates to continue with the innovation.
Keywords: Agriculture, AR4D, Behavioural Change, Prisons, Empowerment, Youth Unemployment

INTRODUCTION
The vision and mission of the Nigerian Prison Service, which is to establish an excellent penal practice that seeks to bring about lasting change in values, attitude and behaviour of offenders, thereby facilitating suitable reformation, rehabilitation and eventually, effective social reintegration into the society. Section 2(4) of the Nigerian Prison Act (1972) is to endeavour to identify the reason for antisocial behaviour of the offenders; to train, rehabilitate and reform them to be good and useful citizens. However, the Nigerian prisons have been identified as a veritable avenue for human resources wastage in the society with 75,772 total inmate population; pre-trial detainees/remand prisoners inclusive in the 240 institutions in the Nigeria (World Prison Brief, 2019), the facilities are being archaic, comatose, non-functional and increasingly overcrowded, with the prison occupancy rate as at 2017 standing at 136.1%, representing a ten percent from the previous years, this will impair good inmates' adjustment (Jefferson and Martin, 2016; World Prison Brief, 2019), as overcrowding has often been associated with bullying, violence, loss of autonomy, poor social network, servitude and perpetuation of crimes from inside the prison walls (Falayi and Ajaja, 2018). This can be attribute to the flawed criminal justice system manifested at every processing point on the

entire criminal justice system line from the executive arm, the legislature arm to the judiciary arm (Osanona, 2015).

The prison community with its distinct culture and way of life epitomizes a complete design capable of changing the attitudes of individual members for good. However, the ideology of the Nigerian prisons system is still hinged on brutality and vengeance. The ideology is premised on punishment than rehabilitation, reformation and resettlement (Danjuma *et al.,* 2019) which brings about the attitudes of some individual inmates changing for bad. Instances abound where the prisons have become a training ground for criminals instead of rehabilitation home in Nigeria (Obioha 1995).

There is a generally acclaimed view that penal institutions in Nigeria are like post-graduate institutions of crime (Opara 1980). Ayodele, (1993) having asserted that the rate at which ex-convicts are returning to jail is alarming further stated that prisons in modern times have become training ground and school for a new category of criminals and patterns of crime unknown to the society. From the foregoing, if prisoners are left unoccupied with constructive and positive activities are likely to perfect their criminal activities through the learning of new tricks from other inmates (Adelaja, 2009). It is evident that various prisons in Nigeria are saddled with the problem of turning out maladjusted releases. Studies like Obioha (1995), Adetula *et al.,* (2010) have shown that contact with the prison institution in Nigeria makes the less hardened individuals to be more hardened in criminal activities upon release, with more tendencies than not, to relapse to criminal activities, which generates a high frequency of recidivism.

There is a shortage of information on recidivism, even with its observed skyrocketing rate. The dearth of information on this impending problem has not helped in exposing it to the public (Omomoyesan *et al.,* 2011; Sambo *et al.,* 2017). It should be noted that except life and condemned prisoners, the rest of the convicts and inmates are still considered as being part of the Nigerian society and they would eventually return to the same society. It is worthy to note that inmates that have served their terms behind the bar will be faced with the challenge of stigma which hinders their employability and alternative ways of employment and empowerment hence the need to explore and ensure a proper reintegration of the inmates into the society.

The reform process of the prisons system is meant to be instituted as an ongoing and self-sustaining exercise, rather than a once off palliative approach. This is based on the fact that reformation and rehabilitation are the modern objectives in the treatment of offenders. Rehabilitation services in Nigerian prisons is provided for prison inmates in order to restore them to fullest physical, mental, psychological, social, vocational and economic usefulness which they are capable of (Nigeria Prison Service, 1989), done through a complicated set of mechanisms consisting among others: conscientization, group work, casework session, recreational activities, religious services and adult and remedial education programmes, educational development projects, skills acquisition programmes, mid-range industrial production, agricultural service and after-care service programmes (Nigerian Prison Service Standing Orders, 2011). There are some programmes in place meant to divert offenders from crime to useful pursuits that make crime unattractive or condemnable such as moral or religious institutions, education, vocational training etc. (Ameh, 2010; Salaam, 2013; Danjuma *et al.,* 2019). The rehabilitation and reintegration programmes have been supported by some financial promises. The Federal Government spare headed the launching of about NGN1 Billion for the provision of relevant skills (Partnership for Prisons Reform, 2006), in this present prisons reforms, a unit is known as Prison Furniture Cottage Industry designed to give prison inmates some vocational training has been established. It is a reformation Centre where doors, office equipment, beds, household furniture, key holders, walking sticks etc are produced (Oluwakuyide, 2001). The behavioural change effect of the various rehabilitation and reintegration programmes is yet to be measured. However, according to Robinson and Raynor

(2009), teamwork among short term offenders is psychotherapy for behavioural change. A similar view was expressed by Sullivan (2008), that time spent on prison farm activities has enabled short term offenders to change their behaviour.

For an agricultural expert to enhance the likelihood and quality of positive outcomes in an Agricultural Research for Development (AR4D) program, there is need to 'create mechanisms for internal learning', which involves a review of the theory of change and re-align the strategy for impact in an institutional framework (Vermeulen and Campbell, 2015).

Clarifying based on Zwane, (2012) the role of an agricultural expert is to serve as an intermediary between agricultural development institutions, in this case, Nigerian Prison Farm Centre, and their target groups, in this case, the convicts, carrying out formulated agricultural policies in addition to helping the development institutions achieve their goals which include linking the target groups with sources of farming inputs and providing timely information on innovations and practises. It further includes bringing about a progressive agricultural development; quantitatively in production increase, wealth creations and qualitatively in welfare increase and behavioral change as a result of technological adoption (Naman *et al*., 2009; Shalaby *et al*., 2010 and Zwane, 2012).

Prison reforms have been advocated in Nigeria but available studies so far have focused on issues like the quality of life of inmates (Armiya'u *et al*., 2019), identification of prisoner's information needs (Sambo et al, 2017), examining the performance of Nigeria's criminal justice system (Osasona, 2015), examining the effectiveness of rehabilitation in prisons on inmates (Ekpenyong and Undutimi, 2017) and the importance of basic educational training and career placement in the process of reintegrating offenders (Salaam, 2013). However, none have considered a particular innovation for empowerment and adoption which will influence a positive outcome hence the importance of this study.

Firstly, for the farmers in this case, the inmates, to respond positively to any new innovation, they must first be aware and be properly educated on how best to apply the new innovation. Secondly, to institutionalise the learning process, there is need to strategically revamp the scanty prison farm centres with an agricultural innovation that serves both food and income purposes. Finally, cassava with is diverse use (Fig. 1 See appendix) and the numerous products along its value chain (Fig. 2 See appendix) can best be used to rehabilitate the convicts and reintegrate the ex-convicts in Nigeria.

This study was aimed at examining the awareness of the inmates of improved cassava varieties, their willingness to adopt the innovation. Attempts were also made to provide answers to the following research questions:

i. What are the existing agricultural innovations available in the study area?
ii. What is the awareness of the inmates of improved cassava varieties?
iii. What is the inmates' willingness- to adopt the innovation?

Objectives of the study

The broad objective of the study was to assess the use of improved cassava varieties as a means of empowerment of the inmates leading to a behavioural change. Specifically, the study wanted to:

i. Identify the existing agricultural innovations in the study area.
ii. Assess the awareness of inmates for the improved cassava varieties
iii. Assess the willingness of the inmates to adopt the innovation.

Theoretical and Conceptual Framework

Deprivation theory of Ted Gurr

This classical theory is an explanation of political violence (riots, rebellion, coups, criminal activities etc.). The theory examines the psychological causes involving frustration and aggression as the primary source of human capacity for violence. Frustration does not necessarily or sufficiently lead to violence, but greed may drive to violence. Though frustration is a much stronger motivating force, prolonged frustration brings about a greater probability for aggression. Relative Discussions (RD) is the discrepancy between what people think they deserve and what they think they can get (Gurr, 1970).

This theory could be used to link rising youth unemployment and violent crimes in Nigeria; a country that churns out thousands of university graduates yearly without commensurate employment opportunities may be brooding a fertile ground for a feeling of frustration among these unemployed graduates. Based on the concept of Relative Deprivation which shows how a person's expectations and capabilities measure their respective RD, indicate man's likelihood of using force to achieve something. Factoring in the following variables within the mix: time, alternatives, levels of frustration, ability to close the gap, a prolonged frustration and the feeling of deprivation of what is expected increases, and there is a greater probability that the individual or people can resort to illegitimate activities in order to actualise their expectations in the society.

Gurr in his work believes that the root of the problem in rebellion is 'relative deprivation' which can be described as the tension that develops from a discrepancy between the 'ought' and 'is' of collective value dissatisfaction.
Value expectation – value capability = value dissatisfaction

Rogers' diffusion theory of innovation
Rogers (1962) in his book Diffusion of Innovations argues that diffusion is the process by which an innovation is communicated over time among the participants in a social system. The origins of the diffusion of innovations theory are varied and span multiple disciplines (Rogers, 1995).

Diffusion of innovations is a theory that seeks to explain how, why, and at what rate new ideas and technology spread. Rogers proposes that four main elements influence the spread of a new idea: the innovation itself, communication channels, time, and a social system. This process relies heavily on human capital. The word "technology" and "innovation" as synonyms. However, for Rogers, (2003) "a *technology* is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving the desired outcome". For Rogers (2003), adoption is a decision of "full use of an innovation as the best course of action available" and rejection is a decision "not to adopt an innovation". Rogers defines diffusion as "the process in which an innovation is communicated through certain channels over time among the members of a social system". The improved cassava varieties serve as the innovation or technology, the communication channel, in this case, is a physical demonstration, time which is in cross-sectional form and prison farm centre as the social system. Although the term social system is fluid and can be used and understand in different ways, across disciplines, this study chose to restrict meaning to the prison farm centre.

Theory of Change
Theory of Change is a specific type of methodology for planning, participation, and evaluation that is used in the philanthropy, not-for-profit and government sectors to promote social change. Theory of Change defines long-term goals and then maps backward to identify necessary preconditions (Brest, 2010).

Theory of Change explains the process of change by outlining causal linkages in an initiative, i.e., its shorter-term, intermediate, and longer-term outcomes. The identified changes are mapped –as the "outcomes pathway"– showing each outcome in logical relationship to all the others, as well as chronological flow. The links between outcomes are explained by "rationales" or statements of why one outcome is thought to be a prerequisite for another (Clark and

Taplin, 2012). However, due to cross-sectional nature of the study, the outcome could not be ascertained.

MATERIAL AND METHODS

Data collection and sampling techniques

This study was carried out in Ogbomosho from the cross–sectional observation of the inmates of the Nigerian Prison Service Farm Centre, Ogbomosho, Oyo State. Ogbomosho is the second largest town in Oyo State made up of two Local Governments, Ogbomoso South and Ogbomoso North Local government areas. The geographical area spreads between 8º08'N and 4º15'E. It has an area landmass covering about 37,984 square kilometres and located in the northern part of Oyo State. The vegetation is dominated by derived savannah vegetation and agriculture is the main occupation of the people. The majority of the people are members of the Yoruba ethnic group. Yams, cassava, maize, and tobacco are some of the notable agricultural products of the region.

Data were collected through primary and secondary sources; the primary sources include Focus Group Discussions (FGD) and non-participant observation method. The secondary source of data included prison records.

Focus Group Discussions (FGD) were conducted, and observational method was used to observe the prison inmates within the prison environment while (FGD) was done with the prison staff alone. The study was qualitative in nature and data were analysed using descriptive and Content Analysis Methods. Data were analysed in the following themes:

1. Nature of skill acquisition and development initiatives in the prison centre.
2. Awareness of improved cassava varieties
3. Awareness of improved farm practises.
4. Willingness to adopt innovation.

The materials used where the following cassava varieties; IITA-TMS-IBA101040, IBA011412, 1070593, IITA-TMS-IBA961089A, TMS-IBA000203, IITA-TMS-IBA912324, TMEB419.

DISCUSSION

The inmates were first taken through a short lecture on cassava varieties identification, the various uses and products that can be gotten along the cassava value chain. Then the inmates were interviewed through the wardens who spoke on their behalf as follows.
The prison is saddled with the duty of bringing about lasting change in values, attitude and behaviour of offenders, thereby facilitating suitable reformation, rehabilitation and eventually effective social reintegration into the society, one of the staff said:

> *In a bid to achieve this, we have been having some skill acquisition and teaching that some inmates have written their West African Examination Council (WAEC) from the prison and we have some studying in the National Open University Nigeria (NOUN) from here.*

However, personal observation of the facilities shows a neglected pen which has not been stocked for a long period of time. This shows an existence Nature of skill acquisition and development initiatives in the prison centre which is a normal thing in the prison with the programmes perceived as fairly successful. This was corroborated by Salaam, 2013; Ekpenyong and Undutimi, 2017) who also reported that lack of fund/inadequate funding has affected inmate's rehabilitation.

The staff revealed through their words they are not conversant with the improved varieties of the they are not conversant with the improved cassava varieties, the staff said:

> *We have these hectares where the inmates plant garri and other products are produced by the inmates from it.*

The awareness of improved cassava varieties was very low, and there were no traces of any garri processing plant to buttress the fact that inmates produce simple products like garri among themselves. This underscores the findings of (Wossen *et al.,* 2017) who found out that farmers' proximity to change agents resulted in a higher level of awareness and the use of improved technologies. The lack of awareness of improved cassava varieties can be attributed to the fact that the Farm Centre has little or no attachment of extension agents while the lack visible processing technologies can be attributed to the paucity of funds to the farm.

A Small Plot Adoption Technique (SPAT) was used for a practical demonstration to the inmates on their 3 hectares' plot, the inmates were very silent about their knowledge and awareness of improved farming practises, observation showed that they were not aware of improved farming practises. In the words of one the inmates "*Let me plant the way we use to do it here."*

The above quotation showed not only the fact that they were not authorised to speak freely; it showed that the method of handling they embraced was traditional farming practises handed down to them. However, the inmates were quick to adopt the improved farming practises for planting the cassava and were also quick to innovate as they planted. The innovativeness displayed by the inmates during planting showed a willingness to adopt the improved cassava varieties and farming practises. This agrees with (Abele *et al.,* 2008) who reported that the speed of adoption of cassava were positively influenced by awareness of the cassava variety's attributes.

CONCLUSION

As observed from this study, the prison facilities have the environment for skill acquisition and technological innovation. However, the inmates are not aware of new agricultural innovations and there was a willingness to adopt innovations.

From the findings of this study, it is imperative to recommend the following:
The prison should be seen as one of the important social institutions in the society, and therefore adequate funding should be provided for it to run properly. The setting up of a training or skill acquisition prison - which will be centred around agriculture, for short term offenders which will help them be reintegrated into the society. The reformation and rehabilitation objectives of our prison should be expanded to include empowerment, to equip ex-convicts with a sustainable behavioural change that will be devoid of relapse. Strengthening the link between inmates and agricultural extension agents/service providers to enhance the adoption agricultural innovations.

Limitations of the study

One important limitation of this study is its narrow scope which is as a result of the non-availability of literature on the Nigerian Prison Farms Centre. Financial problems coupled with the acute limitation of time forced the researcher to study only the adoption and not the behavioural change that will accompany adoption. Having noted the narrow scope of this study, I wish to suggest for a more comprehensive study on using cassava to rehabilitate the convict and reintegrate the ex-convict in all Nigerian Prisons Farm Centres so that a clearer picture of the impact can be achieved. Secondly, there should be further researches on the impact of other improved agricultural technologies on the rehabilitation and reintegration of convicts the ex-convicts

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APPENDIX

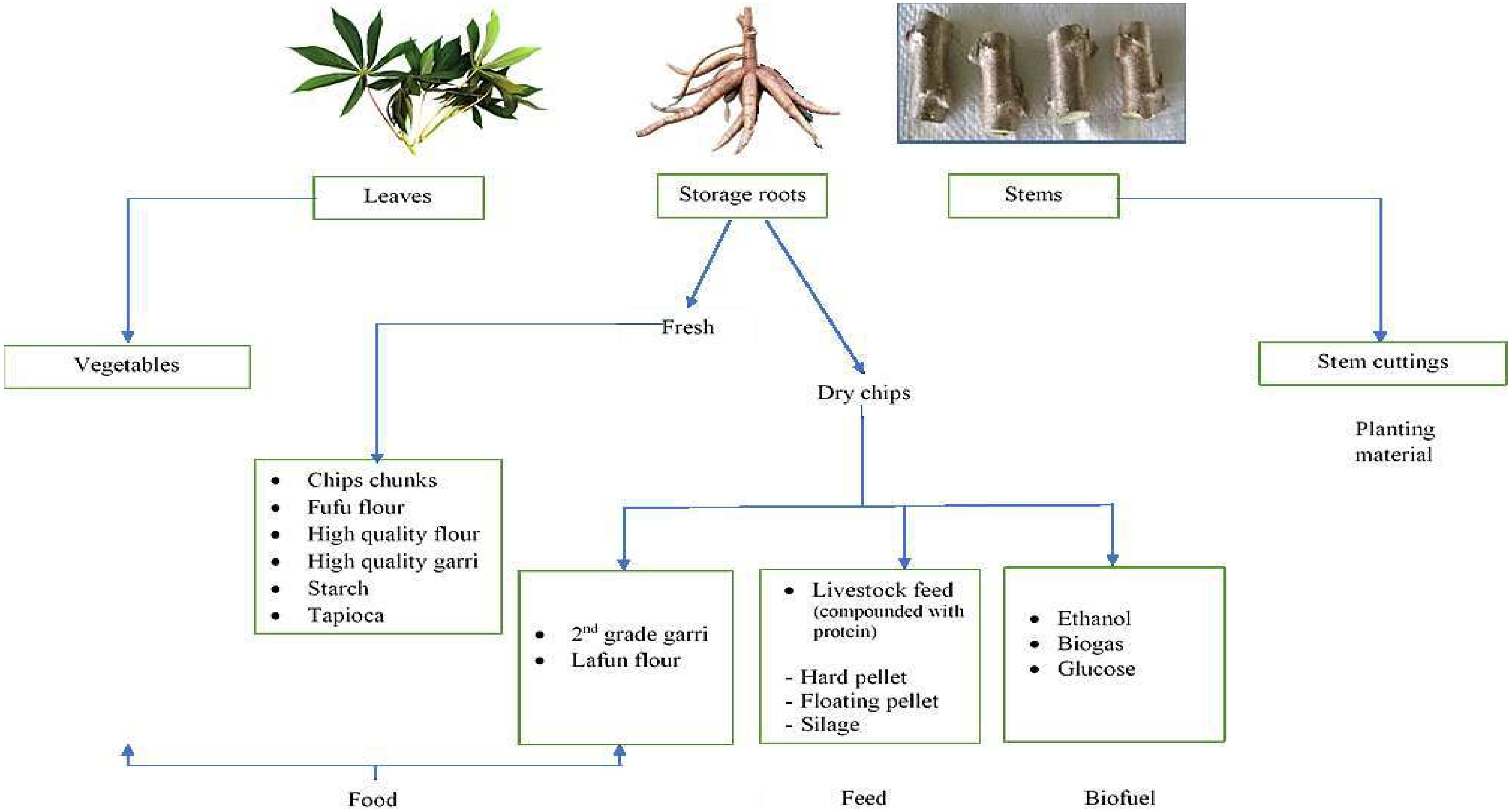

Figure 1: Cassava by-products

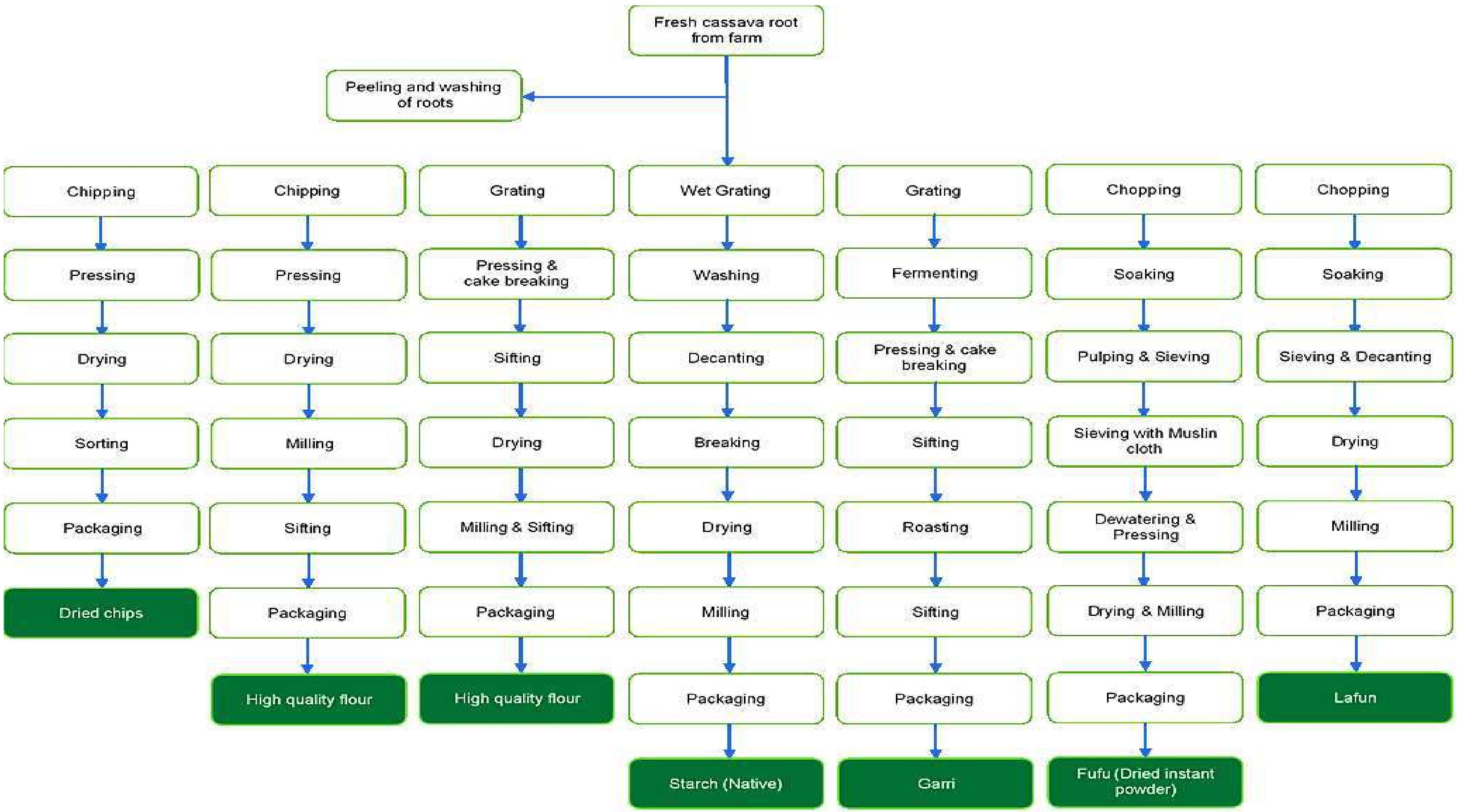

Figure 2: Cassava value chain (Adapted from (Okechukwu, 2005)

Technical Efficiency of Young Cassava Farmers in North Central of Nigeria

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ABSTRACT
Improving technical efficiency is imperative for achieving food security, increasing income and reducing poverty. This study thus assesses technical efficiency of cassava farmers in north central of Nigeria focusing on youth. A cross-sectional data collected with a structured questionnaire from eighty (80) cassava farmers selected through multistage random sampling technique were subjected to descriptive and stochastic frontier analysis (SFA). The estimated mean technical efficiency index was 58.0% indicating that efficiency can be improved at the available technology by 42.0% in Nigeria. Education is an essential policy element with potential to improve productive efficiency in cassava farms. Thus, any government policy geared towards improving farmers' education will consequentially improve technical efficiency and volume of cassava output at the current level of technology in Nigeria.
Keywords: technical efficiency, cassava, stochastic frontier analysis, Nigeria.

INTRODUCTION
Cassava is one of the major root crops grown for consumption in West Africa where it contributes about 40 percent of food calorie intake to over 550 million people and occupies an important position in rural livelihoods (Aerni, 2006; Sanni *et al.*,2009; Adenle *et al.,* 2012; Kleih, 2012; Manyong and Ayedun, 2014; Odongo and Etany, 2018; Sodeeq *et al.*, 2020). The recognized role of cassava in reducing rural poverty and increase food security in Nigeria led to implementation of several government programs supported by development partners in the last three decades. These include the Cassava Multiplication Program (CMP), Nigeria Strategy Support Program (NSSP), Agricultural Transformation Agenda (ATA) among others (Sodeeq *et al.*, 2020). Thus, achieving a high level of technical efficiency on cassava farms is considered a priority for agricultural development in Nigeria. However, this is seldom realized but a growing government commitment and initiative is on to engage youth in agriculture. Perhaps, this may change the face of the situation in Nigeria. This study thus aims to assess the technical efficiency of cassava farmers with focus on youth defined as individual between 15 and 35 years of age (Africa Union, 2006).

METHODOLOGY
This study was carried out in north central of Nigeria. A multistage random sampling technique was used to select eighty (80) young cassava farmers. The first stage was a purposive selection of two states in the region. The second stage was a random selection of one agricultural zone in each state where the sample frame of rural communities was drawn. The third stage was a random selection of four rural communities per state and the last stage was a random selection of ten (10) youth cassava farmers per community. Cross-sectional data were collected with a structured questionnaire. They were analyzed using descriptive statistics and

stochastic frontier analysis (SFA). The empirical model used in this study is expressed under parametric approach as follow:

$$\ln Y_i = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \ldots\ldots.\beta_n \ln X_n + \varepsilon_i \quad (1)$$

Y_i = cassava output (ton), X_1= farm size (ha), X_2 = cassava cuttings (bundle), X_3 = Labour used (Manday), X_4 = fertilizer (kg), X_5 = agrochemical (litre), β = parameters and ε = error term

To examine the role of relevant socioeconomic factors in productive efficiency, the following equation is estimated:

$$EI_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \varepsilon_i \quad (2)$$

Where i refers to the ith farm in the sample; EI = Inefficiency, Z_1= Age in years, Z_2 = Gender (male= 1, female = 0), Z_3 = marital status, Z_4 = Education in years, Z_5 = household size, Z_6 = experience in years, δ is the parameter to be estimated and ε_i is the random error assumed to be normally distributed.

RESULT AND DISCUSSION

Estimated Cobb-Douglas Stochastic Production Frontier for Young Cassava Farmers

The estimated Cobb-Douglas production frontier parameters for young cassava farmers are presented in Table 1. The coefficient for farm size was positive and significant at a 1% level of probability. This conforms to a priori expectation and implies that increase in land cultivation would increase cassava output. A Similar result was reported by Mohammed and Tamer (2016). The coefficients for cassava cutting, labour and agrochemicals were negative, implying that increase in these variables would decrease cassava output. This is consistent with the view of Okoye *et al*., 2016 who opined that this might be due to the inefficient use of these inputs. The coefficient for the cropping system was positive and significant at 5% indicating that cultivation of cassava in a mixed cropping system would increase cassava output. This is contrary to a priori expectation and could be as result of mismanagement of land by farmers who were using mono-cropping system. The use of fertilizer had positive sign and significant at 10% level of probability. This conforms to a priori expectation and implies that increase in fertilizer use would increase cassava output. This is in line with Goni *et al*. (2007); Wongnaa and Ofori (2012); Girei *et al*. (2013) and Isitor *et al*. (2017)

Table 1: Estimated Cobb-Douglas Stochastic Production Frontier

Variables	Coeff.	Std. Error	Z	P
Farm size	1.4116	0.3153	4.48	0.000***
Cassava cuttings	-0.6763	0.4576	-1.48	0.139
Labour	-0.1823	0.1508	-1.12	0.227
System	0.5037	0.2385	2.11	0.035**
Fertilizer	0.3553	0.2118	1.82	0.067*
Agrochemical	-0.3426	0.2241	-1.53	0.126
Constant	2.5228	0.8657	2.91	0.004
6V	0.1029	0.0718		
6U	0.5722	0.0842		
6^2	0.3380	0.0856		
Lambda	5.5407			
Loglikehood	-24.3599			

Source: Field Survey, 2019, *** Significant at 1%, ** Significant at 5%, * Significant at 10%,

Empirical results of technical efficiency of young cassava farmers

Table 2 presents the distribution and summary statistics of estimated technical efficiency indices for the sampled young cassava farmers. The estimated mean technical efficiency index was 58.0% indicating that efficiency can be improved at the available technology by 42.0% and significant scope for increasing the efficiency of young cassava farmers in Nigeria.

Table 2: Technical Efficiency Distribution of youth-owned Cassava Farms

Efficiency (%)	No. of farm	%
40	-	-
40-50	12	15.0
50-60	40	50.0
60-70	24	30.0
70-80	4	5.0
80-90	-	-
90-100	-	-
Mean (%)	58.0	
Minimum(%)	45.0	
Maximum(%)	75.0	
Standard dev. (%)	6.74	

Source: Field Survey, 2019

Determinants of Technical Inefficiency of young Cassava Farmers

The estimated coefficient for the age variable has a negative sign (Table 3). This suggests that an increase in the age of these young farmers leads to reduction in technical inefficiency. A possible reason for this could be that as their age increases towards the adult youth stage, they become stronger, more productive and aggressive in business leading to increase in efficiency level. The coefficient of gender is negative, suggesting that female young farmers were more efficient than their male counterparts. Okoye *et al* (2016) reported similar result despite cultural factors impeding woman from playing a more active economic role in agriculture. The coefficient of marital status is negative, implying that married youth were more efficiency than single. The knowledge of effect of inefficiency on family members could be responsible for this result. The coefficient of education is significant ($p<0.05$) and negatively related to technical inefficiency, implying that uneducated young farmers are less technically efficient than the educated. This aligns with findings of many authors such as Weir and Knight (2000); Chukwuji (2007), Nchare (2007). Household size is significantly correlated with technical inefficiency ($p<0.10$) meaning that increase in household size reduces productive inefficiencies. This is explained by the increased availability of labour at the farm level. However, the number of years of farming experience was highly significant ($p<0.01$) and positively correlated with technical inefficiency, suggesting that new young farmers are more technically efficient than youth who have been in cassava production much longer. Youths newly entering cassava production may have started using new technologies that may not be known to the experienced farmers who may still be using old methods. On the other hand, farmers with higher levels of education are likely to be more efficient in the use of new technologies such as inputs than their counterparts regardless of years of experience.

Table 3: Determinants of Technical Inefficiency of Youth-owned Cassava Farms in Nigeria

Variables	Coeff.	Std. Error
Age (years)	-0.0073(-1.20)	0.0061
Gender	-0.0979(-1.63)	0.0599
Marital status	-0.0232(-0.52)	0.0442
Education (years)	-0.0095(-1.85)**	0.0051
Household size	-0.0007(-0.18)	0.0039
Experience (years)	0.0120(2.89)***	0.0042
Constant	2.1010(9.40)	0.2235

Source: Field Survey, 2019, *** Significant at 1%, ** Significant at 5%, * Significant at 10%, Figures in parenthesis are t- values

CONCLUSION

Technical efficiency of youth-owned cassava farms in derived savannah agro-ecological zones of Nigeria was estimated using the SFA. Technical efficiencies for a sample of 80 cassava farmers were predicted and explained by socioeconomic factors. The results revealed that there is scope for increasing cassava productivity with the same present levels of inputs by simply improving farmers' level of efficiency. The production efficiency at farm level depends on a number of socioeconomic factors. The key factor identified as contributing positively towards improving youth farmers' efficiency is education. Significance of the variable indicates that it is an essential policy element with potential to improve productive efficiency in cassava farms. Thus, any government policy geared towards improving farmers' education and expertise will consequentially improve productive efficiency and volume of cassava output at the current level of technology in Nigeria.

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Socioeconomic Determinants of Poultry Egg Marketers in Kano Metropolis, Kano State, Nigeria

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ABSTRACT
The study analysed the influence of socio-economic variables on poultry egg marketing selected markets in Kano metropolis. The study revealed that all marketers were males with an average age of 38years and 27years for wholesalers and retailers respectively. For wholesalers, the average household size is 8 and 5 for the retailers. According to the results, the wholesalers had 15years as mean years of experience in poultry-egg marketing and retailers have 7 years.it also showed that the average duration of stay of the wholesalers is 15years and 7years for retailers. Results also indicated that 79.5% of the wholesalers were married and 20.5% are single while for the retailers 65.9% are married and 34.04% are single. It also indicated that about 66.7% of the wholesalers and 87.2% are literates. Household size and duration of stay were found to be significant in explaining the socio-economic characteristics that influence egg marketing in Kano Metropolis for both wholesalers and retailers. The most prominent problem for the wholesalers which accounted for 84.6% is transportation, while for retailers it is price instability. It is recommended that good roads and storage facilities should be provided for the people in order to reduce the rate of loss and wastage since egg is perishable.
Keywords: Determinants, Profit Efficiency, Poultry Egg, Marketers, and Kano Metropolis

INTRODUCTION
The importance of the poultry subsector is chiefly in the provision of meat and egg as well as the provision of employment either (Afolami *et al.*, 2011). Eggs, one of the major products of poultry production, are more affordable for the common person than other sources of Animal protein (Ojo, 2003). It gives about 3.5g of the total 7.2g animal protein requires for individual dietary need per day.

Marketing, on the other hand, is concerned with all stages of operatives which include the movement of commodities from the farms to the consumers. Most of the eggs marketed and consumed in Nigeria come from poultry birds however, very few of the marketers are involved in large scale marketing which is much needed so as to achieve the required increase in production that would keep pace with population growth and demand by boosting local supply and thus improving on the dietary need of the growing population especially in Kano which is the most populated State in Nigeria thus, the need to study the influence of socio-economic variables on egg marketing and constraints encountered. Therefore, the objectives of the study were to determine the influence of socio economic variables on poultry egg marketers in Kano metropolis and to describe the constraints associated with egg marketing in Kano metropolis.

METHODOLOGY

Kano metropolis of Kano State, Nigeria, is the study area. Kano metropolis comprises of eight Local Government Areas (LGA); Dala, Kumbotso, Gwale, Kano municipal, Tarauni, Fagge, Ungogo and Nassarawa LGA. Specific areas used for the study were Rimi market in Kano municipal, Yankaba market in Nassarawa LGA, Tarauni market in Tarauni LGA, Singa market and an egg depot in Katsina road in Fagge LGA.

Sampling Technique

Five markets were purposely selected based on concentration and intensity of egg marketing. The markets were Yankaba, Tarauni, Rimi, Singa, and Katsina road. In four of the markets, the egg marketers are stratified with wholesalers and retailers and only wholesalers in one. A simple census of egg marketers was conducted in each of the six markets and thirty-nine (39) and forty-seven (47) wholesalers and retailers respectively were found in all the markets, giving a total of eighty-six (86) egg marketers for the study. Data was collected using a well-structured questionnaire which was administered to the two categories of marketers.

Analytical Techniques

Tools of analysis used in analyzing the data include descriptive statistics and multiple regressions. The Multiple Regression Model was expressed as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 \quad (3)$$

Y = Quantity of egg marketed (numbers for retailers and crates for wholesalers)
$X_1 X_2 X_3 X_4 X_5 X_6$ =Independent variables
β_0 =Constant
$\beta_0\beta_1\beta_2\beta_3\beta_4\beta_5\beta_6$=coefficient of the independent variables
X_1=Age of egg marketer (years)
X_2=marital status (single=1, married=2, divorce=3, widow=4)
X_3=household size (numbers)
X_4=educational status (pri=1, secondary=2, tertiary=3, religious=4,)
X_5 = years of experience (years)
X_6= Duration of stay (years)
U=Error term

RESULTS AND DISCUSSION

The Socio-Economic characteristics associated with egg marketers in Kano metropolis were analyzed in the study. They include age, sex, marital status, household size, level of education, marketing experience, duration of stay, and major source of income.

Age of egg marketers

Age is the amount of time expressed in years someone spends on earth or how long somehow has existed. As indicated in Table 1, the results of the study revealed that the mean age of the egg marketers was 38years for wholesalers and 27 years for retailers. Age plays a significant role in egg marketing. The more energetic an individual is, the higher the possibility of his or her to perform better than the very young or very old marketers (Ndaghu *et al*, 2011). Afolabi, (2007) also reported that age of marketers has positive impact on the business aggressiveness and flexibility in marketing activities.

Household size

Household is simply a social unit, not necessarily living together, comprising of one or more people who benefits from a specific source of income. The results of the study revealed that the egg marketers have a household size mean of 8 for wholesalers and 5 for retailers. The household size affects the managerial of marketing through understanding of more responsibility in terms of high number of population in household size which lead to spending most of the earning/profit to family instead of expanding the capital, it also determines the size of marketing either big or small. This result to some extent agrees with the findings of Onwumere *et al,* (2009) which shows that majority of marketers have household size of 2-11.

Years of experience
Years of experience refers to the period a person has spent operating in a particular business. According to the result, the wholesalers have 15years as mean years of experience in poultry-egg marketing and retailers have 7 years. The result suggests that majority of the poultry-egg marketers in the area are fairly new entrants into the business. It is generally expected that productivity increases with years of experience. Experience in marketing is a key factor in marketing efficiency, margin, and the longer the years of marketing experience, the more exposed the marketer becomes and the more efficient and effective the marketer is expected to be in allocation of resources (Adetimirin, 2000).

Duration of stay
Duration of stay refers to the period a person has been operating in a particular market. The result shows that the average duration of stay of the wholesalers is 15years and 7years for retailers. The table shows that the wholesalers have minimum duration of 5years and maximum of 35years and 2years and 10years for the retailers respectively. It is expected that customer loyalty is developed with increase in duration of stay in a particular market. (Adetimirin, 2000).

Sex of egg marketers
Sex refers to the two main categories (males or females) into which humans and other living things are divided. The result shows that 100% of both wholesalers and retailers are males, which means that males dominated the egg market for both wholesalers and retailers. Domination of many agricultural businesses by males is a common occurrence in northern Nigeria. This has to do with culture and religion of the people dominating Kano metropolis (Fidelia, 2005).

Marital status of egg marketers
Marital status refers to a person's situation with regard to whether the person is single, married, widowed or divorced. The distribution of marketers based on marital status as indicated in the table shows that 79.5% of the wholesalers are married and 20.5% are single while for the retailers 65.9% are married and 34.04% are single. Research revealed that marital status to some extent influences the population of marketers for marketing purposes because the marriage institutions possess some restrictions as regard to which marketer is responsible and trustworthy. This research agrees with the findings of U.N. (2007) that different ethno-religious group continues to attach prestige to marriage as an indicator of social responsibility, trust and achievement.

Education background of egg marketers
Educational background refers to the act or process of acquiring knowledge, especially systematically. According to the results, it can be deduced that (33.3%) of the wholesalers had religious education and (40.4%) of retailers had secondary education. Those who had only tertiary, secondary and primary education were 12.8, 23.1% and 30.8% respectively for wholesalers and those retailers who had primary, tertiary and religious were 34.0%, 12.8%, 12.8% respectively. This indicated that about 66.7% of the wholesalers and 87.2% are literates. The literacy level of the wholesalers would afford them the opportunity to understand and adopt modern marketing services thereby enhancing profitability. Other studies such as Afolami (2007), found that education level influenced productivity and market access.

Other source of income
Source of income simply means where a person's money is coming from. Most of the egg marketers do not engage in other activities besides egg marketing. 7.7% and 2.6% of the wholesalers partake in trading and crop production respectively and 6.4% and 8.5% for the

retailers respectively. The result shows that 89.7% and 85.1% of the wholesalers and retailers depend heavily on egg marketing. This is in line with the findings of (Fatima, 2016) which implies that majority of agricultural marketers did not engage in other occupations.

Influence of socio economic characteristics on egg marketing

Tables 2 shows that, two out of the six variables which are age of the egg marketer, marital status, household size, years of experience, educational attainment and duration of stay. Household size and duration of stay were found to be significant in explaining the socio-economic characteristics that influence egg marketing in Kano Metropolis for both wholesalers and retailers. For wholesalers, the household size was significant at 5% ($P<0.01$) and positively related to quantity of egg marketed. The positive sign of the regression coefficient (0.076) indicates that an increase in household size will result in an increase in the quantity of egg marketed.

Duration of stay was significant at 1% ($P<0.001$) and positively related to quantity of eggs marketed. The positive sign of the regression coefficient (0.081) indicates that the longer the duration of stay in the market, the higher the quantity of egg marketed. For the retailers, the household size was significant at 5% ($P<0.01$) and positively related to quantity of egg marketed. The positive sign of the regression coefficient (0.075) indicates that an increase in household size will result in an increase in the quantity of egg marketed. Duration of stay was significant at 5% ($P<0.01$) and positively related to quantity of eggs marketed. The positive sign of the regression coefficient (0.111) indicates that the longer the duration of stay in the market, the higher the quantity of egg marketed.

Constraints associated with Egg Marketing

The constraints associated with poultry egg marketing were summarized from the responses obtained from the egg marketers as indicated in Table 4. The constraints associated with Poultry egg marketing in Kano Metropolis can be observed from Table 4 that the most prominent problem for the wholesalers which accounted for 84.6% is transportation. The reason behind this is that poultry egg is fragile in nature and can easily get cracked due to bad roads and transportation facilities and that the eggs are mostly sourced from far places which makes the transportation to be very expensive. The 2nd problem in rank is the issue of price instability (76.9%), due to the cost of purchase of the egg that keeps changing randomly. The 3rd, 4th, and 5th in rank are storage problem (53.8%), inadequate capital (28.2%) and high market charges (23.1%) respectively. The storage problem is mostly in terms of how expensive the rent of stores is. In the case of retailers, the most prominent constraint is price instability which accounts for 100% of the egg marketers, followed by inadequate capital (63.8%), storage (55.3%), transportation (51.1%), high market charge (46.8%) and poor sales (23.4%) ranking 2nd, 3rd, 4th, 5th, and 6th respectively.

CONCLUSION

It can be concluded that household size and duration of stay were found to be the only socio economic characteristics that influence egg marketing in Kano Metropolis and the market was relatively highly concentrated and therefore less competitive. In line with the findings of the study, the following recommendations were put forward.

It is recommended that poultry egg marketers be encouraged to increase their scale of marketing for increased profitability. This could be achieved if small scale retailers can come together and pull their resources together and form cooperatives. It should be advocated to the general public that egg marketing should not be seen as a business for the males only; females can also involve making it decent and admirable. Good roads and storage facilities should be provided for the people in order to reduce the rate of loss and wastage since egg is perishable

Table 1: Distribution of poultry egg Marketers according to their socio-economic

Variables	Wholesalers				Retailers			
	Min	max	mean	SD	Min	Max	mean	SD
Age (years)	22	60	38	9.3	20	35	27	3.6
Household size(No)	2	18	8	3.9	2	8	5	1.5
Year of experience	5	35	15	8.3	2	10	10	2.7
Duration of stay	5	35	15	6.8	2	10	10	2.7

Source: Field Survey, 2018

Table 2: Distribution of poultry egg Marketers according to their socio-economic variables (Qualitative)

	Wholesalers		Retailers	
Variable	**Frequency**	**Percentage%**	**Frequency**	**Percentage%**
Marital Status				
Married	31	79.5	31	65.9
Single	8	20.5	16	34.04
Level of education				
Primary education	12	30.8	16	34.0
Secondary education	9	23.1	19	40.4
Tertiary education	5	12.8	6	12.8
Islamic education	13	33.3	6	12.8
Other source of income				
Trading	3	7.7	3	6.4
Agricultural production	1	2.6	4	8.5
None	35	89.7	40	85.1

Source: Field Survey, 2018

Table 3: Influence of socio economic characteristics on egg marketers

	Wholesalers		Retailers	
Variables	**Coefficient**	**T Value**	**Coefficient**	**T Value**
Age of egg marketers	0.009	0.538	-0.001	-0.157
Marital status	-0.025	-0.084	-0.30	-0.481
Household size	0.076	2.053**	0.075	2.610**
Years of exp.	0.029	1.208	0.018	0.267
Educ. Attainment	-0.041	-0.455	0.010	0.399
Duration of stay	0.081	2.831***	0.111	1.712*
Constant	3.644	6.938	0.424	2.504**
R square	24%		91%	
R adjusted	10 %		90%	
F-test	1.704		74.4	
Sample size	39		47	

*=P< 0.1, ** =P <0.05, ***= P< 0.001

Table 4: Distribution of egg marketers based on problems encountered in Egg marketing

	Wholesalers			Retailers		
Constraints	**Frequency**	**Percentage**	**Rank**	**Frequency**	**Percentage**	**Rank**
High marketing charges	9	23.1	5th	22	46.8	5th
Transportation	33	84.6	1st	24	51.1	4th
Storage	21	53.8	3rd	26	55.3	3rd
Price instability	30	76.9	2nd	47	100	1st
Inadequate capital	11	28.2	4th	30	63.8	2nd
Poor sales	0	0		11	23.4	6th

Source: Field Survey, 2018

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Consumers Acceptability on Boiled and Pounded Yam from Multi – Locations for Preleased Genotypes

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ABSTRACT

Yam is grown annually and perennially in Africa, Americas, Caribbean, South Pacific and Asia. It is indigenous to West Africa. Nigeria is one of the countries therein is likewise blessed with different types of local foods example boiled and pounded yam, very popular delicacy. Consumer's acceptability on multi - locations for preleased genotype were determined. The tubers of Dioscorea alata and Discorea alata varieties were collected from different locations, Abakaliki, Umudike and Uyo, the boiled and pounded yam made from white yam and water yam, were compared. the were peeled, sliced and washed with clean water, transferred into cooking pots with water and cooked for twelve minutes and pounded with mortar and pestle. Two different groups of (20 members; 10 men and 10 women). Trained sensory panelists were selected with hedonic scale of 1-5 ascending order of boiled and pounded yam rheological characters, The famers preference in Fig:1 are, TDr8902665, TDr1401220, TDr1100128 and TDr Local both boiled and pounded , Fig:2, TDa1100224, TDa1401253 and Tda1100247 did not perform very well across locations . But on PCA1&2: the most stability among the accessions are TDr1100185 and TDr1100180 in both boiled and pounded. But also on PCA3&4 the most stable across the locations is TDa1100374 in boiled and also in pounded among all the accessions. Therefor Tdr1100180 and Tda1100374 genotypes have the highest general acceptability across the locations both in pounded yam qualities.

Keywords: consumers, acceptability, Boiled, Pound.

INTRODUCTION

Africans are blessed with local foods, Nigeria one of the countries therein is likewise blessed with different types of local foods. One of the local foods is pounded yam, a very popular delicacy (Olaoye and Oyewole, 2012). Pounded yam is eaten with different soups like vegetable, ogbono, okro, egunsi soups. Most occasions and parties in Nigeria, especially the Yorubas serve pounded yam as the menu. Pounded yam is usually made from yam, cocoyam or the mixtures and pound with mortar and pestle. Yam an ingredient of pounded yam is a member of the genus *Dioscorea* is an important staple food in West Africa (Ekwu *et al.,* 2005). It is grown annually and perennially in Africa, the Americas, the Caribbean, South Pacific and Asia. It is indigenous to West Africa (IITA, 2018).

The common species available are the Yellow yam (*D. cayenensis*), Water yam (*D. alata*), *D.rotundata*, and *D. esculenta.* According to FAO (1989), yam has great prospect of contributing to closing the projected food deficit in Africa in the 21st century. Out of the 94% of West African's production, Nigeria single handedly produce 71%, making a total of more than 37 million tons (IITA, 2018). In Nigeria, February and April tubers are planted and are harvested between180 to 270 days. Nutritionally, yam tubers consist of about 21% dietary fiber and are rich in carbohydrates, vitamin C and essential minerals. Yams are processed into less perishable products through a drying process to make flour (Jimoh and Olatidoye, 2009). Pounded yam production is a tedious process, which is carried out by pounding cooked slices of yam in a mortar using a pestle to a smooth dough consistency (Oluwamukomi and Adeyemi, 2015). However, instant pounded yam flour, which is a modern invention to simplify the tedious traditional process. There are has been a lot of improvements in the processing of pounded yam to eliminate the tedious process. For example, poundo yam flour has been developed, this is just a fortified flour, which is stirred in a pot within 5-10 min, it is ready to be served (Oluwamukomi and Adeyemi, 2015; Ayodeji *et al*., 2014; Olaoye and Oyewole, 2012; Adeola *et al*., 2012).

MATERIALS AND METHODS

The tubers of white yam (*Dioscorea rotundata*) and water yam (*Discorea alata*) varieties, were collected from different locations, the gas cooker, pestle and mortar used for this work were procured from Ubani market in Umuahia Abia State, Nigeria.

Production of Boiled and Pounded Yam

The brown outer layer tubers and combs were peeled, sliced and washed the white part with lots of clean water, transferred into cooking pots and cooked with water. Cooked for twelve minutes, and then checked with a kitchen fork by piercing to see if the yams were soft enough for the pounding. Once the yams were soft enough for pounding then it was ready for the pounding part. The water was not completely dried because it was needed for pounding the yam in the mortar and pestle.

Sensory Evaluation

The boiled and pounded yam made from white yam and water yam, were compared. Two different groups of (20 members; 10 men and 10 women) consumer type untrained sensory panelists were selected with hedonic scale of 1-5 ascending order of boiled and pounded rheological characters.

RESULTS AND DISCUSSION

Overall quality on consumers assessment D. rotundata MLT at Abakaliki in boiled yam Fig: 1 shows that, meccakusa, Tdr14000156, Tdr1401220, Tdr1401419 and Tdr8902665 are accepted by the farmers while Umudike farmers like meccakusa, Tdr0900135, Tdr110055, Tdr1400537 and Tdr8902665 in boiled yam also in Uyo Tdr0900135 and Tdr0900295 were accepted in overall quality. Pounded yam in Abakaliki meccakusa, Tdr1400158, Tdr1401220, Tdr1401419, and Tdr8902665were liked highest while in Umudikie only Tdr1100128 was accepted and Uyo Tdr1100128 were also liked. It implied that it is all the organoleptic parameters used in the test gave a good account of the pounded yam samples from both the control and test. Baah *et al*. (2009) and Oluwamukomi and Adeyemi (2015) evaluated the quality of pounded yam and composite of poundo yam respectively.

Overall quality on consumers assessment D. alata MLT at Abakaliki in boiled yam Fig: 2 shows that, Tda1400301 and Tda141253 are accepted, while in Igbariam Tda291 only is liked and in Umudike Tda1100250 and Tda1415201 also liked best, in Uyo Tda1100247 were accepted genotype. The results obtained in his study compared with a commercial poundo yam produced by Adeola *et al*., (2012); "poundmix" (Oladeji and Akanji, 2011); pounded yam (Akissoe *et al*., 2009), "foutou" (Nindjin *et al.,* 2007); pounded yam (Otegbayo *et al*., 2007) in terms of the sensory attributes. On PCA: 1&2 for boiled yam Tdr 1100185 is stable while on pounded yam, meccakusa, Tdr1100185 and Tdr1401593 are more stable across all the locations and in PCA: 3&4 on TDa boiled Tda0000194 is stable while on pound Tda291, Gborogboro and Tda1100374 is also stable in all the locations.

CONCLUSION

The famers preference are TDr8902665, TDr1401220, TDr 1100128 and TDr Local both boiled and pounded, TDa 1100224, TDa1401253 and Tda1100247 did not perform very well across locations . But on PCA1: the most stability among the accessions are TDr 1100185 and TDr1100180 in both boiled and pounded are stability. But also on PCA the most stable across the locations is TDa1100374 in boiled and also in pounded.

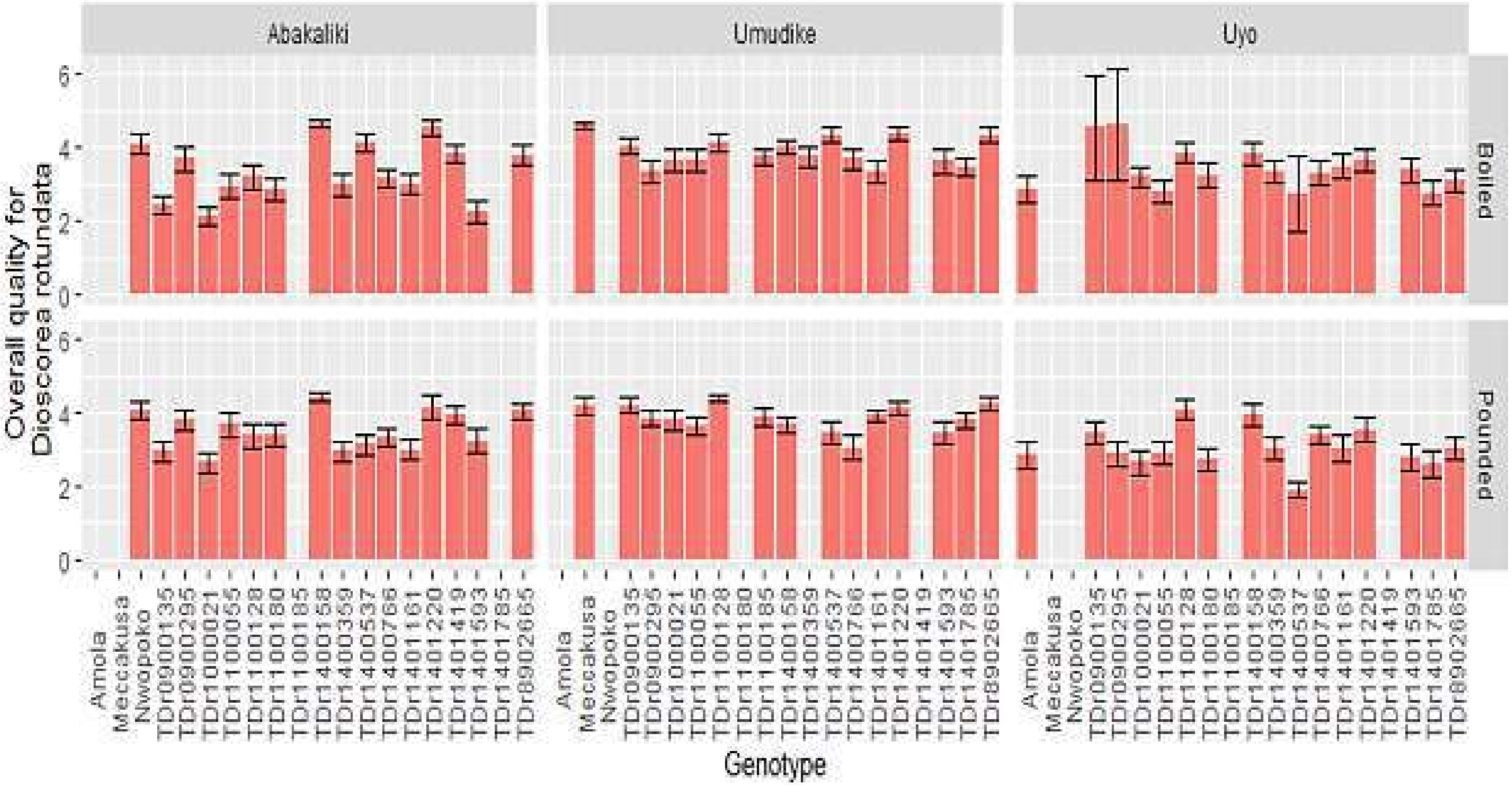


Fig 1: CONSUMERS ASSEMENT ON TDr MLT

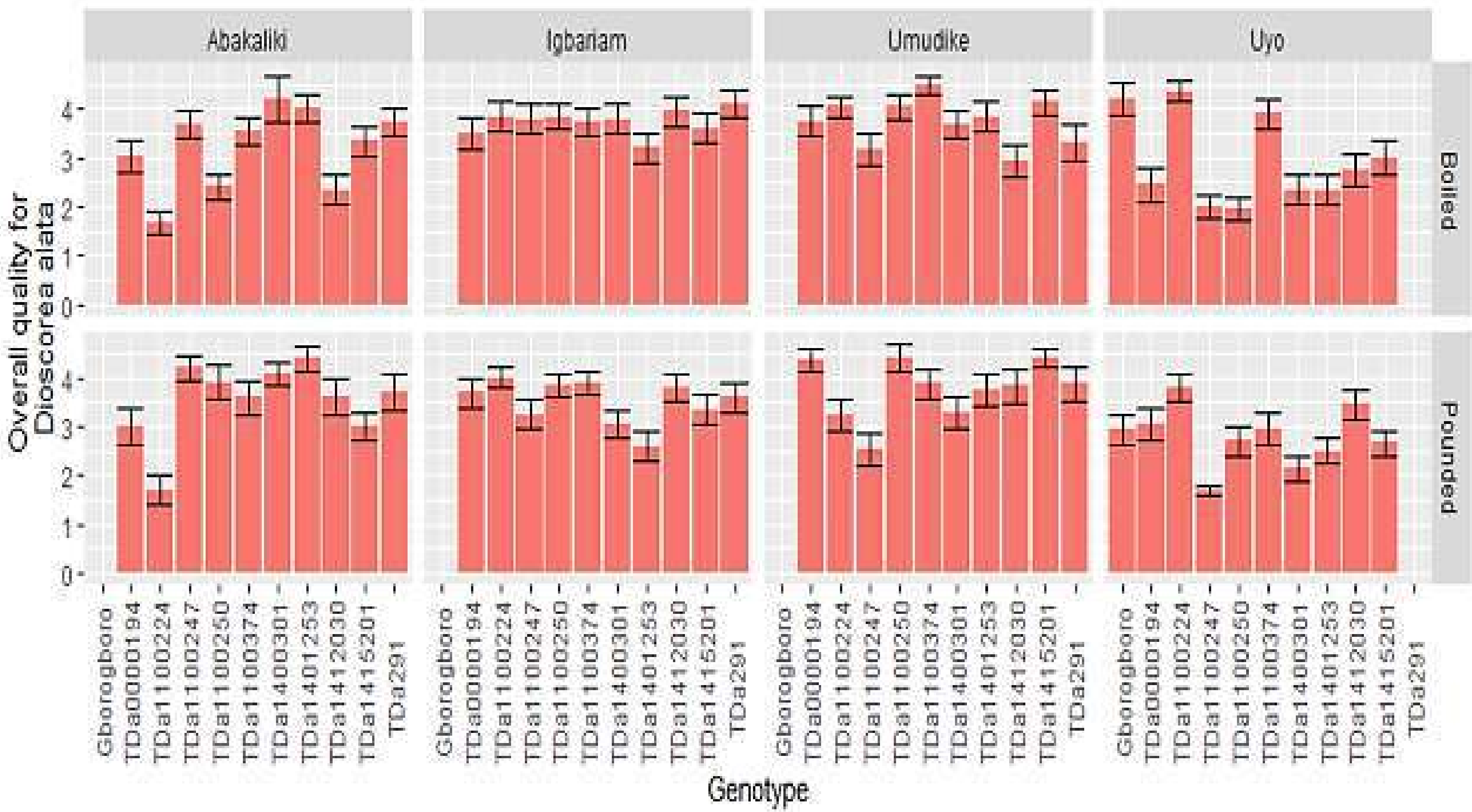
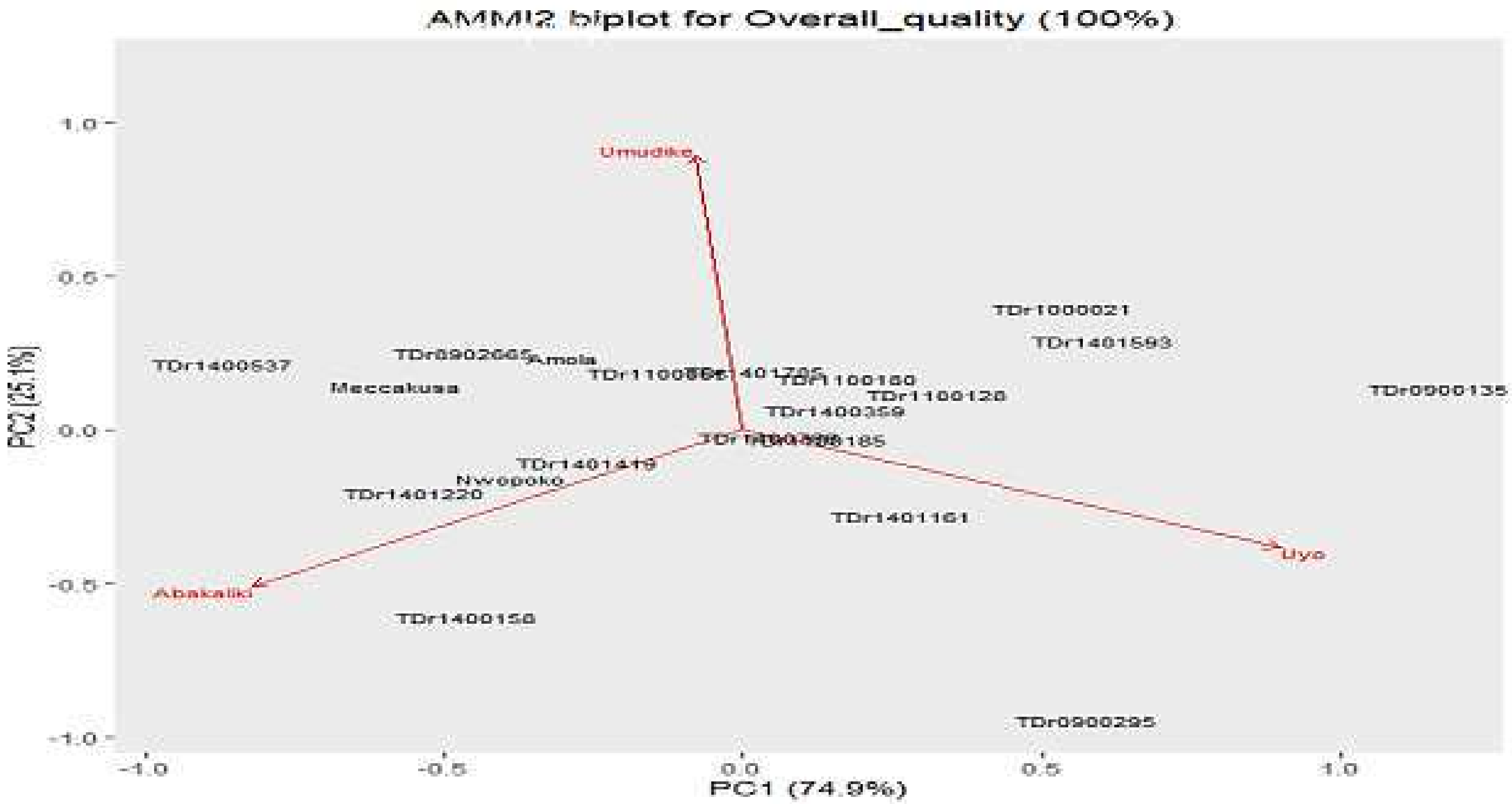
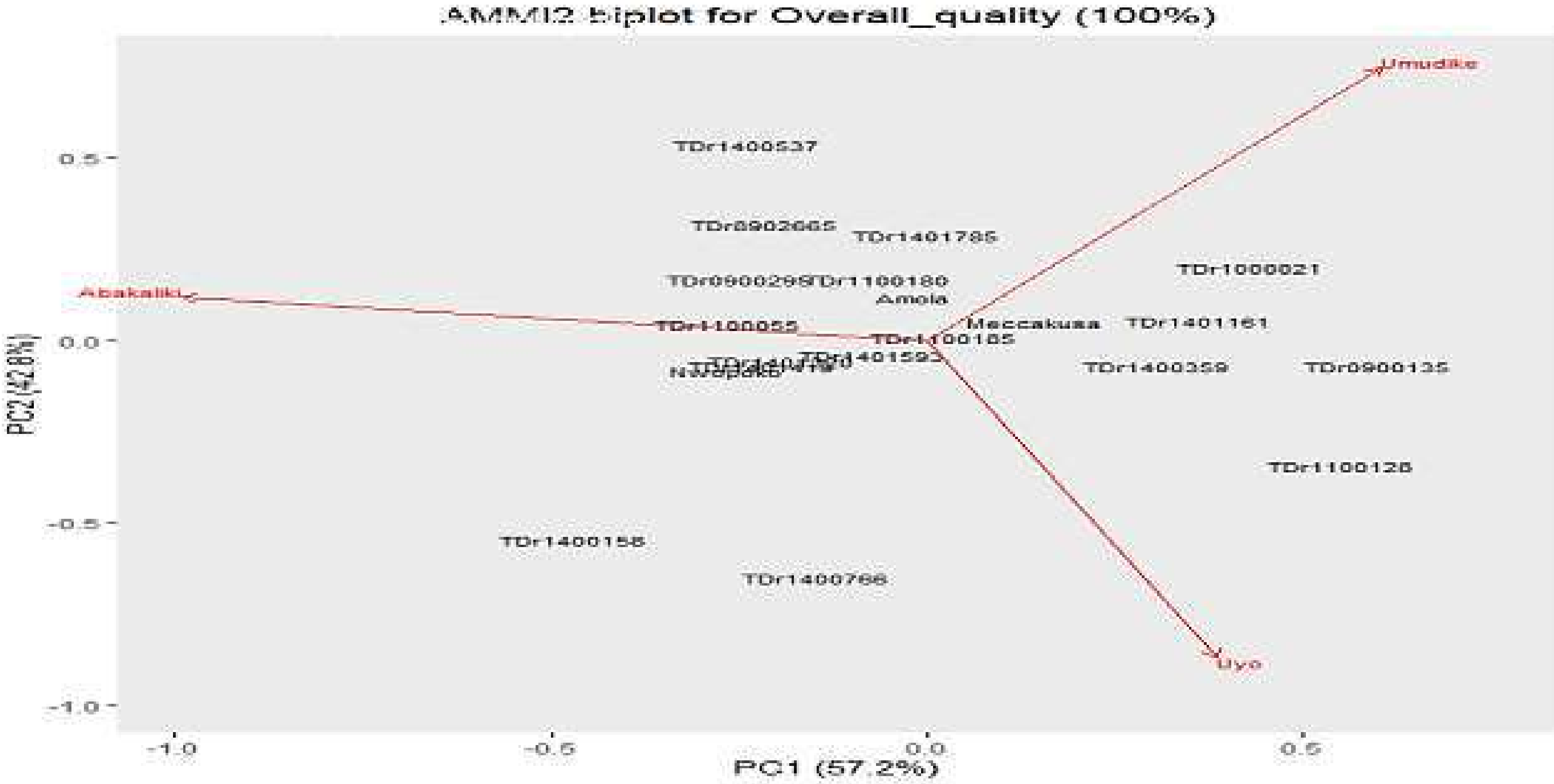


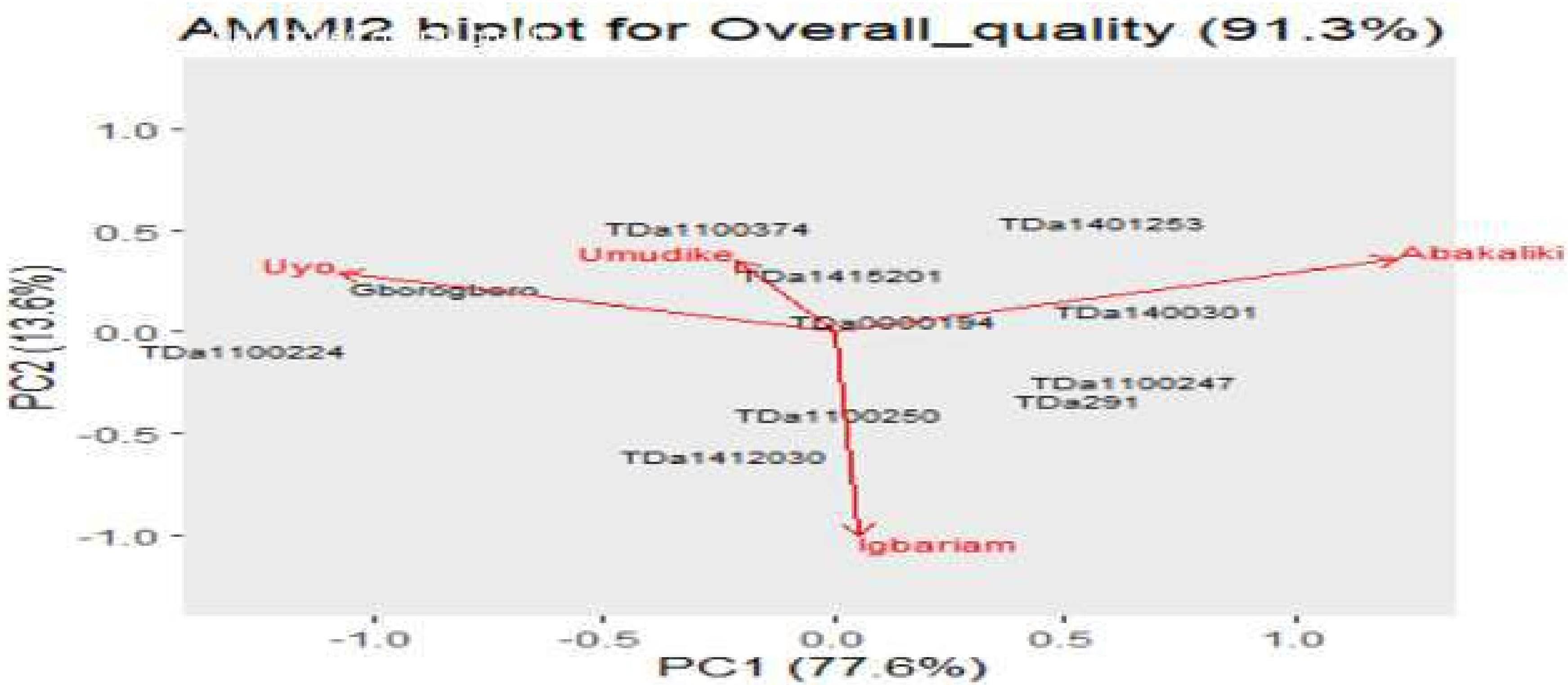
Fig 2: CONSUMERS ASSEMENT ON TDa MLT



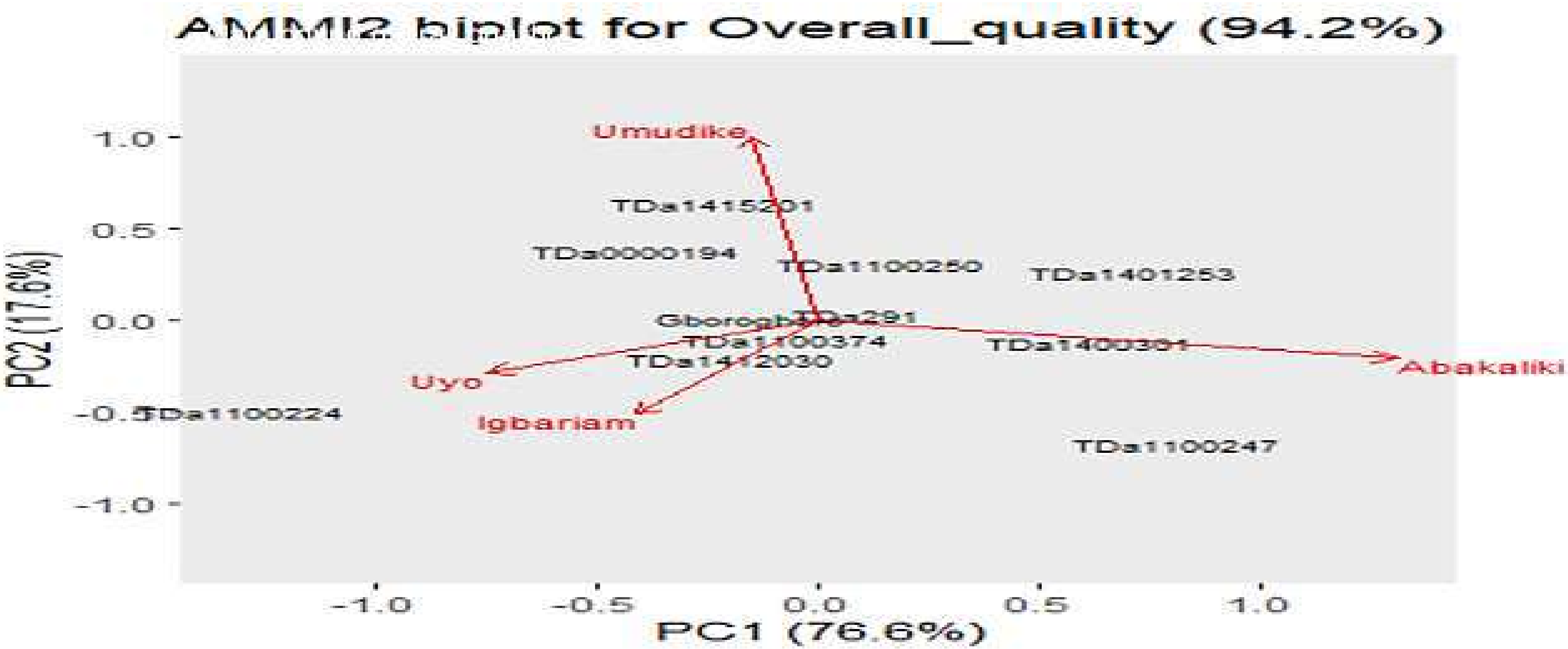
PCA1: CONSUMERS ACCEPTABILITY PCA ON TDr BOILED YAM



PCA 2: CONSUMERS ACCEPTABILITY PCA ON TDr Pounded YAM



PCA 3: CONSUMERS ACCEPTABILITY PCA ON TDa Boiled Yam



PCA 4: CONSUMERS ACCEPTABILITY PCA ON TDa Pounded Yam

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Determinants of Sustainability Practices Among Smallholder Food Crop Farmers in Niger State, Nigeria

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ABSTRACT
The study analyzed determinants of sustainable land management practices among smallholder food crop producers in Niger State, Nigeria. A multistage sampling technique was adopted during this study to select 282 respondents. Primary data were collected and analyzed using descriptive statistics and multivariate probit regression analysis. The predominant sustainability practices carried out were sole cropping (82.6%), mixed cropping (74.11%) and crop rotation (75.4%) (agronomic practices), ridge tillage (97.87%), primary tillage (50.70%), and zero tillage (42.90%) (cultivation practices), construction of ridges across field slopes (22.34%), land grading (3.19%) and contour bunds (2.83%) (structural and mechanical erosion control practices) and fertilizer application (96.80%), mulching (47.87%) and composting (26.24%) (soil management practices). The determinants of sustainability practices among food crop producers were membership of farmer's association ($p \leq 0.05$), source of information ($p \leq 0.001$), years spent in school ($p \leq 0.05$), age ($p \leq 0.01$), farming experience ($p \leq 0.01$), distance from home to nearest market ($p \leq 0.05$), farm size ($p \leq 0.05$), access to wild life ($p \leq 0.05$), rain sufficiency for crop production ($p \leq 0.05$), tenancy security($p \leq 0.05$), access to extension ($p \leq 0.05$), participation in government agricultural programmes ($p \leq 0.05$), days unable to go to work or farm ($p \leq 0.05$), topography of farm land ($p \leq 0.10$), distance from home to all season road ($p \leq 0.10$), staple crops production and off-farm income and staple crops, wages and salaries means of livelihoods ($p \leq 0.10$) each respectively. It was therefore recommended that livelihood strategies, household assets, institutional assets and parcel level factors usage should be scaled up among food crop small scale farmers to enable them carry out sustainability practices against degradation of land.

Keywords: Sustainability, Practices, Food, Niger State

INTRODUCTION
Land deterioration leads to inefficiency in production on a technical level. This is owing to the fact that when land degradation occur, losses are recorded since farms are destroyed when crops are grown. Furthermore, in order to reclaim lost nutrients on degraded lands, more resources maybe used to produce a given output as reported by Agboola (2016) in North Central, Niger State and Federal Capital Territory, Abuja, Nigeria. The menace of degradation include inefficiency in production, Poor income, food shortage, and poverty among problems induced by land degradation. Also, farmers' irresponsible production patterns (Nkoya *et al*., 2011). However, the farmers are hampered by land degradation and lack of appropriate technology to use which have impact on their output (Zhifei *et al*., 2018). The findings of this study will add to existing literature on the field of determinants of sustainability practices among food crop producers.

METHODOLOGY

The study was conducted in Niger State, Nigeria. Niger State lies between Latitudes 8^0 20' N and 11^0 30' N and Longitudes 3^0 30'E and 7^0 20' E (Ojo *et. al.,* 2009). The population of Niger State according to 2006 population census was 3,950,249which could have increased at an annual population growth rate of 3.8% to give a projected value of 6,162,388 at the end of 2018 (NAMDA, 2014).

Sampling Procedure and Sample Size

Multi-stage sampling technique was used to select respondents proportionate Allocation Technique following Ogaji (2019) to select a total of 282 respondents.
The proportionate Allocation Technique is shown in equation 1.

$$S_h = \frac{n \times Nh}{NT} \quad (1)$$

S_h =Number of household heads to be selected, n= Total number of household heads for the survey,
N_h= Farming households in each selected Sub-Cells, N_T= Sum of the farming households in the selected sub-Cells

Method of Data Collection

Questionnaire was used to collect primary data by the researcher and trained enumerators from all selected agricultural zones in Niger State in the months of May to July, 2018.The sampling unit was the farm households in the study area.

Analytical Tools

Descriptive statistics and multivariate probit regression analysis were used. Multivariate Probit regression model was used to examine the influence of household assets, parcel-level factors, institutional variables and livelihood strategies on land management practices, following (Green, 2000; Mugisha and Alobo, 2012).
The model is represented as shown in equation 2:

$$Yi^* = \beta \boldsymbol{X}i \ + \ Ei \quad (2)$$

Where;
Yi^* = Latent variables that index the land management options on a given plot i.e. LMP (i.e. Structural and Mechanical Erosion Control Practice (SMECP), Agronomic Practice(AP), Soil Management Practice(SMP) and Cultivation Practice(CP)),
Xi = Vectors of independent variables, β = vector of parameter to be estimated and
Ei= stochastic term error. The explicit form of the model is as follows:

$$Yi = f(S_i,S_1,S_2,S_3,S_4,H_i,H_1,H_2,H_3,H_4,H_5,F_i,F_1,F_2,F_3,F_4F_5,P_i,P_1,P_2P_3,N_i,N_1,N_2,N_3,N_4,R_i, R_1,R_2,R_3,I_i,I_1\,I_2,LS_i,LS_1,LS_2,LS_3LS_4) \quad (3)$$

Where;
Yi = Latent variables that index the land management options on a given plot i.e. LMP (i.e. SMECP, AP, SMP and CP); S_i, H_i, F_i, P_i, N_i, R_i,I_i, and LS_i are the determinants of adoption of land management practices (Independent variables, Xs)
S_i=Social capital variables
S_1 = Farmers' participation in government agricultural program (number)
S_2=Access to adult education program, (1 for access, 0 otherwise)
S_3= Association membership of farmers (1 for membership, 0 otherwise), S_4=Access to information (number)
H_i= Human capital variables
H_1= Education of the household head (years), H_2= Age of farmer (years),

H_3= Health status (1 for good health status, 0 otherwise), H_4= Farming experience (years), and
H_5 =Family labour.
F_i = Financial capital variables
F_1= Amount of credit (₦), F_2= Savings (₦), F_3 = Amount of pension (₦), F_4 = Income(₦), andF_5 = Access to insurance (1 for access, 0 otherwise).
P_i=Physical capital variables
P_1= Value of Physical assets (₦) P_2=Access to good road (yes=1, No=0), andP_3 =Distance from home to market (km).
N_i= Natural capital variable
N_1= Size of farmland (ha), N_2 = access to wildlife (1 for access, 0 otherwise), N_3 = Rain fall sufficiency for crop production (1 for sufficient, 0 otherwise), N_4 = Adequacy of soil fertility (1 for adequacy, 0 otherwise).
R_i = Parcel- level factors
R_1= Percentage of cultivated farm land over borrowed land (ha), R_2=Topography of farmland (sloppy farm land=1, 0 otherwise), R_3= Tenancy security of farmland (owned land=1, 0 otherwise).
I_i =Institutional factor
I_1= Extension contact (number), andI_2= Access to new crop varieties from research institutes (1 for yes, 0 for no).
L_i=Livelihood Strategies
LS_1=Staple crop/off-farm income, (1 for participation), LS_2=Staple crop/wages and salary, (2 for participation), LS_3 = Staple, fruit and vegetable crops and livestock production and off-farm income, (3 for participation), and LS_4 = staple crop, fruit, vegetables and tree crops, livestock production and off-farm income. (4 for participation). The staple crops in consideration are cereals, legumes and tuber crops.

RESULTS AND DISCUSSION

Sustainable land management practices of food crop producers

The sustainability practices carried out in Table 1. They were sole cropping (82.61%), mixed cropping (75.1%) and crop rotation (74.11%) in agronomic practice. Ridge tillage (97.87%), primary tillage (50.70%), and zero tillage (42.90) in cultivation practice. In structural and mechanical erosion control practices, construction of ridges across field slopes (22.34%), land grading (3.19%) and contour bunds (2.83%) were carried out. While, fertilizer application (96.80%), mulching (47.87%) and organic/ farm yard manure (26.24%) were most carried out in soil management practices respectively.

Table 1: Distribution of farmers according to sustainable land management practices

Agronomic practice (AP)	Frequency/Perc./score
Crop rotation	209 (74.11) 3rd
Multiple cropping	109 (38.65)
Strip cropping	4 (1.41)
Cover cropping	70 (24.82)
Legumes planting	97 (34.39)
Mixed cropping	212 (75.1) 2nd
Sole cropping	233 (82.6)1st
Agro-forestry	6 (2.12)
Bush fallowing	5 (1.77)
Shifting cultivation	23 (8.15)
Cultivation Practice (CP)	
Conventional tillage	12 (4.25)
Minimum tillage	12 (4.25)
Zero tillage	121 (42.90) 3rd
Mold tillage	42 (14.89)
Ridge tillage	276 (97.87) 1st
Primary tillage	143 (50.70) 2nd
Structural and mechanical erosion control practice	
Land grading	9 (3.19) 2nd
Contour bunds	8 (2.83) 3rd
Construction of ridges across field slope	63 (22.34) 1st
Soil Management Practices	
Fertilizer application	273 (96.80) 1st
Composting	74 (26.24) 3rd
Organic manure/farm yard	62 (21.98)
Green manure	43 (15.24)
Mulching	135 (47.87) 2nd

Source: Field survey, 2018. (Figures in parentheses are percentages) * Multiple responses were recorded.

Determinants of Land Management Practices

Result for Multivariate Probit regression model for determinants of Land Management Practice (LMP) is shown in Table1. These are practices carried out to keep in place the value of land as present and future need of human. Choice of sustainability practices by farmers depends on a number of factors which are discussed below.

Coefficients for membership of farmer's association and source of information were significant and positive at 5% and 1%. This implies that when farmers belong to more association, it increases the likelihood of such farmers to remain in carrying out Agronomic Practice (A.P). This is because farmers' association is a significant medium where they source for important information concerning different production methods where they may have difficulties including agronomic practice. In addition, the more the source of information to farmers, the more their level of education concerning livelihood. Since farmers access information from associations, it increases their level of education as well as better understanding of new farm technologies. The result is in agreement with the finding of Simon *et al.* (2015) who reported that farmer's medium where awareness on new technologies are accessed includes membership of associations and sources of information close to them at a particular time.

Coefficients of years spent in school and age of the farmers on the other hand were significant. This implies that as farmer's years spent in school increases, the less the likelihood to carryout agronomic practice. This could be due to reality that increase in one's level of education leads to better preferences. In addition, such food crop producer may decide to practice mixed cropping or multiple cropping and discard sole/mono cropping based on his choice through increase in level of education. Age of a farmer is most likely to increase the level of participation in agronomic practice. This is because as farmer becomes older the more his/her experience which leads to choice made in production. Therefore, age is an important quality through which individual takes valuable decision in production, choice of agronomic practice could be taken based on increase in age. Signifying that as farming experience increases, will lead to decrease in the likelihood of farmer to undertake agronomic practice. There are agronomic measures which may not be carried out by certain individuals based on one reason or another which could have been influenced by level of farming experience they may have gotten over time. Farming experience contribute to decision making in choice of production activities.

Distance from home to the nearest market and farm size were significant at 5% each. It implies that the more the distance from home of farmer to nearest market, the less the likelihood of the farmer to carry out agronomic practices to grow many crops which may be perishable. This is because perishable crops cannot be kept for a long period to withstand the time required to cover long distance from farmer's home to the market. Increase in farm size on the other hand will increase the likelihood of the farmer to remain in carrying out agronomic practice. This is due to the fact that as farmer's size of farm increases, it will lead to carrying out diverse cropping pattern to meet his/her purpose for production. Coefficient for access to wildlife, rainfall sufficiency for crop production and adequacy of soil fertility were significant at 5%, 5%and 5% respectively. The significance for access to wildlife is that increase in access to wildlife will increase the likelihood of the farmer to remain in carrying out agronomic practice. This is because access to wildlife serve as means of additional income to the farmer which could be invested in agronomic practice to carryout food crops production. Conversely, as farmers' access to wildlife increases, the likelihood to carryout agronomic practice could reduce because more access to wildlife could occupy the attention of the farmer as additional means of livelihood.

The finding on distance from farmer's home to nearest market and farming experience differs from the report of Misganaw *et al* (2019), while farm size and access to wild life were reported as determinant factors among farmers to carryout agronomic practice(AP). Increase in rain sufficiency for crop production could decrease the likelihood of the farmers to remain in carrying out agronomic practice because adequate rainfall could result to erosion which hinder farmers from growing certain crops. Adequacy of soil fertility on the other hand could increase the likelihood of the farmer to invest in more agronomic practice because when soil is fertile, farmers are encouraged to grow crops, this is attributable to the reality that such fertile soils does not require fertilizer application during crop production. Coefficients of tenancy security of farm land, extension contact and access to new crops varieties from research institutes were significant at 5%, 10% and 10% accordingly. Tenancy security of farm land and access to new crop varieties differs while extension contact was significant. This further implies that as tenancy security of farmer's land increases, the tendency to carry out agronomic practice decreases. A farmer who is tenancy secured may lease out land to other farmers who may use it for practices that are not necessarily for growing of crops which is agronomic. As extension contact increases the likelihood of food crop producer to remain in carrying out agronomic practice could also increase. This is attributable to the fact that extension agents educate, encourage and guide farmers to carry out new farm technologies. In addition, extension agents are sources of new information to farmers on how to increase farm output. As access to new crop varieties from research institutes increases, the less the likelihood of farmer to carry out more agronomic practice. Coefficients for determinant of cultivation/tillage practices that were significant are farmer's participation in government agricultural programmes, source of information and days unable to go work or farm significant at 5, 1%, 1% accordingly. Increase in level of farmers' participation in government agricultural programmes could increase the likelihood of such farmers to participate in cultivation practice. Participation in government agricultural programmes educate farmers on farming activities which improves their level of production and output.

Furthermore, increase in access to government agricultural programmes expose farmers to acquisition of certain agricultural skills such as processing and off-taking where more income could be generated and invested in cultivation to further grow crops. Increase in source of information by the farmer will likely increase the level of farmer to carry out cultivation practice. When farmers have access to more sources of information, their awareness increasesas they tend to be more informed about new innovations and techniques involved. The findings on extension contact, participation in government agricultural programme and sources of information agrees with the result of Maureen *et al.* (2010) who reported in Ethiopia that on-farm livelihood activities are not successful without good extension contact, farmer's participation in government agricultural programmes and good sources of information.

The coefficient for distance from home to the nearest market. Adequacy of soil fertility and topography of farm land were significant at 1%, 5%and 10% accordingly. The more the distance from home to nearest market, the less the likelihood of the farmer to carryout cultivation practice. This is based on the reasons that a farmer would be more willing to cultivate and grow crops if access to market where he can sell perishable crops is easily accessible. Also, the more the distance to market from home of the farmer, the more difficult the farmer would be to access production inputs to grow crops. Increase in adequacy of soil fertility could lead to decrease in cultivation practice. This may occur when high level of soil fertility caused by increase in soil fertility takes place, it could result into acidic soil which may not allow healthy growth of crops.

When topography of farm land increases, it could result in more cultivation practice. Nature of land result into type of cultivation to carry out as well as crops grown. Results on availability of soil fertility differs from the report of Maureen *et al.* (2010) that availability of soil fertility drives the farmers to cultivate and grow crops. Mugashi and Alabo (2012) reported that cultivation practice to produce certain crops is dependent on distance from farmer's home to nearest market, as well as the nature of agricultural land (topography) where cultivation is carried out.

Coefficient for access to new crop varieties was significant at 5%. The implication is that as farmer continue to have more access to new crop varieties with high yield ability and shorter period of maturity as well as drought and disease/pest resistant, the more the farmer's interest would be to carry out cultivation. Report of Gana (2018) agrees with this finding that among measures to sustain high yields by farmers is additional cultivation to grow crops that are disease resistant with high yield ability. Soil management practice (SMP) is a practice that is carried out to sustain soil nutrients to meet its expected production ability in present and in future. Participation in government's agricultural programmes was significant at 5%. Other variables which were significant are age, days unable to go to work or farm, and years of farming experience significant at 1, 5, and 1% accordingly. The result implies that as farmers continue to participate in government agricultural programmes, their tendency to practice soil management (SMP) increases. Government agricultural programmes is an avenue where farmers acquire different knowledge, access inputs such as fertilizer, new crop varieties which could fix nitrogen to the soil, pest and disease control in farming to improve productivity. Increase in age implies that the farmer may be older and less likelihood to carryout soil management practice. This may be due to experience acquired through age of the farmer to certain agronomic practice because the older a farmer, the less the willingness to accept new innovation. As a farmer is unable to go to work or farm, the more is likelihood to carryout soil management practice because the remaining days to go to farm would be properly utilized for production. Increase in years of farming experience could result to likelihood to carryout soil management practice as methods of carrying out the practice and the possible result may be familiar to the farmer. The result on farmer's participation in government agricultural programme and years of farming experience were in agreement with report of Raufu and

Adetunji (2012) who reported in South-West, Nigeria that awareness and years of farming experience are variables of willingness among farmers to pay for sustainability practices.

Access to all season road was significant at 10%. Distance from home to the nearest market was also significant at 10%. while sufficiency of rain for crop production was significant at 5%. The implication is that the more the distance covered from farmer's home to all season road, the more the likelihood that farmer will remain in carrying out soil management practice. Also, the more the distance a farmer cover from home to nearest market, the less the likelihood of such farmer to remain in carrying out soil management practice. More distance to market hinders food crop producers form buying farm inputs and selling produce. Increase in access to wildlife on the other hand, could lead to decrease in likelihood to carry out soil management practice because the more the access the farmers have to wildlife, the more his attention could be diverted to different livelihood. Coefficients of rainfall sufficiency for crop production, adequacy of soil fertility, topography of farmland, tenancy security, access to extension services and access to new crop varieties were significant at 10, 10, 5, 1, 1 and 5% respectively. The implication is that, increase in sufficiency of rainfall for crop production will increase likelihood of farmers to remain in participation of soil management practice to enable farmers realize more output. This is because when rain is sufficient, farmers are attracted to grow crops. Increase in amount of soil fertility will decrease soil management practice attributed to soil nutrient availability which is the purpose why farmers manage soil for food crop production. if a particular soil contains sufficient nutrient there would be less need to carryout soil management on such soil. As topography of farmland increases, the likelihood of farmers to carryout soil management practice could reduce. This could be attributable to possibility that erosion could easily wash away the management measure. Increase in tenancy security of farm land on the other hand could result in increase in carrying out soil management practice as a result of tenancy security. A farmer who is tenancy secured could utilize land for non-farm livelihood strategy which may not require soil management measure.

As access to extension services increase, the likelihood that farmers will practice soil management may reduce possibly through advisory information acquired from extension contact to carry out specific management measures suitable to condition of production of farmer. Due to cost of management measures, extension officer could advice farmer to plant legumes which will minimize cost and possibly reduce number of measures to be used in managing soil by famer. As farmers have more access to new crop varieties from research institutes, the more likely farmers will carry out soil management practice. New crop varieties could increase the adoption of soil management practice to grow the new crop variety. This could take place if the farmer is convinced to plant such new crops. The results on topography and tenancy security of farmer and extension contact agrees with the findings of Tosakana *et.al.* (2010) who found out that topography and tenancy security of farmer's land are associated with their interest to invest in soil management practice. Results on structural and mechanical erosion control practices show that the coefficients for access to government agricultural programmes, years spent in school, distance from home to the nearest market, rainfall sufficiency for crop production, adequacy of soil fertility, tenancy security of farmland, access to new crop varieties, livelihood strategy one and livelihood strategy two were significant. Participation in government agricultural programmes was significant at 1%, years spent in school was significant at %distance from home to nearest market significant at 5%. Rainfall sufficiency was significant at 1%. Adequacy of soil fertility was significant at 10%.

Tenancy security of farm land was significant at 5. Access to new crop varieties was significant at 5% while livelihood strategy one (Ls_1), and (Ls_2) were significant at 10% each Increase in participation of farmers in government agricultural programmes will lead to a fall in likelihood of the farmers to carry out structural and mechanical erosion control practice because farmer's additional knowledge acquired from participation in government agricultural programmes may make them to choose particular SMECP to carryout. For instance, a farmer maybe advised to use cover cropping which controls erosion and fixes nitrogen as a measure. There may be less need for contour bunds or construction of ridges across field slopes which reduces the number of SMECP carried out. Years spent in school shows the level of education of every individual. If a farmer spent more years in school, such farmer is expected to be more aware and educated. Education expose farmers to more farm/off farm activities which could cause an educated and experienced farmer to carry out more SMECP than the less educated. In addition, increase in level of education among farmers play positive roles in number of activities carried out. Increase in distance from farmer's home to the nearest market, could result in less likelihood to carryout structural and mechanical erosion control practice. This is attributable to the reality that increase in distance from farmer's homes to market could hinder the willingness to produce certain crops where SMECP is required and such crops may cannot be easily sold or kept.

The results on farmer's participation in government agricultural programme, years spent in school, distance from farmer's home to nearest market which partly hinders the farmer from producing particular crops and investing in SMECP are in line with the report of Conrad *et al*. (2012) who reported that nearness to market, educational level and farming experience were determining factors among farmers during choice of sustainability practice in Zimbabwe.

Table 2: Determinants of sustainable land management practices Niger State

Variables	AP:Coeff. /(Z-value)	CP;Coeff./ (Z-value)	SMP:Coeff./(Z-value)	SMECP:Coeff./(Z-value)
Participation in gov't Agric program	-0.0756 (-0.90)	0.2362(2.49)**	0.1298(2.32)**	0.3278(-3.46)***
Access to adult education program	0.4956(1.64)	0.1646(0.51)	0.3045(1.18)	-0.2367(-0.80)
Membership of farmer's association	0.6457(2.37)**	0.0107(0.04)	0.4199(1.56)	0.3157(1.08)
Source of information	0.8092(5.87)***	0.5525(5.45)***	0.1114(1.34)	0.1367(1.32)
Years spent in school	-0.6269(-2.48)**	-0.0363(-1.36)	-0.0084(-0.37)	0.890235(3.57)***
Age	0.5511(2.87)***	0.0061(0.28)	-0.0761(-4.67)***	-0.0060(-0.31)
Days unable to go to work of farm	-0.0057(-1.06)	0.0457(2.78)***	0.0124(2.03)**	-0.0010(-0.11)
Years of farming experience	-0.0575(-2.74)***	-0.0190(-0.95)	0.0520(3.23)***	-0.0088(-0.45)
Family labour	-0.0031(-0.90)	0.0062(1.64)	0.0010(0.34)	0.0030(0.88)
Amount of credit	1.38e-07(0.07)	5.23e-07(0.25)	2.71e-06(1.64)	5.72e-06(-2.00)
Savings	8.15e-06(0.85)	5.30e-07(-0.49)	-8.28e-07(-0.98)	1.01e-06(1.07)
Pension	0.0001(0.02)	5.50e-06(-0.30)	-0.0001(-0.04)	4.28e-06(0.56)
Income	4.33e-07(-0.93)	2.26e-07(-0.65)	-1.22e-07(-0.46)	3.24e-06(1.05)
Access to insurance	-5.2952(-0.02)	3.3045(0.00)	3.402394(0.03)	-4.0682(-0.01)
Physical assets	-4.16e-07(-0.15)	-3.79e-07(-0.21)	2.93e-07(-0.23)	1.50e-06(0.10)
Distance from home to all season road	0.0179(0.37)	-0.0403(-0.77)	0.0714(1.87)*	-0.0043(-0.07)
Distance from home to nearest market	-0.0624(-2.15)**	-0.2249(-4.58)***	-0.0606(-1.98)*	0.6256(2.13)**
Farm size	0.1279(1.97)**	0.0293(0.54)	-0.0050(-0.14)	-0.0075(-0.15)
Access to wildlife	0.5597(1.96)**	0.1781(0.56)	-0.6880(-2.43)**	-0.5491(-1.82)
Sufficiency of rainfall	-0.857(-2.14)**	-0.1076(-0.28)	0.5871(1.85)*	-1.3088(-3.63)***
Adequacy of soil fertility	0.6689(2.24)**	-0.7791(-2.50)**	-0.4600(-1.79)*	0.5507(1.88)*
Percentage of owned land over borrowed land	-0.0590(-0.30)	-0.2284(-0.97)	0.1352(0.79)	0.2060(1.00)
Topography of farmland	0.2061(0.69)	0.5974(1.88)*	-0.5403(-2.03)**	0.2592(0.89)
Tenancy security of farm land	-0.6448(-2.19)**	0.2695(0.88)	0.8364(3.29)***	-0.6826(-2.28)**
Access to extension	0.5294 (1.75)**	-0.3930(-1.35)	-0.1190(-4.52)***	0.0030(0.11)
Access to new crop varieties from research institution	-0.6246(-1.81)**	0.8888(2.07)**	0.7318(2.31)**	0.9582(3.13)***
Livelihood strategy 1	0.2152(0.37)	0.3194(0.44)	0.4446(0.93)	1.0039(1.68)*
Livelihood strategy 2	0.2006(0.27)	0.4026(0.45)	-0.1891(-0.31)	1.1777(1.67)*
Livelihood strategy 3	0.0642(0.11)	0.4538(0.62)	-0.3257(0.68)	0.5670(0.91)
Livelihood strategy 4	-0.1925(-0.29)	-0.4079(-0.51)	0.3717(0.67)	1.1367(1.61)
Constant	-1.7095(-1.76)	-0.6192(-0.57)	0.1542(0.19)	-1841(-1.99)

Source: Field survey, 2018. ***= 1% level of significance. ** = 5%level of significance, * =10%. AP=Agronomic practice, CP=Cultivation practice, SMP=Soil management practice, SMECP=Soil and mechanical erosion control practice.

Implication of negative coefficient of rainfall sufficiency for crop production is that, increase in rainfall will reduce likelihood of farmers to carryout structural and mechanical erosion control practice. The implication of this maybe that adequacy of rains for crop production could cause more erosion which could wash away erosion control measures. Increase in adequacy of soil fertility for crop production, this will increase level of farmer's participation in carrying out SMECP. Increase in adequacy of soil fertility could result in more of practices, this is contributed by availability of soil fertility for crop production. Availability of new crop varieties will increase the tendency of food crop farmer to practice SMECP because of the farmers' interest to plant new variety that could have high yielding capacity and shorter period of maturity. Increase in livelihood strategies one and two on the other hand, will lead to likelihood that farmers will carry out less SMECP because of the farmer's commitment to off-farm income generating activities as well as wages and salaries as other means of livelihoods.

Covariance for determinants of land management practice

Table 3 shows the covariance for determinants sustainability practices. They are Positively signed when they are complementarities and negative when they are substitutes. The complementarity means as a particular land management practice is carried out, it complements features of another. While, it is said to be substitute when carrying out a particular land management practice could substitute for features of another. Result of estimation in Table 3 that coefficients of CP/AP, SMP/AP, and SMP/CP, were significant at 5%, 10%, 1% accordingly and are complementarities. While SMECP/AP significant at 1% are substitutes. This shows that each set of LMP that are positively signed signifies increase in use of a particular land management practice leads to presence of features of another. As cultivation or tillage practice is carried out, it increases the likelihood of farmer to remain in carrying out agronomic practice. This is because when cultivation/tillage is done planting must be carried out as they are complements to each other. Cultivation practice also allow incorporation of organic matter which decomposes and serve as nutrient for plant growth while agronomic practice such as legumes carries ability to add nutrients to soil which makes them complements. Increase in soil management practice will increase the likelihood of farmer to carry out agronomic practice. As soil is managed to maintain nutrients, planting must have taken place or will take place. In addition, agronomic practice such as leguminous planting has ability to manage soil through nitrogen fixation like practice of composting or fertilizer application in soil management which both add nutrients to soil for crop growth. Positive coefficient of SMP/CP implies that increase in soil management practice will increase the likelihood of the farmers to carry out cultivation practice because as soil is managed for nutrient to be maintained, cultivation must take place. In addition, SMP complement TP or CP because when tillage is carried out decomposition of organic matter takes place which serves as a way of soil management. Negative coefficient of structural and mechanical erosion control practice and agronomic practice implies SMECP/AP are substitutes.

Table 3: Covariance for determinants of land management practices

Variables of interaction	Coeff.	Strd.Err	Z-value
Cultivation Practice (CP) and Agronomic Practice (AP)	0.390	0.191	2.04**
Soil Management Practice (SMP) and Agronomic Practice (AP)	0.251	0.143	1.75*
Structural and Mechanical Erosion Practice (SMECP) and Agronomic Practice (AP)	-0.785	0.190	-4.13***
Soil Management Practice (SMP) and Cultivation Practice (CP)	0.475	0.129	3.68***

***: 1% level of significance, **: 5% level of significance, *: 10% level of significance AP=Agronomic practice, CP=Cultivation practice, SMP=Soil management practice, SMECP=Soil and mechanical erosion control practice.

CONCLUSION

Household assets, livelihood strategies, institutional assets and parcel level factors determines choice of sustainable land management practices as a result, it is recommended that farmers should scale up the use of those assets to enable them undertake sustainability practices to control land degradation.

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Influence of Agricultural Cooperatives in Agribusiness Financing in Rivers State

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ABSTRACT
The study examined the influence of cooperatives in agribusiness financing in Okrika Local Government Area of Rivers State, Nigeria. It is believed that cooperative societies are genuine tool for financing agribusiness. The study specifically describes the socio economic characteristics of cooperative farmers, determine the various types of cooperatives in the study area, determine the sources of financing cooperative society, determine the contribution of cooperative society in financing agribusiness, ascertain the challenges facing co-operatives in financing agribusiness. Primary data were sourced through questionnaires. A sample size of 50 respondents was selected through multi-stage sampling techniques. There is a significant change in activeness of cooperative members to agribusiness activities before and after their membership of cooperative society. Several constraints were identified to be affecting the cooperative societies in effectively financing their members prominent among them is lack of finance and bad character of cooperative members. Recommendations were made on how cooperatives can effectively contribute to the development of their members. These includes: collaboration with government agencies, business consultants, food technologists to organize regular seminars for members, cooperatives societies should develop means of sourcing for finds from government agencies and cooperate financial institutions.
Keywords: Influence, Agricultural, Co-operatives, Agribusiness, Financing

INTRODUCTION
In an effort to overcome financial issues, donor agencies and government have re-emphasized co-operative as a strategy to promote collective action to strengthen small holder's livelihood by linking them to national and international markets. Cooperatives are defined as autonomous association of persons who unite voluntarily to meet their common economic and social needs through a jointly owned and democratically controlled enterprise (International Cooperative Alliance (ICA) (2001). Cooperatives are established by like-minded persons to pursue mutually beneficial economic interest and it is a unique tool for achieving economic goals in an increasingly competitive global economy. These goals include achieving economic of size, improving bargaining power when dealing with other business, purchasing in bulk to achieve lower prices and obtaining product and service that are not available.

Develtere (1995), described cooperatives as a medium through which services like provision of farm input, farm implements, farm mechanization, agricultural loans, agricultural extension, member's education, marketing of member's farm produce and other economic activities and services are rendered to members. Cooperatives can be multi-purpose or single purpose. Successive government in Nigeria recognized that Agricultural cooperative societies are essential for the development of the agricultural sector. Cooperative group are organized for better co-ordination of farmers' activities.

The cooperatives approach to group action has been effectively utilized by Agricultural Development Programme (ADP) and River basin and Development Authorities (RBRDA). Although, the primary objective of forming Agricultural cooperatives in ADP, and RBRDAs is to increase agricultural output, it has been possible to get them involved in marketing of their produce as well.

Agriculture accounts for about 20 percent of GDP in the African sub-region (World Bank, 2005); two third of the people derive from livelihoods and 40 percent of exports come from the agricultural sector (World Bank, 2000). Most of the cultivable lands are under cultivation because small holder and farmers who use rudimentary production techniques cultivate most of this land with resultant low yield. The small holder farmers are constrained by many problems including those of poor access to modern inputs and credit, poor infrastructure, inadequate access to markets, land and environmental degradation and inadequate research and extension service (Oluwatayo, *et al* 2012).

Most small holder farmers regardless of gender require services and information obtainable through membership of agricultural cooperative. Such information includes appropriate technology and sound technical advice not only to increase their agricultural productivity and incomes but also making farming and rural life richer and more sustainable. It is against this backdrop that the study was designed to examine the influence of Agricultural cooperative in agribusiness financing in Okrika Local Government Area. Specific objectives of study were to:

i. describe the socio economic characteristics of cooperative farmers.
ii. examine various types of cooperatives in the study area
iii. determine the sources of financing cooperative society.
iv. Evaluate the contribution of cooperative society in financing agribusiness.
v. Identifying the constraints in agricultural cooperative financing.

MATERIALS AND METHODS

The study on influence of agricultural co-operatives in agribusiness financing was conducted in Okrika Local Government Area, in Rivers State. Okrika is situated on a small Island in Southern part of Port Harcourt. The average elevation of Okrika is 452 meters. It lies on the north of the Bonny River and on Okrika Island, 35 miles (56km) upstream from the Bight of Bonny. The population is about 133, 271(NPC 2006). Okrika Local Government Area is made up of 13 towns and 43 villages. It lies between latitude 4°44'31.74''N and longitude 7° 05'1.25''E. their major occupations are fishing and farming.

Purposive and random sampling techniques were employed. Firstly, five (5) towns were purposively chosen from the Local Government Area. They were Abam-Amall, Abioboama, Andikiri, Ibaka, Isaka, for their active involvement in agricultural business. Random sampling technique was adopted in choosing 10 cooperative societies making a total of 50 respondents. Data were collected via well-structured questionnaire. The data collected were analyzed using descriptive statistics.

Object (i), (ii), and (iii) were analyzed using descriptive statistics such as frequencies and percentages. While, objective (iv) and (v) were analyzed using Likert scale.

Likert Scale Rating Technique

The use of 5-point scale rating technique was employed in analyzing objectives (iii). The rating was in this order: strongly agreed (SA) = 5, agreed (A) = 4, Neutral (N) = 3, disagree (D) = 2, and strongly disagree (SD) = 1.
The mean scores of the respondents based on the 4-point scale were 5 + 4 + 3 + 2 + 1 = 15, 15/4 = 3.00. On this basis, mean score greater than or equal to 3.00 was considered relevant, while, mean score less than 3.00 was considered irrelevant and hence ignored.

RESULTS AND DISCUSSION

Socioeconomic characteristics of co-operative members

The information on the socio – economic characteristics of co-operative members is displayed in table 1.

Sex

Table 1, shows that 28(56.0%) were male, 22(44.0%) were female. This implies that most cooperative members are males. This contradicts the findings of Aiyeloja and Ogunjinmi (2013) that females engage mostly in marketing, while male do most of the production activities. This is shown in figure 4.1.

Age

Table 1, shows 13(26.0%) of respondents were between 18-30 years old, followed by 18(36.0%) of respondents who are between 31-40 years old. The dominant age bracket is 19(38.0%) of respondents who are between 41-50 years old. This shows that most people in cooperative societies are above 40 years. This indicates that young adults are actively involved in cow meat activities. Considering the age range of a majority of the dealers, their productivity is at its peak and hence is of great value to cow meat supply. Yakubu, (2002) concurred with the findings based on his assertion that farmers who are between the ages of 30-49 years are willing and able to take risk with the expectation of a larger profit than the older farmers.

Marital Status

Table 1, showed that 29(58.0%) of respondent are married, 18(36.0%) of respondents are single while 3(6.0%) of respondent are divorced. This indicates that there are more married people in cooperative societies in the study area. The singles had a less responsibility in terms of household commitments hence in most cases they have the full complements of their produce for sale as compared to the married who uses some for feeding the household and as gifts to other families and friends. Simpa (2014) showed a negative relationship between married status and profitability though it was statistically insignificant.

Educational status

Table 1, showed that 4(8.0%) of respondents had no formal education, 22(44.0%) of respondents had primary education, 19(38.0%) had secondary education and 5(10%) had tertiary education. This implies that majority of them are literate and they can manage their resources. This finding agrees with that of Thompson and Agbugba (2015), that majority of the respondents do not have the resources to get to higher/tertiary level of education.

Experience

Table1, showed that 14(28.0%) of respondents have spent between 4-6 years, 13(26.0%) have spent between 7-9 years. This implies that members of the cooperative had long time experience and they can coordinate the cooperative effectively and efficiently. This result contradicts the findings of Aiyeloja and Ogunjinmi (2013) in which 63% of the respondents had between 1 and 5 years of grass cutter production experience.

Table 1. Socioeconomic characteristics of co-operative members

Variables	Frequency	Percent	Cumulative Percent
Gender			
Male	28	56.0	56.0
Female	22	44.0	100.0
Total	50	100.0	
Age			
18 - 30 years	13	26.0	26.0
31 - 40 years	18	36.0	62.0
41 - 50 years	19	38.0	100.0
Total	50	100.0	
Marital Status			
Married	29	58.0	58.0
Single	18	36.0	94.0
Divorced	3	6.0	100.0
Total	50	100.0	
Educational status			
Not Educated	4	8.0	8.0
Primary	22	44.0	52.0
Secondary	19	38.0	90.0
Tertiary	5	10.0	100.0
Total	**50**	**100.0**	
Experience (Years)			
1 - 3 years	14	28.0	28.0
4 - 6 years	23	46.0	74.0
7 - 9 years	13	26.0	100.0
Total	**50**	**100.0**	

Source: field survey, 2021

Types of cooperative

The information on types of cooperatives is displayed on table 2. The Table shows that majority 18(36.0%) of respondents are in common cooperative, 12(24.0%) are in marketing cooperatives. the minority are in producer's cooperative 8(16.0%) housing cooperative 6(12%) and credit cooperative 6(12%). Common cooperatives are purchasing associations which sells primarily consumption goods. This implies that most of the respondents are in common cooperative and are involved in the purchase and sell of agricultural consumable goods.

Table 2: Distribution of type of Cooperative

Type	Frequency	Percent	\Cumulative Percent
Common cooperative	18	36.0	36.0
Producers cooperative	8	16.0	52.0
Marketing cooperative	12	24.0	76.0
Housing cooperative	6	12.0	88.0
Credit cooperative	6	12.0	100.0
Total	**50**	**100.0**	

Source: Field survey, 2021

Sources of Financing Cooperative Society

The information on the source of financing cooperative society are displayed in table 3. Table 3 indicates that 24(48.0%) of the cooperative funds comes from thrift savings while 16(32.0%) comes from donation. 3(6.0%) of respondents indicated that donation, levies and fines where main source of funds to their society. 2(4.0%) of respondents indicate that levies and fines, loans and overdraft brought more funds to their societies. While 1(2%) of respondents had different combination of donation and thrift savings, levies and fines, loans and overdraft; capital; thrift saving, levies and fines; thrift savings, reserve, levies and fines, loans and overdraft. This implies that thrift savings and donations were the major sources of financing cooperative society in the study area.

Table 3: Sources of financing cooperative

Sources	**Frequency**	**Percent**	**Cumulative Percent**
Donation	16	32.0	32.0
Donation and Thrift savings	1	2.0	34.0
Donation, Levies and fines	3	6.0	40.0
Donation, Thrift savings, Levies and fines	1	2.0	42.0
Levies and fines, Loans and overdraft	2	4.0	46.0
Share capital	1	2.0	48.0
Thrift savings	24	48.0	96.0
Thrift savings, Levies and fines	1	2.0	98.0
Thrift savings, Reserve, Levies and fines, Loans and overdraft	1	2	100
Total	**50**	**100.0**	

Source: Field survey, 2021

Contributions of Cooperative financing on Agribusiness

Table 4, Indicated the response of members on the extent they were active in agribusiness activities before they joined the cooperative society. It also shows that most of the respondents were less active in agribusinesses such as crop production, agro processing, poultry and palm oil production with mean score of 5.12, 5.92, 5.56 and 5.52 respectively. While few of them were active in fishery with a mean score of 4.68, before they joined their cooperative society.

Table 4: activeness in agribusiness before joining cooperative society

Valuables	**TS**	**Mean**	**Remark**
Crop production	256	5.12	To a very low extent
Agro processing	296	5.92	To a very low extent
Poultry	278	5.56	To a very low extent
Palm oil Production	276	5.52	To a low extent
Fishery	234	4.68	To a great extent

Source: Field survey 2021. Mean criterion = 3.0

Constraints in Agricultural Cooperative Financing

Table 5 indicates that most respondents agreed that complex procedure, bad character and corruption are constraints faced when seeking for funds from cooperative society but to a low extent. While some respondents acknowledged that lack of funds, credit unworthiness and unacceptable condition are constraints that affect members seeking for funds. This corroborate with the findings of FAO, (2010) promoting entrepreneurship for vulnerable youths.

Table 5: Constraints in Agricultural Cooperative Financing

Valuables	**TS**	**Mean**	**Remark**
Lack of funds	150	3	To a great extent
Complex procedure	290	5.8	To a low extent
credit unworthiness	266	5.32	To a great extent
Bad character	286	5.72	To a low extent
Unacceptable conditions	268	5.86	To a great extent
Corruption	292	5.84	To a very low extent

Source: Field survey 2021

CONCLUSION

The study concluded that both male and female farmers that are married with educational and agribusiness experience are involved in agricultural cooperative society, they are mostly involved in common cooperative, their main source of finance are donation, thrift savings, levies and fines, their major constraint is inadequate funding. Based on these findings, the study recommended that cooperatives societies should sort for funds from government agencies and cooperate financial institutions. They should collaborate with government agencies, business consultants and food technologists to organize regular seminars for members.

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Economic Effects of Flooding on Agricbusiness: A Case Study of Fishery Value-Chain n Bayelsa State, Nigeria

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ABSTRACT

This study examined the economic effects of flooding on agribusiness: a case study of fishery value-chain in Bayelsa State, Nigeria. The study specifically described the socio-economic characteristics of the respondents; examine the effects of flooding on fishery value chain; and identify the approaches to leverage flood effects on the fishery value chain activities in the study area. A multistage sampling technique was employed in selecting 120 respondents from six coastal fishing communities in the study area. Primary data were sourced through questionnaires. Descriptive statistical tools were used to analyze the data collected. The findings showed that 60% 0of the respondents are between the age range of 31-40; gender in exclusive with male having 52.5% and female 47.5%; 50% are married, majority of them are literate with years of experience; 50.8% agreed that offloading and loading business was very low after flooding incidence. However, 50.8% affirmed that scale and intestinal removal in big fish was both averaged before and after flooding incident. After, flooding incidence, the activities and outputs of buying at the point of initial supply, grounded and used for feed formulation especially the smaller fishes, grounded and used for fertilizer formulation especially the smaller fishes, and drying and smoking business were low with 40%, 31.6%, 43.3% and 40.8% respectively. Furthermore, 33.3% of the respondents agreed that catering and restaurant services was very low, while, 43.3% agreed that road sided roasted fish for immediate consumption was very low after flood incident. The study concluded that flooding has adverse effect on the fishery value-chain. It was recommended that flood risk management strategies for environmental sustainability should be provided by the government such as the foundation of buildings used for fishery business and accommodation buildings should be elevated, resilience walls should be build for the affected communities.

Keywords: Economic, Effect, Flooding, Fishery, Value-chain

INTRODUCTION

Nigeria has become a major destination for imported seafood ever since the government made a tariff reduction on all fishery products in 2001 from 25% to 5% (NBS, 2006). The European Union accounts for more than 70% of the Nigerian sea food supply while the US provides about 1% (Nzeka, 2003). Despite the massive potentials of a coastline, and the abundant fisheries resources there is a relatively high consumption of fish in Nigeria (FDF, 2008), its domestic output of 0.85 million metric tons in 2010 still falls short of demand of 3.02 million metric tons (CBN, 2007, FDF, 2008, FDF, 2010). The fisheries sector represents a major food source, which is valuable for the protein and the industrial products they produce. Fish is economically, socially and culturally important as a global dietary aspect of sustainable food security. Economically fish provides an important source of food and income for fisher folks. It has an important social and cultural position in riverine communities. However, a deficit of 2.17 million metric tons is required to meet the ever increasing demand for fish in Nigeria. The large deficit between the demand and supply of fish is augmented by massive importation of frozen fish which is a rigorous drain on the exchange earnings of the nation (FDF, 2008).

Availability of fish to the consumers at the right time, right form, right place and at the lowest possible cost requires an effective marketing system (Shamsuddoha, 2007). Marketing of fish passes through various market participants and exchange points before they reach the final consumers (Ali *et al*., 2008). Nigeria has a great potential of fish resources whose distribution and value chain needs to be strengthened and developed to bridge the gap between demand and supply of fish in Nigeria (Amao *et' al.,* 2006).

Fish is highly susceptible to deterioration without any preservation or processing measures (Okonta and Ekelemu 2005). Immediately fish dies a number of physiological and microbial deterioration sets in which invariably degrades the quality of fish (Eyo, 2001). It will become unfit for human consumption within about one day of capture, unless it is subjected to some form of processing or preservation. Even after the fish has been processed, particularly if traditional methods have been used, the fish is still subject to many forms of losses and spoilage. Hence, fish being a highly perishable substance needs to be transported to the consumer or final user in time (Ali *et' al*., 2008) to avoid post harvest spoilage through a coordinated marketing channel (fish value chain).

The Nigeria fishery industry plays a significant role in the development of this country by providing livelihood for more than 50 million people in terms of employment, income generation and provision of principal protein to the diet (Akpaniteaku *et al*., 2005). Each year, there are an additional 80-90 million people to feed, most of them in developing countries, the most reliable source of protein for many of them is fish (Nzeka, 2003). However, irrespective of the great opportunities embedded in captured fisheries in Nigeria, a lot of the fish resources are being discarded on daily basis due to an unorganized or uncoordinated distribution channel (Aihonsu and Shittu, 2008). Analyzing fisheries value chain provides an insight into various employment opportunities that remain untapped in the fisheries sector (Kaplinsky and Morris, 2000). Fish value chain in Nigeria are not yet developed to meet international market requirements as limited value addition is done in the industry, with the result that market for fish and fish product are limited to domestic markets (Investopedia, 2011). Over the past decades, development practitioners have increasingly shifted their attention from farming systems to targeting agricultural value chains and fisheries by extension, to improve smallholder production and participation in markets (Rota and Sperandini, 2010). This is because small-scale producers are often unable to increase production by adopting productivity-enhancing technologies unless the value chains for their products are sufficiently developed and dynamic (Kaplinsky and Morris, 2000).

In many coastal communities many natural rhythmic flooding patterns are known. These types of floods can help connect rivers with floodplains and supply organic matter and nutrients to aquatic-terrestrial zones, thus stimulating biological productivity and habitat heterogeneity. This kind of river-flood plain connectivity is very important in impounded rivers, where sediment imbalances associated with dam operation and tributary inputs cause sedimentary deltas to form (Graf *et al*., 2010). Such floods induces greater habitat and resource availability that usually stimulate fish productivity and increase species abundance, richness, evenness, and diversity compared to stable regimes (Carlson *et al*., 2016).The floods experienced in many parts of the country in rainy season of since 2010 have come with some devastating effects and communities living close to river banks are often the worst hit with attendant loss of lives, livestock, inundation of farm lands and crops; dislodgement of economic trees; destruction of road networks; loss of productive fishing areas and paralysis of socio-economic activities.

According to report by the International Federation of Red Cross and Red Crescent Societies (IFRC 2018), nearly a quarter of a million households in Nigeria are at risk after heavy rains caused flooding that has inundated 80 percent of the country. Heavy seasonal rains have caused the Niger and Benue rivers to burst their banks, inundating communities, farms and trapping tens of thousands of people in their homes, hundreds of people died and about two million others were left homeless (Vanguard, 2018). Understanding the effects of disturbances such as flooding on aquatic biota and the livelihoods that depends on them is an important step towards all round management of impacted resources. In riverine communities that are affected by floods fish community structure indices such as specie richness and diversity have been found to decline when such indices are compared before and after floods. However, fish communities have been known to exhibit short-term resistance to the flood as the indices may return to balance after a while (Carlson *et al*., 2016). The capacity of fishers, farmers, processors and other stakeholder to respond effectively to floods by reducing the risk and enhancing preparedness should be enhanced. This study on economic effects of flooding on fishery value chain is designed with the following specific objectives: describe the socio-economic characteristics of the respondents; examine the effects of flooding on fishery value chain; and to identify the approaches to leverage flood effects on the fishery value chain activities in the study area.

METHODOLOGY

Study Area

Bayelsa is a state in southern Nigerian located in the core of the Niger Delta region. It shares a boundary with Rivers State to the east and Delta State to the west; with the beautiful waters of the Atlantic Ocean dominating its southern borders. The state comprises of eight Local Government Areas. It has a coordinates of 4.7719^{0}N, 6.069^{0}E with latitude of 4.664030, longitude coordinates of 6.036987 and the total land area about 8000square miles. It has a riverine and estuarine setting. Many communities are surrounded by water, making them inaccessible by road. It has one of the largest crude oil and natural gas deposits in Nigeria. As a result, petroleum production is substantial in the state, with an estimated population of about 1,704,515 (NPC, 2006) their major occupations are fishing, farming, and boat caving and local gin preparation.

Sampling Technique and Sample Size

A purposive sampling technique was used in the selection of six coastal fishing communities from Bayelsa State coastal because of their high intensity of fishing activities and flood prone area; they are (Anyama-Ijaw, Otukpoti, Agudama Ekpetiana, Awazakiri, Obogoro and Tombia). The second stage involves the use of simple random sampling in the selection of 20 respondents (involved in fishery value chain) from each of the six selected communities who were interviewed to give a total of 120 respondents which formed the sample size for the study.

Analytical Techniques

Descriptive statistical tools were used to analyze the obtained data. These include frequencies, means and percentages to describe the socio-economic characteristics, effect of flooding on fishery value chain and the approaches to leverage flooding effect on the fishery value chain activities in the study area.

RESULTS AND DISCUSSION

The socio-economic characteristics information of the respondents in table 1 showed that 52.5% of people involved in fishery value chain activities is not gender exclusive but is mostly carried out by the male. These findings were in line with the findings of Olubanjo and Odebiyi *et al*., (2007), Olawumi *et al*., (2010) and Olaoye and Odebiyi (2011) were business biased. Many (60%) of the respondents interviewed were between 31 and 40 years of age, a highly productive and active age when respondents could undertake strenuous task. This is in line with the findings of Bello (2000) and George *et al*., (2010) that age had a positive correlation with agricultural productivity.

Table 1: Socio-economic Characteristics of the Respondents
(n=120)

Variables	Description	Freq.	%	Mean
Age	<20	0	0.0	
	21-30	12	10	
	31-40	72	60	32
	41-50	24	20	
	50 & above	12	10	
Gender	Male	63	52.5	
	Female	57	47.5	
Marital Status	Single	27	22.5	
	Married	60	50	
	Separated	5	6.7	
	Divorced	10	8.3	
	Widowed	15	12.5	
Educational Level	Non formal	43	35.8	
	Primary	38	31.6	
	Secondary	27	22.5	
	Post secondary	12	10	
Years of Experience	1-10	20	16.6	
	11-20	31	25.8	
	21-30	43	35.8	20.5
	>30	26	21.6	

Source: Field Survey, 2021

The marital status of respondents as presented in table 1 indicated that 50% of the respondents were married, implying that most of the respondents involved in fishery value chain in the study area were matured and can manage their business prudently. This corroborates with the findings of Alfred and Fagbenro, (2006) and who reported higher percentage of married people in perception of tilapia farmer's on information sources in the coastal region of Ondo State, Nigeria.

Education is an important factor which can influence fish production and determine level of awareness on the rate of return on value addition in fish. Table1 showed that 35.8% of the respondents had no formal education. This confirmed the general opinion that most respondents were illiterate or semi-illiterates; most of whom have dropped out of formal school system (Olubanju *et al*., 2007 and Alfred *et al*., 2006). The low level of education in Bayelsa waterside coastal fish value chain could be explained by some reasons: Firstly, fishing communities are generally isolated and marginalized, with limited or no education services and facilities, available government schools are very far. Additionally, regular flooding and threats from hostile crocodiles are some reasons for parents not sending their children to school; also, school premises are sometimes flooded with water, other important factor given is that fishing is the main economic activity, so children are often assimilated into the fishing industry at early age to help their parents or guardians in fishing and fishery activities.

Experience in fishery activities were determined by the number of years the respondents had been in the business. Majority (35.8%) of respondents had between 21 and 30 years of experience with an average mean score of 20.5. it implies that their efficiency would be enhanced. This finding is in line with Schumpeterian theory of economic development, which suggest technical efficiency is influenced by technical knowledge and understanding in addition to other socio-economic environment with which the respondents take decision (Kalirajan, 1990) as cited by Olaoye *et' al*., (2012).

Table 2: Flood Effects on Fishery Value Chain Output/Activities in Bayelsa

Before Flooding Incidence	VH	H	A	L	VL
Offloading and loading business	48 (40)	16 (13.3)	20 (16.6)	12 (10.8)	23 (19.1)
Scale and intestinal removal in Big fishes	15 (12.5)	11 (9.1)	61 (50.8)	12 (10)	21 (17.5)
Buying at the point of initial supply	38 (31.6)	18 (15)	23 (19.1)	13 (10.8)	13 (10.8)
Grounded and used for feed formulation especially the Smaller fishes	52 (43.3)	30 (25)	10 (8.3)	19 (15.5)	9 (7.5)
Grounded and used for fertilizer preparation especially the smaller fishes.	60 (50)	27 (22.5)	17 (14.1)	11 (9.1)	5 (4.1)
Drying and smoking business	49 (40.8)	38 (31.6)	11 (9.1)	14 (11.6)	8 (6.6)
Catering and restaurant services	28 (23.3)	40 (33.3)	16 (13.3)	18 (15)	18 (15)
Road sided roasted fish for immediate consumption	52 (43.3)	10 (8.3)	30 (25)	19 (15.8)	9 (7.5)
Fish transportation business	17 (14.1)	47 (39.1)	13 (10.8)	23 (19.1)	20 (16.6)
Fish marketing from middlemen to consumers	46 (38.3)	30 (25)	20 (16.6)	12 (10)	12 (10)
Fish grading, measurement and bagging	56 (46.7)	23 (19.2)	18 (15)	11 (9.2)	12 (10)
Hired freezing business or cool room business	39 (32.5)	27 (22.5)	12 (10)	13 (10.8)	29 (24.2)
Cutting and supplying of firewood for fish drying	40 (33.3)	18 (15)	32 (26.7)	25 (20.8)	5 (4.2)
Fish cum rice culture	13 (10.8)	20 (16.7)	55 (45.5)	19 (15.8)	13 (10.8)

Table 2 and 3 indicates the extent of flood effect (before and after) on fishery value chain output and activities in Bayelsa. The result indicated that 40% of the respondents agreed that offloading and loading business was very high before flooding incidence while after flooding, the activities was very low with 50.8%. Scale and intestinal removal in big fish was both average with 50.8% before and after flooding incident. Buying at the point of initial supply, grounded and used for feed formulation especially the smaller fishes, grounded and used for fertilizer formulation especially the smaller fishes, and drying and smoking business before flood incidence was very high with 31.6%, 43.3%, 50% and 40.8% respectively while after flooding incidence, its activities and output were low with 40%, 31.6%, 43.3% and 40.8% respectively. Catering and restaurant services were high with 33.3% and very low with 33.3% which indicates scarcity of food in the study area. Road sided roasted fish for immediate consumption was very high with 43.3% before flood incident and low with 43.3% after flood incident. Flood has low effect on fish transport business with 39.1%. Fish marketing from middlemen to consumers and cold room business is reduced and very low after every flooding incident with 38.3% and 46.7% respectively.

Table 3: Effect of Flooding On Fishery Value Chain Output/Activities in Bayelsa

After Flooding Incidence	VH	H	A	L	VL
Offloading and loading business	11 (9.1)	12 (10)	15 (12.5)	21 (17.5)	61 (50.8)
Scale and intestinal removal in Big fishes	12 (10)	11 (9.1)	61 (50.8)	21 (17.5)	15 (12.5)
Buying at the point of initial supply	16 (13.3)	13 (10.8)	20 (16.6)	48 (40)	23 (19.1)
Grounded and used for feed formulation especially the Smaller fishes	18 (15)	13 (10.8)	28 (23.3)	38 (31.6)	23 (19.1)
Grounded and used for fertilizer preparation especially the smaller fishes.	9 (7.5)	10 (8.3)	30 (25)	52 (43.3)	19 (15.8)
Drying and smoking business	38 (31.6)	11 (9.1)	8 (6.6)	49 (40.8)	14 (11.6)
Catering and restaurant services	28 (23.3)	16 (13.3)	18 (15)	18 (15)	40 (33.3)
Road sided roasted fish for immediate consumption	10 (8.3)	19 (15.8)	9 (7.5)	52 (43.3)	30 (25)
Fish transportation business	17 (14.1)	23 (19.1)	13 (10.8)	20 (16.6)	47 (39.1)
Fish marketing from middlemen to consumers	12 (10)	12 (10)	46 (38.3)	30 (25)	46 (38.3)
Fish grading, measurement and bagging	29 (24.2)	13 (10.8)	12 (10)	39 (32.5)	27 (22.5)
Cool room business	12 (10)	11 (9.2)	18 (15)	23 (19.2)	56 (46.7)
Cutting and supplying of firewood for fish drying	13 (10.8)	20 (16.7)	13 (10.8)	55 (45.5)	19 (15.8)
Fish cum rice culture	5 (4.2)	25 (20.8)	18 (15)	40 (33.3)	32 (26.7)

It further shows that the frequency and percentage rating on the extent that flood sometimes affects the fish grading, measurement and bagging; cutting and supplying of firewood for fish drying, and fish cum rice culture with a relative low output/activities with 32.5%, 45.5% and 33.3% respectively.

Table 4, identified approaches or ways to leverage the effects of flood on fishery value chain in Bayelsa, the results showed that all respondents agreed with the approaches mentioned above as ways to leverage the effects of flood on the affected fishery value chain in Bayelsa; with a criterion mean score of 3.00. According to Pollard *et al*., (2018), stated that the big data approaches involves the use of historical data, live data streams and different technologies to get insights into societal complexities through storage and analytical capabilities. In Nigeria's environmental sector, BDAs have not been effectively utilized. Therefore, Nigeria can leverage the approaches to get insights into flood and environmental risk assessment. The big data approaches proposed by Pollaard *et al.,* (2018) and which can be adopted in Nigeria include: synthesis and harmonization of coastal data sets; process-base modeling and Bayesian networks; ensemble information; handling validating satellite imagery; and natural language processing of social media.

Table 4: Approaches to Leverage the Effects of Flood on the Affected Fishery Value Chain Activities in the study Area

Value Chain Activities	Mean	Remark
Building of resilience walls around affected Communities	3.55	A
Building of culverts and drainage channels	4.05	A
Land reclamation	3.61	A
Afforestation	3.11	A
Establishment of fish pond	3.23	A
Elevated foundation of buildings used for fishery Business and accommodations	4.55	A
Seasonal business and marketing planning	3.00	A
Provision of preservative facilities	4.19	A
Government intervention responses plans	3.97	A
Procession of fish for long storage value	4.28	A
Funding	3.67	A
Standard road network	4.01	A
Standard marketing environment	3.70	A

Source: Field Survey, 2021. Criterion mean 3.00

Secondly, spatial planning:- Nigeria's flood response is more focused on post-disaster approach than control and pre-disaster approach (Cirella and Iyalomhe, 2018). To solve these problems, Oladokun and Proverbs (2016) proposed the use of spatial planning as an innovative flood risk management strategy primarily because it can integrate existing practices. With spatial planning, Nigeria can adopt modern concepts like sustainable and flexible collaborative planning (Lagopoulo, 2018). Spatial planning also integrates sustainable drainage system as flood risk management.

According to Siang (2020), design thinking is an iterative process employed by teams to understand users, redefine problems, challenges assumptions, and builds innovative solutions to prototype and test. Also, flood risk management is done by the states with inadequate supports from the federal government. Among these states there is lack of coordination and partnership of state with similar environmental problems adopting such practices (Oladokun and Proverbs, 2006).

CONCLUSION

The systematic literature reviewed has unveiled the flooding effects on fishery value chain activities in Bayelsa State. From the study, it was concluded that flood has a negative impacts and has distorted the value added activities of people involved in the fishery business. From these findings, the following recommendations were made: innovative ways or approaches that can be utilized to leverage flooding effects such as identified in the study should be strengthened, flood risk management strategies for environmental sustainability should be provided by the government. The foundations of buildings used for fishery business and accommodation buildings should be elevated.

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Postharvest Losses along Citrus Value Chain in Osun State: Implication for Sustainable Economic Development in Nigeria

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ABSTRACT
Reducing post-harvest losses has been identified as a strategic way to improve farm incomes, especially for the rural poor. This study was designed to estimate postharvest loss of citrus fruit along the value chain and the reduction strategies. A two-stage sampling procedure was used to select one hundred and fifty respondents for the study. The data collected using structured interview schedule were analysed using frequency counts, percentages, mean and standard deviation. Findings of the study revealed that the mean age of the actors was 46.4 years, mostly males (54.0%) and were married (95.3%) with an average household size of 7 persons and 14.4 years of experience in citrus business. The study estimated that postharvest losses of 6.82, 8.56 and 5.36% occurred; on the part of the growers, the wholesalers and the retailers respectively. and citrus storage in aerated places was the major (WMS =1.67) loss reduction strategy practiced by the value chain actors. The study recommends that efforts should be geared towards promoting modern post-harvest handling practices for the adoption of citrus value chain actors.
Keywords: citrus, loss reduction, postharvest, principal component analysis, rapid loss assessment

INTRODUCTION
The greatest challenge for agriculture in the twenty-first century is producing enough to feed the rapidly growing global population (FAO, 2017). Food and nutrition insecurity is a major threat in sub-Saharan Africa. To improve the diet and quality of life of communities in this region, tropical fruits play a major role (Jamnadass *et al*., 2011).

In spite of the important role fruit production plays in improving nutrition and livelihood security, the sector suffers greatly from postharvest losses. These postharvest losses are as a result of the degradation of aesthetic and market value of fruits due to pests, diseases and physical and chemical deterioration (Musasa *et. al*., 2015; Kader 2002). Musasa *et. al* (2015) also identified inadequate fruit storage facilities, poor post-harvest fruit handling, lack of access to better technology and markets as other causes of postharvest losses in the fruit production value-chain.

In fruit industry, Citrus especially sweet orange is identified as one of the leading fruits with high priority for cultivation in most parts of Nigeria. The crop has the potential to grow on variety of soil and is in high demand across the country. Unfortunately, this citrus specie is susceptible to a number of destructive pests and diseases that can cause severe economic losses (Etebu and Nwauzoma, 2014). To satisfy the demand in existing production, reducing the postharvest losses along the value chain and maintaining its quality are vital. As mentioned by Musaa *et al*., (2013), controlling and/or preventing postharvest losses is less costly as compared to producing the similar amount of the fruit loss. Postharvest management determines not only quality and safety of food but competitiveness on the market. The aim of the present study was to estimate postharvest loss of citrus fruit along the value chain in Osun State and identify the reduction strategies. This study was conducted to bridge the gap in the available baseline data on citrus postharvest losses in Osun State, Nigeria. Information from this study may provide insights on critical factors that need to be addressed along the value-chain to reduce postharvest losses in citrus and increase profitability. To establish this aim, the following objectives were considered:

1. To determine the socioeconomic profile of the value chain actors in the study area,
2. To estimate the postharvest losses along the value chain and
3. To identify strategies used by the actors to reduce the postharvest losses

METHODOLOGY

The study was carried out in Osun State, Nigeria. Osun state lies within the South west geopolitical zone of Nigeria. It has a land area of approximately 14,875sq km and a population of 3,423,535 (NPC, 2006). Though the state is a land locked state it is blessed with the presence of many rivers and streams which serves the water needs of the state. The soils have high agricultural productivity, which is also a characteristic of agro-ecological region. The state is located between the latitude 7°30' 0'' N and longitude 4°30' 0 E. The average temperature ranges between 26°C-30°C and annual rainfall of about 1241 mm. Osun state is classified into six (6) agro-ecological zones by the Osun State Agricultural Development Project (OSSADEP).

The inhabitants of the area are predominantly Yoruba speaking people who engage in farming and other small businesses like tailoring, mechanic, driving, trading etc. Major fruits produced in the state include oranges, grape, lemon, tangerine, plantain/banana, mango, pineapple, pawpaw, walnut, *Albidium chrysophyllum* (agbalumo), *Invingia gabonensis* (Osun state, 2009). The population for the study comprised all citrus value chain actors in the state. Three stage sampling procedures were employed in the selection of the actors. The first stage involved the purposive selection of one local government area each from the six Agricultural Development Project (ADP) zones in the state based on the concentration of citrus value chain activities in the areas. The second stage was an aided-selection of one hundred and fifty citrus value chain actors in the selected LGAs (This consists; 60 citrus growers, 30 wholesalers and 60 retailers. Snowballing approach was used to locate the actors. This selection approach was used because there are no organized citrus value chain actors in the zones. Structured interview schedule was used to collect data for the study. Data were summarized and presented using frequency counts, percentages and mean. The socioeconomic profile of the actors including sex, marital status, educational attainment, and were measured in a nominal scale. Data on age, years of experience in citrus enterprise and household size were measured on an interval scale. In estimating the proportion loss at each stage of the chain, total quantity of citrus not used/sold was subtracted from the total quantity of citrus harvested or bought. This was expressed as:

$$TQ_L = TQ_H - TQ_U$$

Computation of quantity at each stage was standardized using 50kg sack. Total quantity loss was the sum of all losses experienced by 60 citrus growers, 30 wholesalers, and 60 retailers at each stage of postharvest handling activity. Thus, the percent loss was expressed as a ratio of total quantity loss (in kg) to total quantity harvested/bought (in kg) multiplied by 100.

$$\%L = \frac{TQ_L}{TQ_H} \times 100$$

Where TQ_L = Total Quantity Loss; TQ_H = Total Quantity Harvested/Bought; TQ_U = Total Quantity Unused; percentage of citrus lost. The strategies used by the actors to reduce the postharvest losses was identified using three-point likert-type scale of highly utilized =2, utilized =1 and never used =0. The frequency values on the Likert-type scale were added to obtain 3 and a mean score of 1; hence variables with mean scores of 1 or above were regarded as important strategy while mean scores below 1 were considered as not important strategy.

RESULTS AND DISCUSSION

Socioeconomic Profile of the Citrus Value Chain Actors

Data in Table 1 reveals that more than halve (54%) of the respondents were males. Citrus enterprise like other tree crops is labour intensive, especially the orchard management routines, making men have a leading role in cultivation and women in marketing. A notable proportion of the respondents (33.3%) falls between the age bracket of 46-55 years. This age group, since they are relatively young have the tendency of positively responding to innovations that could enhance their business. Majority (95.3%) of the value chain actors are married. Being married gives a sense of responsibility that makes individuals seek information to improve their business performance.

Table 1: Distribution of respondents based on socioeconomic profile

Variables	Growers (N=60)		Wholesalers (N=30)		Retailers (N=60)		Pooled	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Sex								
Male	54	90.0	18	60.0	09	15.0	81	54.0
Female	06	10.0	12	40.0	51	85.0	69	46.0
Age of Respondents								
Less than 35	03	5.0	07	23.3	20	33.3	30	20.0
36-45	06	10.0	12	40.0	28	46.7	46	30.7
46-55	31	51.7	09	30.0	10	16.7	50	33.3
Above 56	20	33.3	02	6.7	02	3.3	24	16.0
Mean	52.7 years		45.3 years		41.2 years		46.4 years	
Marital Status								
Single	00	0.0	02	6.7	05	8.3	07	4.7
Married	60	100.	28	93.3	55	91.7	143	95.3
Educational Status								
No formal education	04	6.7	09	30.0	12	20.0	25	16.7
Primary	21	35.0	12	40.0	34	56.7	67	44.7
Secondary	32	53.3	09	30.0	14	23.3	55	36.6
Tertiary	03	5.0	00	0.0	00	0.0	03	3.0
Household Size								
1-5	20	33.3	08	26.7	25	41.7	53	35.3
6-10	31	51.7	17	56.7	33	55.0	81	54.0
11-15	09	15.0	05	16.6	02	3.3	16	10.7
Mean	7 persons		7 persons		6 persons		7 persons	
Primary Occupation								
Citrus Enterprise	07	11.7	11	36.7	12	20.0	30	20.0
Crop Farming	15	25.0	03	10.0	05	8.3	23	15.3
Artisanship	17	28.3	07	23.3	10	16.7	34	22.7
Trading	12	20.0	09	30.0	33	55.0	54	36.0
Civil Service	09	15.0	00	0.0	00	0.0	09	6.0
Years of experience								
1-5	00	0.0	04	13.3	19	31.7	23	15.3
6-10	08	13.3	05	16.7	23	38.3	36	24.0
11-15	12	20.0	07	23.3	11	18.3	30	20.0
16-20	16	26.7	09	30.0	07	11.7	32	21.3
Above 21 years	24	40.0	05	16.7	00	0.0	29	19.4
Mean	17.2 years		16.8 years		9.2 years		14.4 years	

Only 16.7% of the respondents have no formal education while the rest (83.3%) have one form of education of the other. Estruk and Oren (2014) mentioned that education enables easier access to information from various sources and facilitates knowledge generation out of those sources. More than halve (54%) of the respondents have 6-10 household size with an average of 7 persons. Household size has been linked to the availability of 'own' labour that could be of assistance in the enterprise. Most (36.0%) of the actors in citrus value chain indicated trading as their primary occupation and averagely holds 14.4 years of experience in the citrus business.

Postharvest Loss Estimation at each stage of the chain

Table 3 revealed that majority of the postharvest loss in the citrus value chain occurred at the wholesalers' stage (8.56%). Followed by the growers (6.82%) and the retailers (5.36%).

Table 2: Distribution of the respondents based on output of citrus harvested/purchased and postharvest losses

Variables	**Growers (60)**		**Wholesalers (30)**		**Retailers (60)**	
	No of Sacks	In Kg	No of Sacks	In Kg	No of Sacks	In Kg
Output (harvested/ purchased)	2800	140000	1950	97500	840	42000
Quantity of output lost	191	9550	167	8350	45	2250
Quantity of output used/sold	2609	130450	1783	89150	795	39750
Percentage of output lost (%)	6.82%		8.56%		5.36%	

Postharvest Loss Reduction Strategies

The information on Table 3 shows that the most important strategy used by the actors in the citrus value chain was storage of the fruit in aerated environment. This was evident in the weighted mean scores of the actors on this strategy; growers (WMS= 1.63, St. dev= 0.61), wholesalers (WMS= 1.58, St. dev= 0.49), retailers (WMS =1.79, St. dev=0.73). The standard deviations were all less than 1.0 indicating that their responses did not differ much from the mean score. According to Musyoka *et al*. (2020), in order to deliver and maintain good quality fruit, proper handling and management culture must be maintained by the actors.

Table 3: Distribution of respondents based on the type of postharvest loss strategies used

Strategies	**Growers**		**Wholesalers**		**Retailers**	
	WMS	**SD**	**WMS**	**SD**	**WMS**	**SD**
Chemical application	1.21	0.74	1.08	0.69	0.45	0.88
Selective harvesting/purchase	1.36	0.68	1.53	0.77	1.64	0.87
Sorting and grading	1.03	0.84	1.54	0.86	1.72	0.64
Storage of fruits in aerated environment	1.63	0.61	1.58	0.49	1.79	0.73
Harvesting/purchase of fruit in unripe state	1.44	0.67	1.51	0.59	1.28	0.87
Checking for bruises	1.11	0.66	1.66	0.72	1.71	0.81
Checking for disease or pest infection	1.09	0.75	1.57	0.54	1.66	0.59
Processing fruit to juice	0.12	0.89	0.21	0.38	0.98	0.31
Washing with water	0.45	0.59	0.97	0.42	1.77	0.40
Quick sales	1.36	0.60	1.57	0.73	1.76	0.81

CONCLUSION

From the study, it was observed that wholesalers suffer most from postharvest losses. Also, processing of fruits into juice was the least utilized strategy to reduce postharvest loss. Therefore, to reduce the high postharvest loss and supply quality products for consumers throughout the year, intervention activities such as the construction of permanent selling place equipped with evaporative cooling technologies for wholesalers and promotion of value addition technologies especially for processing should be prioritized.

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Demand for Local Frozen Chicken in Ilorin Metropolis, Kwara State, Nigeria

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ABSTRACT
The nutrition requirement among households requires understanding consumers demand and preference for protein sources. Frozen foods, such as local frozen chicken, are means of readily available sources of protein. This study, therefore, focused on the demand for local frozen chicken in Ilorin Metropolis, Kwara State, Nigeria. Specifically, the study assessed the level of demand for local frozen chicken, the factors that affect the demand for local frozen chicken and the attributes influencing consumers' preference for local frozen chicken in the study area. Primary data were obtained from 180 randomly selected chicken consumers with the use of questionnaires. Data collected were analysed using descriptive statistics and the Almost Ideal Demand System Model. The study revealed that local frozen chicken was purchased mostly every week and majority of the consumers demand 1 to 5 kg of local frozen chicken monthly. Household size, monthly income, total monthly expenditure on frozen meats, local chicken expenditure and price of local frozen chicken were significant factors that influenced the consumers' demand for local frozen chicken. The attributes that influenced the consumers' preference for local frozen chicken were taste, freshness, nutrition, affordability, hygiene and environmental friendliness of local frozen chicken. Incentives for investment, such as a conducive environment for indigenous poultry farmers via the provision of credit facilities to enhance wholesome production and processing, should be increased to encourage already existing poultry farmers and the integration of new individuals into the poultry value chain in a bid to meeting up with the high demand for chicken.
Keywords: AIDS model, Frozen Chicken, Demand, Income, Expenditure, Kwara State

INTRODUCTION
The agricultural sector in Nigeria is the most important non-oil economic activity and it is the single largest employer of labour forces, employing about 70% of its workforce (NBS 2009; USDA, 2013). It contributed 40%, and 22% (pre and post debasing period respectively) of Gross Domestic Products (GDP) in 2010 and 2014 respectively (NBS, 2014). The sector consists of crops, fishery, forestry and livestock sub-sectors. Agriculture contributes about 30% of the country's earnings while the GDP contributed by sub-sectors are; Crops (22.19%), Fisheries (0.46%), Forestry (0.21%), and Livestock (1.58%), (NBS 2017). The livestock sub-sector is an important component of the Nigerian agricultural economy. Nigeria's livestock population consist of 16.3 million Cattle; 40.8 million Goat; 27 million Sheep; 3.7 million Pigs and 151 million poultry (Lombin, 2011). Going by this figure, poultry alone constitutes more than 60% of the total livestock production, indicating a relative dominance of the poultry sub-sector in the livestock industry. In Nigeria, the poultry sector has developed such that large scale production is being practised and a lot of people derive their means of livelihood from poultry

production and its associated industries such as processing. Processing can be defined as the sequence of operations to which a poultry bird is subjected to preparation for consumption (Shari, 2002). The chicken after reaching maturity is usually slaughtered, de-feathered, cleaned, before storage at a temperature usually below -18^{0}C to preserve them.

The poultry industry plays important role in the development of Nigeria economy. The industry provides employment opportunities for the populace, thereby serving as a source of income to the people. Also, it provides a good source of animal protein in terms of meat and eggs. Other animal protein sources are fish, beef, milk, bacon, pork and mutton (Apantaku, 2006). Chicken consists of high-quality protein, hence, the most widely accepted meat in Nigeria. Unlike beef or pork, it does not have any religious/health taboo. It contributes to a nutritious, balanced diet, which is especially important for children, nursing mothers and people who are ill (Australian Centre for International Agricultural Research, ACIAR, 2009). Nigeria, with a population of over 200 million (World Bank, 2019), is grossly underprovided with the essential food component, which is protein. Nigeria's per capita daily protein intake is far below the FAO recommended minimum of 53.8g, while the per capita chicken intake stood at 18.1g in 2010 (FAOSTAT, 2012).

According to FAO (2012) poultry accounts for approximately 33% of world meat intake, serving as the chief meat in consumer diets in many low to middle-income countries and it is said to be the second-largest consumed meat worldwide. Nigeria chicken supply is either through local productions or by importation but unfortunately far above this, half of the chicken consumed in Nigeria is imported despite the ban on importation. The high spate of poultry importation into the country has raised a lot of complaints from both poultry farmers and policymakers in the country since it is believed to have greatly affected local poultry farmers negatively. Meanwhile, it has been found that urban dwellers in Nigeria have shown a preference for imported poultry products over the years before the ban on importation due to their comparatively cheaper price, their ready-to-use nature, and rapid growth in the restaurant, hotel, and fast-food sector (Global Agriculture Information Network, 2011). The ban on poultry products enhance local frozen chicken for households consumption. Several factors could influence the consumers' preference and demand for either the local frozen chicken and or imported frozen chicken. There is thus a need to examine consumers preference for local frozen chicken.

Meanwhile, there is dealt information on demand for local frozen chicken in the study area. The study, therefore, seeks to analyse the demand for locally produced frozen chickens in Ilorin Metropolis. The specific objectives were to assess the level of demand for local frozen chicken, investigate the determining factors of local frozen chicken and assess the attributes influencing consumers' preference for local frozen chicken. This is to improve local production and marketing of locally produced frozen chickens. This would provide the basis for synergizing the activities of marketers to enhance more efficiency and develop an approach that stresses the importance of all marketers in the supply chain including all major policies and supporting institutions in working more harmoniously together to promote increased production. It will help interested investors and entrepreneurs who want to invest in the Country's poultry sector while pinpointing the importance of value addition in satisfying the needs of consumers. Finally, this study will be relevant to policymakers in promoting Government involvement in supporting agricultural production.

MATERIALS AND METHODS

Study area/Data collection

This study was conducted in Kwara State, Nigeria. The State is referred to as "State of Harmony" and is one of the 36 states that make up the Federal Republic of Nigeria. It is located within the North Central geopolitical zone, commonly referred to as the middle belt. Kwara consists of 16 Local Governments Areas. It has a total land area of about 105 square kilometres and a population of 364,666 as of the 2006 census with a population density of 3501/KM^2 (NPC, 2006). Agriculture and allied activities were the major occupation for the majority of the population, especially the rural dwellers. They grow cash and arable crops such as cashew, oil palm, teak, rice, corn, and millet in addition to livestock production e.g., poultry, fishery, and ruminant animals.

Sampling procedure

Multiple stage sampling procedure was used to select respondents for this study. In the first stage, three Local Government Areas (LGAs) were randomly selected in Ilorin metropolis. In the second stage, three markets were randomly selected from each of the Local Government Areas making it a total of nine markets involved in the study. In the third stage, 20 frozen chicken consumers were randomly selected to make a total of 180 respondents involved in the study. Trained enumerators were used for administering the questionnaires.

Data collection

Primary data were used for this study. The data were collected using a well-structured questionnaire. Information was collected on demographic features, income, and expenditure pattern of frozen chicken consumers. Information on the attributes of consumers that could influence local frozen chicken was also collected.

Analytical techniques

Almost Ideal Demand System (AIDS) model

Almost Ideal Demand System (AIDS) model was used to analyse the determinants of demand for local frozen chicken in the study area. The model is expressed as:

$$W_{it} = \alpha_i + \sum_{j}^{n} \gamma_{ij} Ln\, P_{jt} + \beta_i Ln\left(\frac{X_t}{P_t}\right) + \mu_{it}$$

Where W_{it} = Budget share of frozen chicken, P_{jt} = Nominal price of the frozen chicken, lnXt = Total expenditure, X = Total expenditure on the group of goods being analysed, P = Price index, U_{it} = Random or error term, lnPt = Translog price index

Where the dependent variable is explicitly expressed as:

$$W_{it} = P_{it}.\frac{Q_{it}}{X}$$

Pit = Price of commodity, Qit = Quantity demanded, Xt = Total expenditure.

$$X = \sum_{i=1}^{n} P_{it} \,.\, Q_{it}$$

Likert Scale

This was used to identify the attributes influencing consumers' preference for local frozen chicken in the study area. Responses were based on a four (4) point Likert scale: Very important (V.I) =4, Important (I) = 3, Less important (L.I) = and not important (N.I) = 1.

RESULTS AND DISCUSSION

Socioeconomic characteristics of local frozen chicken consumers

Table 1 presents the results of the socio-economic characteristics of local frozen chicken consumers in the study area. Results reveal that the majority (53.3%) of the frozen chicken consumers were females. This simply means that purchase of food items (frozen chicken) in the household is mostly done by the female gender. The local frozen chicken consumers with the highest percentage of age distribution fall between 20 and 39 years of age. About 29 per cent of the local frozen chicken consumers fall between 40 and 59 years of age while only 2.2% of the respondents were less than twenty years and above 59 years. The average age of frozen chicken consumers was about 35 years. On the marital status, the majority (68.9%) of the consumers were married, 21.7% were single, 7.2% were widowed and only 2.2% of them were divorced. On the household size, the majority (78.9%) of the local frozen chicken consumers had a household size between 2 and 6 members. About 21.1 per cent had a household size between 6 and 9 members. The frozen chicken consumers had a mean household size of four persons.

Results also revealed that most (78.9%) of the consumers had tertiary education, 13.9% had secondary education, 2.2% had primary education while only 5% had no formal education. This implies that the frozen chicken consumers were well-educated. About 64.4% of the consumers were Muslims, 32.2% were Christians, and 3.3% were traditional worshippers. The main occupation of the consumers was civil service (69.4%). About 17.2% were farmers, 13.3% were artisans and 21.1% are into other forms of occupation.

Table 1: Socio-economic characteristics of the Local frozen chicken consumers

Variable	Category	Frequency	Percentage	Mean
Gender	Male	84	46.7	
	Female	96	53.3	
Age (Years)	< 20.0	04	2.2	34.77
	20.0 - 39.0	120	66.7	
	40.0 - 59.0	52	28.9	
	≥ 60.0	04	2.2	
Marital Status	Single	39	21.7	
	Married	124	68.9	
	Widow(er)	13	7.2	
	Divorced	04	2.2	
Household size	2 – 5	142	78.9	4.47
	6 - 9	38	21.1	
Educational level	Primary	04	2.2	
	Secondary	25	13.9	
	Tertiary	142	78.9	
	No formal	09	5.0	
Religion	Christianity	58	32.2	
	Islam	116	64.4	
	Traditional	04	2.2	
	Others	02	1.1	
Main Occupation	Civil Service	125	69.4	
	Farming	31	17.2	
	Artisan	24	13.3	

Source; Field Survey, 2019

Level of Demand for Local Frozen Chicken in the Study Area

Table 2 presents the results for the level of demand for local frozen chicken in the study area. The results revealed that local frozen chicken is purchased mostly every week followed by fortnightly, monthly and daily. Also, the majority of the consumers demand about 1 – 5 kg of local frozen chicken monthly. This was followed by demanding 6 to 10kg monthly by 25 per cent of the consumers. About seven per cent of the consumers demand 11 to 15kg of frozen chicken monthly. A few of the consumers demanded 16 to 20kg (2.2%) and less than 1kg (1.1%) monthly. This suggests that the consumers always demand a reasonable amount of frozen local chicken.

Table 2: Level of demand for local frozen chicken

Variable	Category	Frequency	Percentage
Frequency of buying	Daily	08	4.4
	Weekly	105	58.3
	Fortnightly	49	27.2
	Monthly	18	10.0
Monthly demand (kg)	< 1.0	03	1.1
	1.00 - 5.00	116	64.4
	6.00 - 10.00	45	25.0
	11.00 - 15.00	13	7.2
	16.00 - 20.00	04	2.2

Source: Field survey, 2019

Determinants of Demand of Local Frozen Chicken in the Study Area

Table 3 shows the result of the AIDS model on the determinants of demand for local frozen chicken in the study area. The R-Square value was 0.88, meaning that the explanatory variables explained about 88% of the variations in the dependent variable. Regarding variables that influence the demand for local frozen chickens, household expenditure on frozen meats, and monthly income positively influenced the demand for local frozen chicken. This confirms Engel's law, and was found to be significant at 1%, and 10% probabilistic levels, respectively. This implies that household expenditure on frozen meats and monthly income enhance the demand for local frozen chickens among the consumers. This is because the higher the monthly income, ceteris paribus, the higher the available money to be spent on frozen chicken which, in turn, increase local frozen chicken demand.

The coefficient of household size was positive and significant in relation to demand for local frozen chicken among the consumers. This is likely because there exists a positive relationship between household size, and household protein consumption demand, which to a large extent is been positively influenced by household income level. An increase in household requirements will, in turn, increase households demand for local frozen chicken, *ceteris paribus*.

Table 3: Determinants of demand for local frozen chicken among consumers

Local frozen chicken	**Coefficient**	**Standard Error**	**t-ratio**	**P-value**
Expenditure on frozen meats	5.13000***	7.97000	6.44	0.000
Price of frozen fish	-.0118065	.0180034	-0.66	0.512
Price of frozen turkey	.0074607	.0260188	0.29	0.774
Price of frozen cowhide	.0151641	.0635948	0.24	0.812
Price of frozen cheese	-.0054326	.0232653	-0.23	0.815
Price of imported frozen chicken	.0668222	.0788649	0.85	0.397
Age	.0002247	.0005251	0.43	0.669
Household size	.0021843*	.0012548	-1.74	0.082
Educational status	.0018423	.007419	0.25	0.804
Monthly income	1.39000*	-8.4000	-1.65	0.099
Local frozen chicken expenditure	-.3018763***	.0095227	-31.70	0.000
Price of local frozen chicken	-.1520916***	.0235774	-6.45	0.000
Constant	1.272393	.7949745	1.60	0.109
$R^2 = 0.8815$				

Source: Field Survey, 2019

The coefficient of local frozen chicken purchase expenditure and price of local frozen chicken were negative and significant in relation to demand for local frozen chicken among the consumers. This negative relationship confirms that the local frozen chicken is a normal good in the study area. This supports the law of demand, the higher the price the lower the quantity demanded. Thus, an increase in the price of local frozen chicken would lower the demand for the product by the consumers. This corroborates the findings of Adetunji and Rauf (2012).

Features Influencing Consumers' Preference for Local Frozen Chicken

Table 4 presents the result of the analysis on the attribute influencing consumers' preference for local frozen chicken in the study area. The result revealed that the taste of the local frozen chicken was the most important attribute that influences the consumers' preference for local frozen chicken in the study area. Chicken has a good taste which influenced consumers to prefer chicken to other frozen meat products. The freshness of local frozen chicken was ranked second among the attributes that influenced consumers preference. The nutritional value of local frozen chicken also influenced consumers preference for local frozen chicken and was ranked third. Furthermore, affordability, hygiene and environmental friendliness of local frozen chicken were also major attributes that influenced consumers preference for local frozen chicken in the study area. The consumer found local frozen chickens more hygiene for human consumption.

Table 4: Attribute influencing consumers' preference for local frozen chicken

Variable	Not important	Less important	Moderately important	Very important	Mean	Rank
Safety	2 (1.1)	11 (6.1)	66 (36.7)	101 (56.1)	3.48	6th
Nutritional value	1 (0.6)	13 (7.2)	52 (28.9)	114 (63.3)	3.55	3rd
Hygiene/Handling	4 (2.2)	15 (8.3)	79 (43.9)	82 (45.6)	3.33	8th
Environmental friendliness	5 (2.8)	27 (15.0)	66 (36.7)	82 (45.6)	3.25	9th
Taste	5 (2.8)	9 (5.0)	31 (17.5)	135 (75)	3.64	1st
Convenience	2 (1.1)	10 (5.6)	60 (33.3)	108 (60)	3.52	4th
Freshness	3 (1.7)	8 (4.4)	47 (26.1)	122 (37.8)	3.60	2nd
Quality assurance	3 (1.7)	8 (4.4)	63 (35.0)	106 (58.9)	3.51	5th
Affordability	1 (0.6)	22 (12.2)	51 (28.3)	106 (58.9)	3.46	7th

Source: Field survey, 2019

CONCLUSION

This study focused on the demand for local frozen chicken in Kwara state, Nigeria. The study has shown that local frozen chicken is purchased mostly weekly and the majority of the consumers demand about 1 to 5 kg of local frozen chicken monthly. Furthermore, the significant determinants of demand for local frozen chicken were household expenditure on frozen meats, monthly income, household size, local frozen chicken purchase expenditure and price of local frozen chicken. The attribute that influenced consumers' preference for local frozen chicken were a taste, freshness, nutritional value, affordability, hygiene and environmental friendliness of local frozen chicken.

Based on the conclusions, the following recommendations are inferred. Provision of business-friendly environment for indigenous poultry production, and marketing, to promote output level and stabilize output price. Provision of storage facilities for frozen chicken marketers to maintain the wholesomeness of output. Food safety measures should be implemented to curb adulteration of meats sold in market places thereby reducing circulation and consumption of unhygienic foods. Incentives for investment, such as the provision of credit facilities to enhance wholesome production and processing, should be increased to encourage already existing poultry farmers and the integration of new individuals into the poultry value chain in a bid to meeting up with the high demand for chicken.

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Livelihood Trends and Women Activities in Ensuring Household Food Security in Kajuru Local Government Area of Kaduna State Nigeria

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ABSTRACT
The study assessed the livelihood trends and women activities in ensuring food security in Kajuru LGA of Kaduna State. The objectives of the study were to determine the socio-economic status of respondents, highlight the distribution of respondents based on their livelihood activities and determine the distribution of respondents based on their food security status. Multistage sampling procedure was used for this study. Out of the fourteen (14) districts in Kajuru LGA, five (5) districts were randomly selected, from each district; two villages were selected to give a total of ten villages. Ten (10) rural women were randomly sampled from each village to give a total of one hundred (100) respondents. Primary data was used for this study and this was carried out through the use of a well-structured questionnaire. Descriptive statistics was used to analyze data obtained from the study. Majority (46 percent) were between the ages of 31 – 40 years while the least (10 percent) were between the ages of 10 – 20 years. The marital status of the respondents showed that majority (52 percent) are married while the least (7 percent) are divorced. The result also showed that majority (34 percent) had secondary education while the least (11 percent) had primary education. Household size of the respondents showed that majority (44 percent) had between 6 – 10 members while the least (4 percent) had 21 members and above. Membership of respondents in different organizations showed that they belonged to cooperative group, farmers' cooperative and monthly contributions group with 53 percent, 10 percent and 37 percent respectively. The monthly income of the respondents in the study area showed that majority had an income between the range of #31, 000 - #40, 000 while the least had income between #51, 000 and above. Farming (62 percent) was the major livelihood means of the respondents with most cultivating crops such as maize, beans, potatoes etc. Majority (43 percent) guarantee food security in their homes while the least (16 percent) were severely classified as households with food insecurity. The importance of household food security in the study area is such that women have less to contend with hunger. Access to capital / grants through the available women's organizations such as farmers' cooperative groups will empower most of the women in the study area. This will serve as an empowerment in boosting their farming activities and yield more income to their households.
Keywords: Livelihood, women, food, security, household

INTRODUCTION
Food security is a vital is a vital phenomenon that ensures that people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life (FAO, 2011). Sibhatu and Qaim (2017) reported that food insecurity remains one of the serious problems in many countries. Food security is an extremely high priority in the

developing regions of the world like Nigeria, where population growth coupled with increased intensity of such environmental events as floods, droughts, extreme variability in temperature or rainfall often pose a threat to food security (Ahmed *et al*., 2017; Pawlak and Malgorzata 2020).

Women play vital role in sustaining food security at the household level, as well as contributing to cash crop production (Malik *et al*., 2012). Dameen (2005) reported that women highly contributed to the development of subsistence economy which ensures food security in many parts of Africa. The proportion of women working in the agricultural sector varies from 20% in South America to almost 50% in certain parts of Africa and Asia. In South-East Asia, the Middle East and North Africa, the percentage of women working in this sector is greater than that of men. Furthermore, due to the migration of men to urban areas, women are taking on greater responsibilities and tasks in rural areas (FAO, 2010). Maxwell and Wiebe (1998) described food security as the state of having secure and sustainable access to sufficient food for an active and healthy life. Focus on food security ensures that the basic needs of the poorest and most vulnerable groups are not neglected in policy formulation (Ajibola, 2000; Adepoju *et al*., 2015). This is because food security is one of the several necessary conditions for a population to be healthy and well nourished (Nord *et al*, 2001; Adepoju *et al*., 2015). Adepoju *et al*., (2015) submitted that the central role women play as producers of food, managers of natural resources, income earners and caretakers of household food security and nutrition has become increasingly recognized.

Rural women play crucial role in determining guaranteeing food security and well-being for the entire household. Not only do women produce and process agricultural products but they are also responsible for much of the trade in these and other goods in many parts of the third world. In many parts of the world, women continue to play an important role as rural information sources and providers of food to urban areas. This may involve food from the sea as well as from the land. Although women rarely work as fisher people, they are often involved in net making, processing and sale of the catch. Women's roles and status over the world are determined by social institutions, norms, religious ideologies, ecosystems and by class positions. It is needful to emphasize on the significant contribution of women to agricultural production and household food security because in the process of production, handling and preparation of food, women play multiple roles throughout the sequence, said to be feeding the world (Rabinowick, 2002).

Livelihood trends of women in their various communities have shown that they contribute major quota in ensuring food security. Their activities have placed them in vantage position of determining how resources are harnessed in their communities and households. The need to understand this trend will help in policy formulation in ensuring food security and the roles played by women.

MATERIALS AND METHODS

Study Area

Kajuru Local Government area of Kaduna State is located in southern part of the state with headquarters in the town of Kajuru. It is located on Longitude 9^0 -59'N and 10^o 55' N and latitude $7^0$34' E and $8^0$13'E with an area of 2, 229km^2. Kajuru LGA has an estimated population of 110,865 people according to 2006 census sub-divided into 14 districts to reflect the political divisions namely Kasua Magani, Rimau, Kalla, D/Gaiya, Dawaki, Sunka, Kajuru, Buda, Kugamara, Kufana, Afogo, Idon, Iri and Kutura (Bulus and Adefila, 2014). Multistage sampling procedure was used for this study. Out of the fourteen (14) districts in Kajuru LGA, five (5) districts were randomly selected, from each district; two villages were selected to give a total of ten villages. Ten (10) rural women were randomly sampled from each village to give a total of one hundred (100) respondents. Primary data was used for this study and this was carried out through the use of a well-structured questionnaire. Descriptive statistics was used to analyze data obtained from the study.

RESULTS AND DISCUSSION

Table 1: Socio-Economic Status of Respondents in the Study Area

Variables	Frequency (n = 100)	Percentage (%)
Age		
10 – 20	10	10
21 – 30	32	32
31 – 40	46	46
41 and Above	12	12
Marital Status		
Single	11	11
Married	52	52
Widow	20	20
Divorce	7	7
Separated	10	10
Educational Status		
Primary	11	11
Secondary	34	34
Tertiary	26	26
Adult Education	29	29
Religion		
Christianity	51	51
Islam	45	45
Traditional	4	4
Purdah		
Yes	30	30
No	70	70
Household Size		
1 – 5	30	30
6 – 11	44	44
11 – 15	13	13
16 – 20	9	9
21 and Above	4	4
Membership in Organization		
Co-operative group	53	53
Farmer's cooperative	10	10
Monthly contributions	37	37
Monthly Income		
Below #10, 000	16	16
#11, 000 - #20, 000	20	20
#21, 000 - #30, 000	15	15
#31, 000 - #40, 000	22	22
#41, 000 - #50, 000	14	14
#51, 000 – Above	13	13

Source: Field survey data, 2021

Table 1 above shows the result of the socio-economic characteristics of respondents in the study area. Majority (46 percent) were between the ages of 31 – 40 years while the least (10 percent) were between the ages of 10 – 20 years. Others were within the age brackets of 21 – 30 years, 41 years and above with 32 percent and 12 percent respectively. The fact that many of the respondents are married is expected to influence their level of contribution to household food security (Okunade *et al*., 2015). The marital status of the respondents showed that majority (52 percent) are married while the least (7 percent) are divorced. The single, widow and separated accounted for 11 percent, 20 percent and 10 percent respectively. This study is in conformity with Akintonde (2009) that marital status may suggest a high degree of level headedness and great capability for sound decisions among farmers (Okunade *et al*., 2015).

The result also showed that majority (34 percent) had secondary education while the least (11 percent) had primary education. Adult education and tertiary education accounted for 29 percent and 26 percent respectively. The result further showed that the religion practiced by the respondents in the study area are Christianity, Islam and traditional religion with 51 percent, 45 percent and 4 percent respectively. The practice of Purdah was not prevalent in the study area with 30 percent of the respondents involved in it. This is contrary to the findings of Ariyo, (2019) who reported the dominance of the practice in Igabi LGA, Kaduna. The practice of purdah secludes women based on religion restriction only to household jobs. Household size of the respondents showed that majority (44 percent) had between 6 – 10 members while the least (4 percent) had 21 members and above. In rural environment where agriculture is the main economic activity, the size of the household plays a very important role since it influences the supply of labour for immediate family employment (Bulus and Adefila, 2014). Membership of respondents in different organizations showed that they belonged to cooperative group, farmers' cooperative and monthly contributions group with 53 percent, 10 percent and 37 percent respectively. The monthly income of the respondents in the study area showed that majority had an income between the range of #31, 000 - #40, 000 while the least had income between #51, 000 and above. Cicera and Masset (2010) submitted that as the income of poorer households grows, larger shares of their budget are available for food consumption.

Table 2: Distribution of Respondents based on their Livelihood Activities

Variable	**Frequency (n = 100)**	**Percentage**
Trading	21	21
Tailoring	39	39
Civil Servant	13	13
Weaving	20	20
Animal rearing (Poultry/Goat)	7	7
Other Income Generating Activities		
	Yes (%)	No (%)
Farming	62 (62%)	38 (38%)
Brewing	18 (18%)	82 (82%)
Grinding	27 (27%)	73 (73%)
Fish Farming	26 (26%)	74 (74%)
Food Vending	9 (9%)	91 (91%)

Source: Field survey data, 2021

Table 2 above shows the distribution of respondents based on their livelihood activities. The result showed that majority (39 percent) engage in tailoring while the least (7 percent) were involved in rearing of poultry and goats. Also, respondents in the study area were engaged in trading, civil service, and weaving with 21 percent, 13 percent and 20 percent respectively. The result further showed other income generating activities embarked upon by the respondents as means of livelihood. Such activities included farming, brewing, grinding, fish farming and food vending. Farming (62 percent) was the major livelihood means of the respondents with most cultivating crops such as maize, beans, potatoes etc. That women in the study area are involved in agricultural activities for livelihood aligns with the findings of Ingevall *et al* (2002), who said women are taking on an increasing responsibility in agricultural production.

Table 3: Distribution of Respondents Based on Food Security Status

Variable	Frequency (n = 100)	Percentage
Food Secure	43	43
Moderately Food Secure	19	19
Averagely Food Insecure	22	22
Severely Food Insecure	16	16

Source: Field survey data, 2021

Table 3 above shows the distribution of respondents based on food security status. Majority (43 percent) guarantee food security in their homes while the least (16 percent) were severely classified as households with food insecurity. The result also showed that respondents agreed that their households were moderately food secure and averagely food insecure with 19 percent and 22 percent respectively. The importance of household food security is such that rural women have less to contend with hunger. This is in conformity with Okunade *et al*. (2015) that food security has significance effect on the quality and quantity of food as regards household food security.

CONCLUSION

Rural women engage in different activities to alleviate food insecurity and they are key agent in achieving food security because they play tremendous roles in contributing to household food security. The fact that many of the respondents are married is expected to influence their level of contribution to household food security. The size of household plays a very important role since it influences the supply of labour for immediate family employment. Women in the study area are involved in agricultural activities for their livelihood as majority engage in one form of farming or the other. The importance of household food security in the study area is such that women have less to contend with hunger. Access to capital / grants through the available women's organizations such as farmers' cooperative groups will empower most of the women in the study area. This will serve as an empowerment in boosting their farming activities and yield more income to their households.

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Introduction of Improved Okra (NHAe47-4) Variety as a Means of Economic Enhancement of Farmers in Ido Village, Ido Local Government Area. Oyo State

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ABSTRACT
This study introduces improved okra (NHAe 47-4) variety to farmers in Ido Village, Ido Local Government of Oyo State. The project used SAFE approach to agricultural extension which includes: capacity building among farmers to enable them to diagnose their problems, solutions' identification, plans development and implementation with or without support from outside. Farmers in the studied area were selected based on purposive sampling method and they were made to form a group comprising twelve (12) members. Sensitization and awareness creation were made in the study area by facilitating several interactive group discussions and meetings with the farmers to educate them about the improved okra variety using teaching and management techniques. Descriptive statistical tool such as frequency distribution and percentages was used to analyze the objectives. At the end of the harvesting, the group (farmers) was interviewed verbally to know their levels of awareness for adoption and their general view about the improved variety in relation to the local okra variety they were used to. The farmers embraced the technology and actively participated. Having known all the techniques involved in the production cycle, the farmers also tried the technology on their individual plot which served as an encouragement factor for adoption. The result of the study thus resulted into improving the standard of living and economic enhancement of the farmers in the study area.
Keywords: Okra, varieties, economic enhancement, farmers, Ido village

INTRODUCTION
Young immature okra fruits are important fresh fruit vegetable that can be consumed in different forms. They could be boiled, fried or cooked. In Nigeria, okra is usually boiled in water resulting in slimy soups and sauces, which are relished. The fruit also serves as soup thickeners (Schippers, 2000). The leaves buds and flowers are also edible. Its seed could be dried and be used to prepare vegetable curds, or roasted and ground to be used as coffee additive or substitute. Okra leaves are considered good cattle feed, but this is seldom compatible with the primary use of the plant. Okra mucilage is suitable for medicinal and industrial applications. It has been medicinal as a plasma replacement or blood volume expander. Industrially, okra mucilage is usually used to glace certain papers and also useful in confectionery among other uses (Markose and Peter, 1990).

Nigeria with a population of about 150 million people and an exponential population growth rate of 2.52% (World Bank, 2011), is likely to face a challenge of population explosion. This situation is capable of translating into more unemployment and poverty. Thus, it is necessary to develop the agricultural sector to provide employment and thereby alleviate poverty. One aspect of the sector is vegetable production, which contributes to the nutritional value and improving the standard of living of farmers.

The yield of okra in Nigeria is very low (about 2 tons/ha^{-1}) (Adesina and Baid-Forson, 1985). Among the factors that could result in low yield include unimproved local cultivars commonly grown and scanty stands. Yayock (1979) suggested that one of the important ways of increasing the economic yield of most crops is by cropping in high density as well as using improved varieties.

Adeniji (2003) in previous study on performance of different varieties of West African okra observed that improved and serial varieties produce high yield. Series of research work on okra has been conducted at National Horticultural Research Institute (NIHORT) Ibadan and Institute for Agricultural Research (IAR), Ahmadu Bello University, Samaru Zaria, where much emphasis on agronomy and physiology performance and improvement programme has made little progress due to the fact that okra continues to be regarded as a marginal crop. As a result of socio- economic importance of okra as a vegetable, its production has rapidly increased in recent years. Therefore, different varieties were used by farmers in order to meet the demand of okra by consumers.

Modern agriculture requires that farmers should use scientific knowledge in the production of okra. In Nigeria, a lot of technological innovations to improve agricultural yields are available, but these technological innovations could not be accessed by the farmers. Famers' major problem is the dependence on the use of local or traditional varieties that gives very low yield and poor in nutritional quality. Hence, the need for the introduction of high yielding improved variety of okra (NHAe 47-4) (Adeboye and Oputa, 1996; Iremiren and Okiy, 1999).

The introduction of NHAe 47-4 variety is to help farmers to improve and increase okra production. This will in turn increase their income, improve their standard of living and meet the demand of the consumers. The main objective of this study is to introduce improved okra variety (NHAe 47-4) to farmers in the study area with a view to create awareness of improved okra variety (NHAe47-4), acquaint the farmers with the new agronomic practices involved and to determine the performance of the improved okra variety (NHAe 47-4) in relation to those traditional okra variety (*Abelmoschus caillei*) which farmers were used to in the study area.

MATERIALS AND METHODS

The study was carried out at Ido village, Ido local government area of Oyo State located in the forest region of Nigeria. The study area experiences two seasons (wet and dry) which allows the practice of both dry season and rain-fed cropping.
Data were collected from primary and secondary sources using the following methods:

1. Use of verbal interview and administering questionnaire to farmers.
2. Collective participation.

Descriptive statistics such as percentage and frequency distribution was used to analyse the data. A target group comprising twenty (20) farmers was formed based on the information gotten from the community leaders. This group was later purposively streamlined into twelve (12) volunteered farmers who were actively involved in okra production. These farmers were introduced to the production of NHAe 47-4 and its agronomic practices. The study was not an experimental, but an action research because no experimental designed method was involved. The techniques employed includes: group formation, demonstration plot training and awareness campaign exercise. The use of demonstration plot has enhanced the extensive uses of their senses and skills which improved their knowledge on agronomy activities of NHAe 47-4 okra variety.

RESULTS AND DISCUSSION

Socioeconomic characteristics of rural households

For the purpose of measuring the response of farmers to the new technology on okra production in the study area, a total of twelve well- structured questionnaires were administered in order to gather information on their socio-economic characteristics. This distribution shows that the average age of the sampled farmers was about 35years constituting 58.33% and this implies that most of the farmers were at their youth stage. This indicated that younger farmers are more likely to adopt the technology than older/aged farmers because of better education and exposure to new ideas. The results supported the observation reported by Aktas (1973) that the age of farmers contributes to the adoption of new technologies. Table 1 shows the socio-economic characteristics of rural households.

Table 1: Socioeconomic characteristics of rural households

Item	Frequency	Percentage
20-30	-	0.00
31-40	7	58.33
41-50	4	33.33
51-60	1	8.33
61 & above	-	0.00
Total	12	100.0
Gender		
Male	11	91.67
Female	1	8.33
Total	12	100.0
Marital Status		
Married	10	83.33
Not married	2	16.67
Total	12	100.0
Education status		
Quranic Education	1	8.33
Primary School	2	16.67
Secondary School	7	58.33
University Degree	2	16.67
Post Graduate	-	-
Total	12	100.0
Households' size		
0-5	8	66.67
6-10	3	25.00
11-15	-	-
16-20	-	-
None	1	8.33
Total	12	100.0
Years of experience		
1-2	3	25.00
2-3	5	41.67
3-4	2	16.67
4-5	2	16.67
5 & above	-	-
Total	12	100.0

Source: Field survey, 2017

The distribution of the respondents according to their gender shows that 91.67% of the respondents were males while 8.33% were female. The findings indicated that males are more in vegetable production, while women are likely to be actively involved in marketing. Further, the statistics shows that 83.33% of the respondents were married while about 16.67% were single. Also, 8.33% of the respondents attended Quranic education, 16.67% attained primary school, 58.33% of the respondents' attained secondary school level and only 16.67% attained university degree. The results supported that of Knight's (2000) findings, where he stated that the household level of education affected the timing of adoption of new technology in Ethiopia.

Likewise, Table 1 shows that, household size ranging from (0-5) had 66.67%, (6-10) had 25%, (11-15) and (16-20) had 0% and none had 8.33%. This result shows that the household size of the sampled farmers affected the adoption of *NHAe 47-4* technology. This finding supported the observation reported by Just and Zilberman (1985), that when the number of the non-working adult is greater than the working adult, technology adoption is affected negatively. In terms of farming experience of the respondents, 41.67% had farming experience between two to three years (2-3yrs) and 25% farmers having farming experience between one to two years. While three to four years and four to five years were 16.67% respectively. This result supported what was obtained by Aktas (1973) who pointed out that the farming experience affected the rate of technologies adoption.

Size of Farmland Devoted to okra Production

Table 2: shows that 8.33% of the respondents devoted 0.5-1ha of the farmland to okra production, 25% devoted 0.5ha, while 66.67% accounted for others of the total farm land for okra production. This result shows that the total farmland of the respondents could affects the rate of NHAe 47-4 okra adoption and it agrees with the result of Manfield (1968) who reported that the total farmland contributes to technologies adoption.

Table 2: Farmland devoted to okra Production

Farmland for okra	Frequency	(%) Distribution
0.5ha	3	25.00
0.5-1ha	1	8.33
1-1.5ha	-	-
Others	8	66.67
Total	12	100.0

Source: Field survey, 2017

Improved varieties of seed used before NHAe 47-4 okra variety

From Table 3, it was observed that 75% of the farmers within the community made use of improved okra variety, while 25% still go for the local variety due to their low source of income which prevented them from obtaining necessary input.

Table 3: Respondents that used other improved seed before NHAe47-4

Adoption	Frequency	(%) Distribution
adopted	9	75.00
Non adoption	3	25.00
Total	12	100.0

Source: Field survey, 2017

Reasons for Adopting NHAe 47-4 okra variety

Table 4 shows that 50% of the respondents adopted NHAe 47-4 okra because of its high yield, 41.67% adopted it because of rapid growth, while 8.33% did not adopt the variety for the reason best known to them.

Table 4: Reasons for Adopting NHAe 47-4

Reasons	Frequency	(%) Distribution
Resistance to diseases and Pests	-	0
Low Fertilizer requirement	-	0
Rapid growth	5	41.67
Better yield	6	50.00
Non Adopters	1	8.33
Total	12	100.0

Source: Field survey, 2017

Level of adoption

Table 5 revealed the reaction of farmers after observing the results of the demonstrations in terms of yields obtained. This was a result of the strict observance of the recommended practices demonstrated as follows:

- Land clearing – After clearing the demonstration plot, farmers undertook clearing of their own fields to prove the demonstrator's recommendation.
- Ridging – The recommended form of making ridges was accepted, compared to former way of making their ridges for planting which made some operations difficult to be carried out for effective output.
- Improved seed – They used their local varieties. Although they (local varieties) were affordable but it was discovered that their yields were not as higher as that of the improved okra varieties.
- Seed treatment – Farmers discovered that treated seeds had about 100% germination rate with vigour unlike old okra varieties, which gave about 65% - 70% germination rate with less vigour and requires planting supplementation.
- Planting time – it was recommended that planting should be done at appropriate time so as to reduce infestation of diseases.
- Seed rate – farmers discovered that, their seed rate per hole was too much and so resolved to be using recommended seed rate.
- Plant spacing – Close spacing was believed to give crowded plant population and reduced the size of the okra pods, therefore recommended spacing was adopted.
- Weeding – it was recommended that weeding should be done regularly to avoid nutrient competition between the crops and weeds.
- Use of herbicide – the group had known the use of herbicide on the field for clearing grasses before cultivation. This helps to add more nutrient into the soil as nothing is burnt or packed before ridges were made.

Table 5: Level of adoption of recommended practices

Reasons	Frequency	(%) Distribution
Land clearing -	12	100
Ridging -	12	100
Use of improved seed	12	100
Seed treatment	12	100
Planting date	12	100
Seed rate	12	100
Plant spacing	12	100
fertilizer application	12	100
Weeding	12	100
Use of herbicide	12	100
Total	12	100.0

Source: Field survey, 2017

NHAe 47-4 Okra farmers that indicated early maturity

Table 6: shows that all members of the group (100%) agreed that NHAe 47-4 okra variety is early maturing than other variety that they were used to as compared by the number of days to maturity.

Table 6: NHAe 47-4 Okra farmers that indicated early maturity

	Frequency	(%) Distribution
Late maturing	Nil	-
Medium maturing	Nil	-
Early maturing	12	100
Total	12	100.0

Source: Field survey, 2017

Awareness of NHAe 47-4 okra

After the completion of this project, all group members indicated their interest in the variety and were extended to the entire farmers in the village and mostly the farmers became show more interest in the variety due to its value and other superiorities such as early maturity and high yield. Others are production practices.

Group management and strengthening

At the end of the exercise, though the farmers group have been practicing the use of communal effort in their farming activities, the group had more cohesion for continuity and management even though they are not registered. For consistency and effective management, the group selected their leader for proper coordination to avoid failure and to achieve desired results. They are also aware of the importance of forming cooperatives society as it is the easiest way to have linkage with government agencies on agriculture.

Record keeping in the group

At the end of the demostration, record keeping by the student has helped taught the farmers' group of proper record keeping of activities.
The result showed that good record keeping will help them to:

- Compare their previous and present activities.
- Determine their total expenditures, profit and loss within a cropping season.
- Determine worthiness of the group if seeking for loan.
- Shows the role of members of the group.
- Reference for feature use by members in the method of practices.

CONCLUSION

The introduction and adoption of an improved (*NHAe47-4* okra) variety boosted their production level compared to local variety. Therefore, adopting the recommended agronomic practices orchestrated by this demonstration would boost good crop performance and ensure high crop yield per unit area. Likewise, continuous sensitization, awareness creation, group formation and regular field days demonstration responsible for easy adoption of the technology among the vegetable (okra) farmers in the study area.
Based on the above findings from this study, the following recommendations were proposed:

- Extension staff should be adequately trained on the use of improved varieties and motivated to enhance timely dissemination of new technology.
- Awareness about *NHAe47-4* variety and its improved agronomic practices as a means of yield increase should be extended to other parts of the State on the economic importance of the production of this okra variety.
- Agricultural shows or field days should be introduced in the State to serve as a medium for demonstrating the results of improved practices to farmers.
- More enlightenment campaigns should be embarked upon to reach more farmers with the new approach to okra production and the importance of vegetables in general.
- Government should ensure availability of agricultural inputs at all levels especially fertilizers and improved seeds because farmers are willing to produce more.

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Farmers' Awareness and Attitudes toward Land Degradation in Illela Local Government Area of Sokoto State, Nigeria

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ABSTRACT
This study analyzed farmers' awareness and attitudes toward land degradation in illela Local Government Area (LGA) of Sokoto State, Nigeria. Data were collected using structured questionnaire from 113 randomly selected farmers. Data were analyzed using descriptive statistical tools such as mean, frequency distribution, percentages and Likert scale. The study showed that the entire respondents (100%) were aware of land degradation in the area. Majority (76.0%) of them obtained information on land degradation through extension agents. The result also showed that the respondents had positive attitude concerning land degradation as a natural occurring phenomenon ($\bar{X}$= 4.9). They also believed that land degradation had negative effect on crop production with ($\bar{X}$= 4.85) and on their incomes ($\bar{X}$=4.75). Is was concluded that farmers in the area were fully aware and had a positive attitude on land degradation, which could make it easier for mobilizing them to take measures in reclaiming the degraded farmlands. It is recommended that extension workers, in addition to media houses should be used by all stakeholders (Government, Non-governmental and Community based Organizations) in educating the farmers on measures for reclamation of the degraded farmlands.
Keywords: Awareness, Attitude, Farmers, Land Degradation, Crop, Production

INTRODUCTION
Agricultural production remains the main source of livelihood for most rural communities in developing countries and sub-Sahara Africa in particular (Onyerika, 2016). Nigeria is richly blessed with agricultural resources such as rich arable land, water bodies, vegetation and active human population that supported high productivity. Agriculture remains one of the most important fabrics of Nigerian economy with 23.92 % Gross Domestic Product (GDP) contribution to the economy in 2020 with a great potential for improvement. However, land degradation, a serious environmental problem, is growing at an alarming rate across all the ecological zones of Nigeria. Population increase, unemployment, unsustainable agricultural practices, mining and quarrying, infrastructure, transportation and energy are the drivers of the degradation. The resultant effects of land degradation in Nigeria include unemployment, pockets of conflict for resources (herdsmen crises), food insecurity, desertification, drought, flood and erosion [United Nations Convention to Combat Desertification (UNCCD), 2018]. Land degradation is a long term loss of ecosystem function and productivity caused by disturbances from which the land cannot recover independently (Bai and other 2008). Land degradation aggravate slowly and has long lasting effects on rural people who become increasing vulnerable (Adebayo *et. al*., 2003).

In Nigeria, it has been reported that over 35 million tons of soil particles are lost annually to land degradation and 2-3 million tones are lost annually in Sokoto State, thereby causing great decline in crops productivity (Dike, 2000). Land degradation results in severe soil fertility depletion and productivity decline, shrinking crop yield and ecological damages including erosion loss, leaching, water run-off, flood and gullies which are some of the adverse effects of the uncontrollable land use and agricultural intensification in the country (Adebayo *et. al.*, 2003). Consequently, Scherr and Yadav (2002) opined that by the year 2020, land degradation may cause serious threat to food security in the rural areas of the developing country such as Nigeria.

Sokoto State has a high population density and most households particularly in the rural areas depend largely on the output of the land and other natural resources for their means of livelihoods. The high population and lowland per capital have led to intensive pressure on land, forests and other natural resources which have maximized natural resources degradation in the state (Sokoto State Ministry of Environment, 2011).

Quite a number of the initial responses to land degradation such as studies, media analysis and government intervention programs have always proposed towards controlling the incidence of land degradation or reclaiming already degraded areas. Akporido (2005) assertion indicated that limited research attention on land degradation in relation to agricultural production in some parts of Nigeria like the North West and North East regions of the country. World Bank has insisted on a fully developed and manned land use planning and Agro-forestry component in all the Agricultural Development Programmes (ADPs) that operate in every State in Nigeria particularly in the southeast region in the quest to remedy land degradation. It is in this regard that this study was designed to assess farmers' awareness and attitudes toward land degradation in Illela Local Government Area of Sokoto State, Nigeria. It specifically determined the level of the farmers' awareness on land degradation and examine the farmers' attitudes towards land degradation in the study area.

METHODOLOGY

This study was conducted in Illela LGA, Sokoto State. It shares border with the Republic of Niger to the north. It is among the LGAs that make up the Northern Agricultural Zone of Sokoto State. It lies within latitude 13º 43^{1}N and 13º 57^{1}N and longitude 5º18^{1}E and has a total area of 1, 246 square kilometers while the total population is more than 150, 489 people (NPC, 2006).

Illela LGA is characterized by 3-4 months of rainfall, from June to September or October and 7-8 months of dry season from October to May. The climate of the State is largely control by two opposing air masses, the moist tropical maritime from the north, across Sahara, which is dry and dusty and brings harmattan (Mbagwu, and Obi, 2003). Evaporation and transpiration are high as a result; the zone is prone to strong moderate drought risk (English, 2008). The people are pre-dominantly Hausa by tribe and practice Islam as their main religion. The major economic activities of the people include farming, petty trading, agro-processing etc. the major crops grown include onion, tomatoes, sweet potato, carrot, rice, wheat, millet, garden egg etc. animals reared include cattle, sheet, sheep, goat, donkey, camel, horses and poultry. (SMANAR, 2008).

This study targeted Illela LGA of Sokoto State Nigeria because it is among the most affected LGAs by land degradation in the State. A two-stage sampling procedure was used to obtain the sample for this study. In the first stage 4 out of 11villages were purposively selected from the LGA due to their higher level of land degradation. They are Gidan-Hamma, Kalmalo, Gidan-Katta and Araba. In the second stage, 113 farmers out of 1129 were randomly selected from the 4 villages to give the study sample. Data for this study were collected with the use of structured questionnaire administered to the respondents. The data were analyzed using descriptive statistical tools such as mean, frequencies, percentages and Likert scale.

RESULTS AND DISCUSSION

Table 1 revealed that the entire respondents (100.0%) were aware of land degradation in the area. About 58.4% of the respondents were aware of the land degradation for 11-20 years, while 27.4% for 1-10 years and13.3% for 21-30 years. The high level of awareness may have resulted from various campaigns and sensitization of the farmers on land degradation menace by the State Government especially through the Agricultural Development Programmes and other concerned stakeholders. The implication is that all the farmers in the State were exposed to various innovations and methods of farming to boost their food production and therefore help to reduce the incidence of degradation in the area. This result is in line with the work of Okezie and Amaefula (2006) who reported that majority of the farmers in his study area were aware of land degradation.

Table 1: Distribution of respondents according to awareness of land degradation (n=113)

Awareness	Frequency	Percentage	Mean
Aware	100	100.0	
Not aware	0	0.0	
Awareness Period (years			
1-10	31	27.4	
11-20	66	58.4	
21-30	16	13.3	16.33

Source: Field survey 2019

Sources of information on land degradation

Table 2 showed that majority (76.0%) of the respondents got information on land degradation through extension agents, while 24.0% got their information through family and friends. The result implies that extension agents were the major sources of information on land degradation to the farmers. This study is in line with that of Umahi (2014), who reported that majority of the farmers in his study area got their information about land degradation through contact with extension agents.

Table 2: Distribution of Respondents according to sources of information on land degradation (n=126)

Source	Frequency	Percentage
Family and friends	30	24.0
Extension agents	96	76.0

Source: Field survey 2019. *Multiple responses by the respondents

Farmers Attitudes toward Land Degradation

The findings further revealed that the most positive attitude of the respondents was on the belief that land degradation is a natural occurring phenomenon ($\bar{X}$= 4.91), closely followed by the belief that land degradation had negative effect on crop production ($\bar{X}$= 4.85). They also believed that land degradation had effect on their incomes ($\bar{X}$= 4.75) and was accelerated by over cultivation of farmland ($\bar{X}$= 4.32). This implies that farmers in the study area believe that land degradation is a natural occurring phenomenon (Table 3). This result is contrary to the finding of Onyerika (2016), who stated that farmers in his study area belief that land degradation is a man-made occurring phenomenon. It indicates that farmers in the area have a positive attitude to land degradation which can make it easier to take reclamation measures of degraded farmlands.

Table 3: Distribution of Respondents according to their attitudes toward land degradation observed

Attitudinal statement	Mean	Rank
Land degradation is a natural occurring phenomenon	4.91	1
Land degradation is a man-made occurring phenomenon.	3.61	7
Rapid population growth leads to land degradation.	3.73	6
Land degradation is mostly affected by rural population.	4.17	5
Land degradation has negative effect on crop production.	4.85	2
Land degradation has negative effect on farmers income.	4.75	3
Over cultivation accelerate land degradation	4.32	4

Source: field survey, 2019

CONCLUSION

Based on the study findings, it is concluded that farmers in Illela LGA of Sokoto State were aware of land degradation. They also had a positive attitude on land degradation, which could make it easier for mobilizing them to take measures in reclaiming the degraded farmlands. Based on the findings of the study, it is recommended that extension workers in the area should sustain campaigns and sensitization about land degradation menace in the area. The extension workers, in addition to media houses should be used by all stakeholders (Government, Non-governmental and Community based Organizations) in educating the farmers on measures for reclamation of the degraded farmlands.

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Trend and Pricing Strategies of Sweetpotato Seed Demand in Umudike, Abia State

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ABSTRACT
This paper provides empirical information on the trend analysis and pricing strategies of sweet potato seed demand in NRCRI, Umudike, Nigeria within the months of March to October, 2020. Purposively, the study sampled all the customers that sourced seeds from the Institute within the study frame time with the use of structured questionnaire. Descriptive statistics were used to describe the socio-demographic features of respondents; identified the types of sweetpotato seed varieties demanded, trend of seed demand and perception on pricing strategy. Pricing strategies matrix was used to estimate the effect of PS on the quantity demanded. The study showed that majority (68.40%) of the respondents demanded orange fleshed sweetpotato (OFSP) other than white fleshed sweetpotato (WFSP) (25.40%) and yellow fleshed sweetpotato (YFSP) (6.14%). The study recorded the highest quantity of sweetpotato seed demanded in May (1310 bundles), 827 bundles in July, 476 bundles in June and 393 bundles in April. Many (51.80%) of the respondents were not aware of the Institutes' sweet potato pricing strategy and this led to about 2 or 3 customers that benefited from early and advanced payment, while 21, 4 and 81 customers (farmers) benefited from immediate order cash payment strategy on bulk order, medium order, and few order respectively. Majority (73.0%) of the farmers did not increase the quantity of seed demand, even though they were aware of the pricing strategy. The study therefore calls for sweetpotato seed production stakeholders to plan in time to ensure availability of seeds at the right time and also cue in to benefit from the Institutes' pricing strategy particularly on early order offer.
Keywords: Beneficiaries, Variety, Price, Time and Quantity

INTRODUCTION

The need to understand the trend of sweetpotato seed demand and build on or improve current practices of seed distribution system among seed entrepreneurs becomes crucial. To encourage farmer/entrepreneur-based seed systems and strengthen linkages to sources of seed, new varieties, disease-free planting material, knowledge and skills on agronomic practices, there is need to understand the price-demand behavior of sweetpotato seed among other factors that influence seed demand. According to Mohamed *et al.* (2013), demand is the rate at which consumer is willing to buy a product. It is a price and quantity relationship. It tells the quantity of a product that will be sold at various price levels. An efficient marketing is usually guided by the forces of demand; this implies that the amount of any commodity consumed at any time is a function of the interaction of demand and supply through price mechanism. The success of any business depends not only on adoption of improved technologies but also on the ability to sustain the business through detailed knowledge of demand structure and as well the trend of demand/sales. National Root Crops Research Institute (NRCRI), Umudike, has national mandate to research into the genetic improvement and value chain of sweetpotato; initiated scientific measures to ensure continuous availability of different classes of sweetpotato seed (of all released varieties) all year round on a revenue basis. NRCRI also have developed capacity of cluster of decentralized vine multipliers (DVMs) in almost all the States where seed production technologies were extended to ensure clean planting materials for improved and enhanced yields. This group of farmers and others get quality seed (certified) from NRCRI for subsequent and continuous production. As well, in other to encourage quantity demand and supply, the Institute also developed pricing strategies for seed customers where discounts were made based on certain criteria. However, this study analysed trend of demand and also effect of pricing strategies on the demand for sweetpotato seed among farmers that sourced seeds from NRCRI, Nigeria.

METHODOLOGY

The study was carried out in NRCRI, Umudike, Nigeria within the months of March to October, 2020, where sales were recorded. Structured questionnaire was used to collect data purposively from all customers who come to buy seed from the Institute using direct contact and/ online survey for those that purchased through proxy to capture all individual opinion on the subject. Descriptive statistics (such as frequency, percentage and mean, charts and graphs) were used to describe the socio-demographic features of the respondents, identify the types of sweetpotato seed varieties demanded from the Institute, period and trend of seed demand and perception on pricing strategy. To determine the effect of pricing strategies on the quantity demanded, pricing strategies matrix was used following Okoye and Njoku (2017) specified in the Table 1.

Table 1: Pricing Strategies Matrix on Sweet Potato Seed by NRCRI

Pricing Strategy	Early order and advanced payment (2 months)	Immediate order and cash payment
Bulk order (100 bundle and above)	30% discount of ₦500/bdl	20% discount of ₦500/bdl
Medium order (40-99 bundles)	15% discount of ₦500/bdl	10% discount of ₦500/bdl
Few order (1-39bundle(s))	10% discount of ₦500/bdl	No discount (₦500/bdl)

Source: Okoye and Njoku (2017)

RESULTS AND DISCUSSION

Socioeconomic Characteristics of the Respondents

The results in Table 2 show the socio-economic characteristics of the respondents. The data were analyzed using 114 respondents that made demand for sweetpotato seed from NRCRI within the period (March to October, 2020) of the study. The study estimated an average age of the respondents as 40.97 years, indicating that the respondents are young, and agile. The empirical result supports the study of Olagunju *et al.* (2013) who noted that sweetpotato production is dominated by younger farmers. Hence, younger farmers tend to take more risk more than their aged counterparts (Adesina and Zinnah, 2015). The average years of level of education (15.96 years) implies that the farmers are educated. Basic education enhances the overall quality of the farmer by providing them with basic numeric and literacy skills (Okoye *et al*., 2020). An average farming experience of 2.9years in sweetpotato production, with land holdings of 0.44 hectare and household size of about 5 persons indicated few numbers of years of experience in sweetpotato production, small farm holding with an average household size. Many (57.0%) of the respondents were male farmers, married (93.9%), few (21.9%) belong to cooperative organizations and also access to extension contact (15.8%). Being married have advantage since the spouse and children serve as major sources of labour as they lend a helping hand in farms and play major roles in production (Okoye *et al*., 2020). Farmers who do not belong to cooperative organizations or have access extension services were sometimes denied of relevant agricultural information. However, such networks ensure cooperation among farmers in the use of scarce and communal resources.

Sweet Potato seed Variety Type demanded (NRCRI)

The results in Figure 1 show the percentage distribution of sweetpotato seed varieties demanded from NRCRI. The results showed that majority (68.40%) of demand for sweetpotato seed (SPS) were OFSP type other than the WFSP (25.40%) and YFSP (6.14%) types. This showed that there was a high demand of OFSP from the Institute than other variety types, probably due to certain attention and promotion in the use and consumption of OFSP roots in combating Vitamin A deficiency, following Mitra (2012).

Demand Trend (March-October, 2020)

The result in Figure 2 shows the trend distribution of quantity demanded of sweetpotato seed (from NRCRI) within the months of March through October, 2020. The result recorded the highest quantity of SP (sweetpotato) seed demanded on May (1310 bundles), followed by 827 bundles in July, 476 bundles in June and 393 bundles in April. This confirmed the planting season of most farmers in the South-East and South-South regions due to the regularity of the rains within the period of May through June. However, the study also recorded low (26, 17, 9 and 8 bundles) demand and supply of SP seed within the months of September, August, October and March respectively.

Pricing strategies

The result in Figure 3 shows the level of awareness among SP seed customers on NRCRI sweetpotato seed pricing strategy. The result shows that many (51.80%) of the respondents were not aware of the Institutes' sweetpotato pricing strategy when compared to 48.02% that were aware. The average number of customers that were aware and thus indicated interest to benefit in the pricing strategy was those that sourced seed from the Institute in the past. The result in Table 2 shows the matrix distribution of farmers' that benefited in sweetpotato seed pricing strategy in 2020. The result found that only about 2 (bulk order of 100 bundles and above) or 3 (few order of 1-39 bundles) farmers ordered for early and advanced payment (2 months), while 21, 4 and 81 customers (farmers) benefited from immediate order and cash payment strategy on bulk order, medium order and few order respectively. This implies that majority of the farmers do not benefit from the pricing strategy, probably because they were not aware or do not have production plan to benefit maximally from early order special offer.

Perception of customers on Pricing Strategy

The result in Figure 4 shows the perception of customers on sweetpotato pricing strategy. The study shows that majority (73.0%) of the farmers do not increase the quantity of SP seed demand, even though they were aware of the pricing strategy. This may be probably due to other factors affecting demand other than price. Furthermore, 52.11% of the farmers do not prefer the price offer, while 47.90% were okay with the price. The study also found an average of preferable price rate of N250/bundles for sweetpotato seed among the farmers were agitating for the price consideration.

CONCLUSION

The studies found that majority of varieties demanded by the customers were the orange fleshed variety. The demand trend result shows that most of the demands were made in April through July with peak in May. Many of the customers were not aware of the Institutes' pricing strategy and therefore do not benefit from the early order and advance payment special discount offer. Many of the customers indicated that the pricing strategy does not have effect on the increase in quantity demanded. The study therefore, call for efforts on sweetpotato seed production units and other seed entrepreneurs' to emphasize more on the production of OFSP varieties, since it commands more demand and also ensure continuous promotion of other varieties to sustain the system. More so, seed entrepreneurs are advised and encouraged to plan sweetpotato seed production ahead of time to ensure availability by April through July, especially at the peak demand on May. The planning will also expose them to benefit from the the Institutes' pricing strategy, particularly on early order offer.

Table 2: Socio-Economic Characteristics of the Respondents

Socio-economic variables	Minimum	Maximum	Mean	Std. Dev
Age	28.00	60.00	40.9735	7.8869
Education	12.00	16 .00	15.9649	0.2637
Farming experience	0.00	20.00	2.8593	4.0884
Hectare	0.05	1.4	0.4437	0.6414
Household size	1.00	10.00	4.87	2.1318
Dummy (%)				
Gender (male)	57.0			
Marital status (married)	93.9			
Membership of cooperation (yes)	21.9			
Extension contact (yes)	15.8			

Source: Field survey, 2020

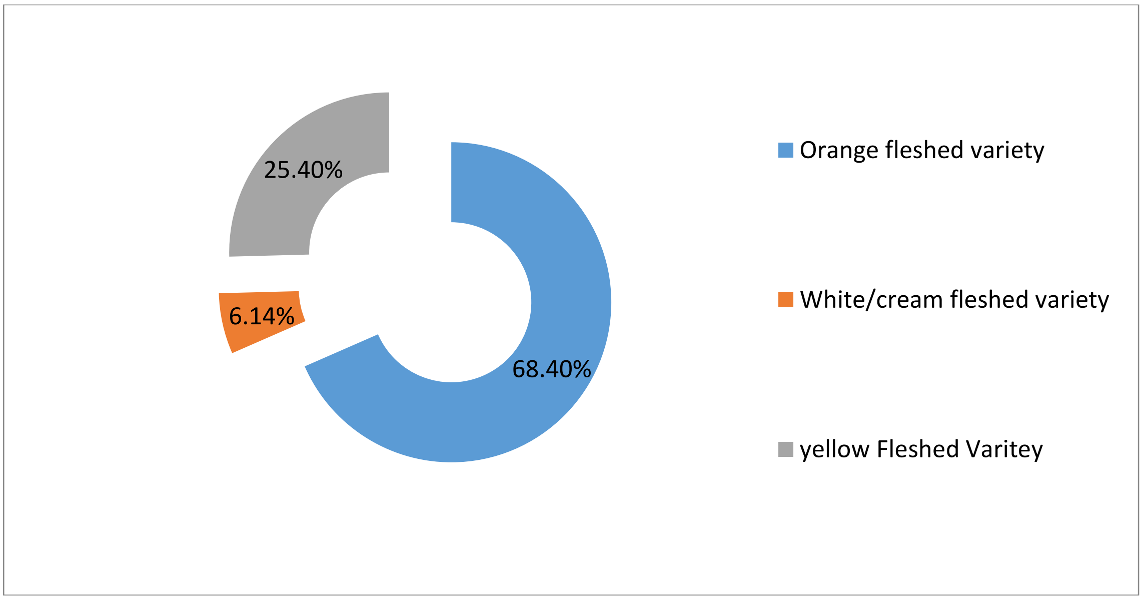


Figure 1: Percentage distribution of sweet potato seed variety demand from NRCRI

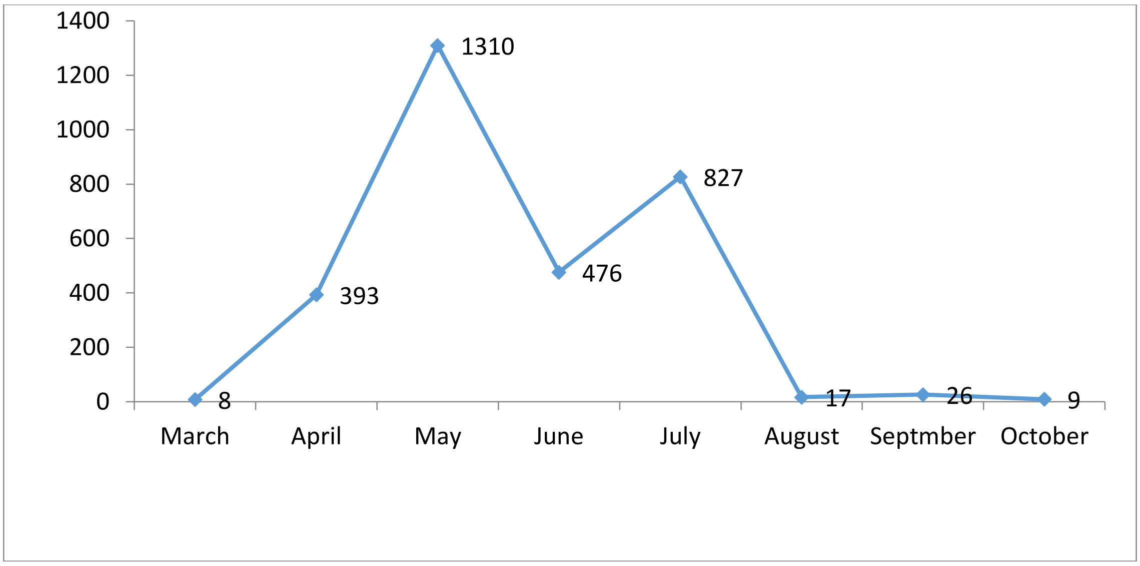


Figure 2: Trend in quantity of SP seed demand from March to October, 2020

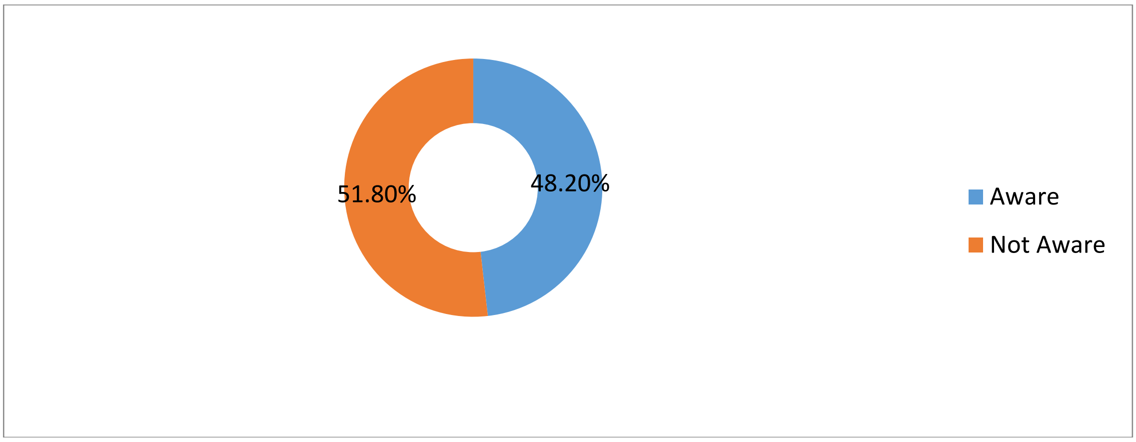
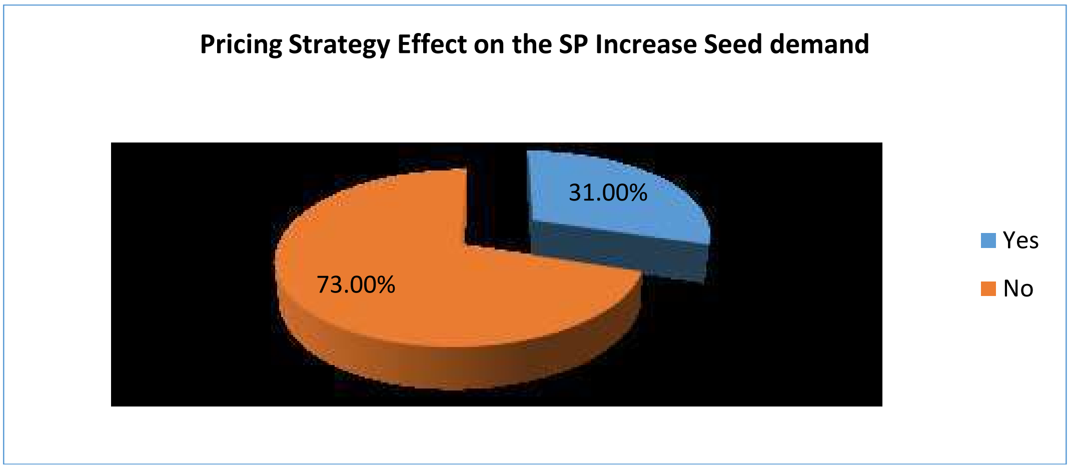


Figure 3: Percentage distribution of respondents according to the level of Awareness of SP seed Customers on NRCRI SPS pricing strategy

Table 3: Matrix Distribution of Farmers' Beneficiaries on pricing strategy on Sweet potato Seed

Pricing Strategy (order)	Early order and advanced payment (2 months)	Immediate order and cash payment
Bulk (100 bundle and above)	2	21
Medium (40-99 bundles)	0	4
Few (1-39bundle(s))	3	81

Source: Field Survey, 2020



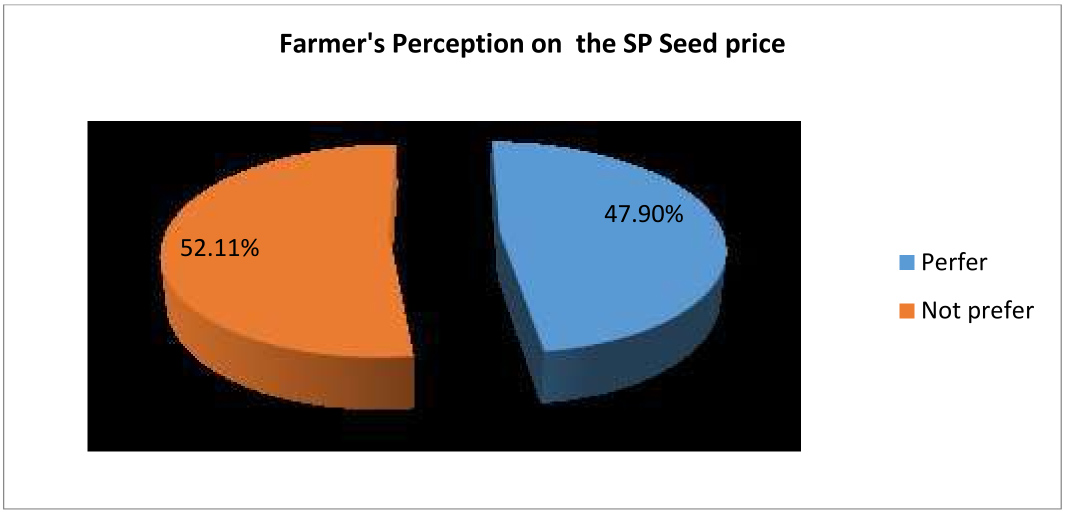


Figure 4: Perception of customers on pricing strategy
***Preferred price of SP seed by famers = N250/bundle**

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Determinants of Agricultural Products Value Chain Actors' Use of Electronic Banking Platforms in Accessing Savings Closure in Southeast Nigeria

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ABSTRACT

This study focused on analyzing the determinants of agricultural products value chain actors' use of e-banking platforms in accessing savings closure in Southeast Nigeria. Specifically, the study described the socioeconomic characteristics of the agricultural products value chain actors; ascertained their level of use of e-banking platforms in advancing access to savings closure; correlated the relationship between the use of e-banking platforms and access to savings by actors in agricultural products value chains, estimated the determinants of use of e-banking platforms in accessing savings by agricultural products value chain actors and examined the motivating factors for the use of -banking platforms in accessing savings by agricultural products value chain actors in the study area. A multistage random sampling technique was adopted in selecting a total of eighty (80) respondents used in the study. Primary source of data was used for the study. Data for the study was obtained using structured questionnaires and personal interviews. Data obtained were analyzed using both descriptive statistics such as frequency distribution, percentages, and means as well as econometric tools such as Pearson product moment correlation and probit regression technique. Finding showed that majority of the agricultural products value chain actors are males (62%), married (55%), had tertiary education (40%), owned certificate of business registration (70%), belonged to a cooperative society (72%), uses social media (63%) and saves their money in the bank (97%). E-banking application platform was identified as the most used platform for accessing savings by these actors. In addition, e-banking apps, Quickteller and ATM services had a strong correlation with access to savings by agricultural products value chain actors at 1%, 1% and 5% levels of significance. Sex, age, level of education, membership of co-operation, target market, time saving, easy business transactions and access to internet facilities significantly determined the use of e-banking platforms by agricultural value chain actors in the study area. The study recommends that agricultural products value chain actors receive ongoing training on how to use e-banking platforms to access their saved money, as this will increase their access to other financial services that are necessary to keep their enterprises sustainable.
Keywords: Electronic banking Platforms, access to savings, agricultural products value chain actors, Southeast Nigeria

INTRODUCTION

There have been various recent developments in the global business environment, but none has had such a significant impact on business-like technical innovation efforts. Although technological innovation has impacted every industry, its revolution and impact in the banking industry is particularly concerning (Oteh *et al*., 2017). With an enhanced platform rooted on an electronic system, technology has reengineered bank service delivery to a whole new level (Ayuba and Aliyu, 2015). This has made it easier for consumers to manage their finances, have access to their accounts without having to go to the bank, and has sparked digital finance management, resulting in enhanced financial inclusion and customer experience.

Furthermore, technology has bolstered agricultural service and financial intermediation through various financial technology companies, allowing many agribusinesses and entrepreneurs to access investment, growth, and satisfy the demands of the world's increasing population in desperate need of food. Technology has made it easier for organizations and individuals to take and make financial decisions on complex operations; it has also shifted control to customers, making it impossible for banks to regulate client choices and preferences. One of the most significant outcomes of financial innovation is the virtually endless conveniences it provides clients in terms of accessing financial data and improving corporate efficiency. In contrast, the development of electronic banking systems has changed and redefined how banks operate, as the need to lower both operational and administrative costs has driven banks to the electronic world; however, cost reduction is only possible if consumer usage increases (Shankar and Rishi, 2020; Ugwuja and Onavwie, 2019; Ugwuja *et. al*., 2017).

Electronic banking (e-banking) system undoubtedly provides a more efficient and fastest way to increase access to financial services and other range of value-added services (Shankar and Rishi, 2020), given that financial services is not present in many parts of Nigeria due to several factors such as infrastructural facilities and security concerns, but it mostly hinders by factors such a financial illiteracy, and others concerns such as security and protection perceptions among Nigerians. This reflects the going realities of agripreneurs in many rural economies. Evidence has shown that many agripreneurs are poor resource farmers and lacks financial literacy. As such recent developments to improve financial inclusions are unknown to them. This no doubt reflects the growing consensus that adoption is a function of one's socio-economic profile. For instance, Oteh *et al*., 2017), established there exist a link between demographic factors and adoption of e-banking platforms. Beside this, adoption is a function of other factors and have been highlighted by different researchers to include unreliable electronic communication infrastructure, poor public perception, inadequate facilities, poor internet security, incidence of fraud, low telecommunication penetration and other infrastructure (Ayuba and Aliyu, 2015; Xu *et al*., 2020; Asongu *et. al*., 2018; Gosavi, 2018; Shankar and Rishi (2020). Other studies have shown that poor awareness of e-banking transaction platforms, social influences and poor knowledge of technology hinders adoption (Ugwuja and Onavwie, 2019; Abor, Amidu and Issahaku, 2018). These challenges are partly responsible for the exclusion of bankable adults in most developing countries from financial services with several far reaching economic and social implications

Looking forward, the above issues serve as pull and push factors and will continue to provide basis to assess progress in advancing policies to change financial access and digital financing. Studies such as Oteh *et al*. (2017) has examined the twin issue of usage and adoption for general bank consumers but in recent time, there has been development in agricultural financing opportunities through financial technology companies. The impact on business has been alarming and interesting. Interesting because its open conversations around new realities in mobilizing resources for agricultural investment and opportunities for farmers to save and invest. In this study, examine how adoption of e-banking platforms by agripreneurs is increasing their investment and other opportunities such as propensity to save. Our interest is to present a narrative and compare how electronic connection between bank and agripreneurs is assisting their financial management especially financial control. According to Ayuba and Aliyu (2015), electronic connection between the bank and the customer in order to prepare, manage and control financial transactions. Such control and management are necessary if agripreneurs are to increase their capacity to meet the projected food supply before 2050. Therefore, this study sought to determine the various factors that influenced agricultural products value chain actors' use of e-banking platforms in improving savings in Southeast Nigeria. Specifically, the study described the socioeconomic characteristics of the agricultural products value chain actors; ascertained their level of use of e-banking platforms in advancing access to savings closure; correlated the relationship between the use of e-banking platforms and access to savings by actors in agricultural products value chains, estimated the determinants of use of e-banking platforms in improving access to savings by agricultural products value chain actors and examined the motivating factors for the use of -banking platforms in accessing savings by agricultural products value chain actors in the study area. The study hypothesized that there is no relationship between use of e-banking platforms and access to savings among agricultural products value chain actors.

METHODOLOGY

The study was carried out in Enugu state, Nigeria. A multistage sampling technique was used to sample the respondents. In the first stage, three (3) Local Governments Areas (LGAs) from the state were selected namely Udi, Igboeze North and Igboeze South LGAs. The second stage involved a random selection of 2 communities each from the LGAs. This gave a total of six (6) communities used for the study. The third stage involved the selection of 2 villages from each of the communities and this gave a total of 12 villages sampled for the study. The last stage involved the selection of seven (7) respondents from each of the villages, and this gave a total sample of 84 respondents. Data for the study was obtained using structured questionnaires and personal interviews. Data collected included financial inclusion questions on ownership of bank account, status of Bank Verification Number (BVN) registration, ownership of savings account, amount saved monthly, household, personal and farm level characteristics. Data obtained were analyzed using both descriptive statistics and inferential statistics. socioeconomic characteristics of the agricultural products value chain actors was analyzed using descriptive statistics such as frequency distribution, percentages, and means. The level of use of e-banking platforms in advancing access to savings closure was analyzed using a mean score. The item statements were rated on a five-point Likert rating scale of very often = 5, Often = 4; low use = 3, very low use = 2 and not use =1. To calculate the mean score using the five-point rating scale, a midway (decision cut-point) was calculated by summing the weights of the rating scales (5+4+3+2+1), which equaled 15 points, and then divided the total point by 5 to get a mean score of 3.00. Mean responses of ≥ 3.00 implied use of a given e-banking platforms while values < 3.00 implied non-use of a given e-banking platforms.

The relationship between the use of e-banking platforms and access to savings by actors in agricultural products value chains were correlated using Pearson product moment correlation technique. The determinants of use of e-banking platforms in accessing savings by agricultural products value chain actors was estimated using ordered probit regression model. The motivating factors for the use of e-banking platforms in improving savings by agricultural products value chain actors in the study area was analyzed using mean score. The item statements were rated on a five-point Likert rating scale of strongly agree =5, Agree = 4; Indifference = 3, Disagree = 2 and Strongly disagree =1. To calculate the mean score using the five-point rating scale, a midway (decision cut-point) was calculated by summing the weights of the rating scales (5+4+3+2+1), which equaled 15 points, and then divided the total point by 5 to get a mean score of 3.00. Mean responses of ≥ 3.00 implied motivated to use e-banking platform while values < 3.00 implied not motivated to use e-banking platform.

The ordered probit regression model used to estimate the determinants of use of e-banking platforms in improving access to savings closure by agricultural products value chain actors is specified as:

$$Q_{i=0,1,\ldots,4} = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12} + \beta_{13}X_{13} + e_i \quad (1)$$

Where,

Q_i = Use of e-banking platforms by agricultural value chain actors (i is stance for e-banking platforms where Banking codes = 0, Banking apps = 1, Quickteller = 2, ATM services = 3, Point of sale = 4)

X_1 = Sex (male = 1, female = 0)

X_2 = Age of respondents (years)
X_3 = Marital status (Married = 1; Unmarried = 0)
X_4 = Level of education (Years)
X_5 = Type of business (Crop = 1; Otherwise = 0)
X_6 = Co-operative membership (Yes = 1; No = 0)
X_7 = Business registration (Yes = 1; No = 0)
X_8 = Targeted market location (Rural = 1; Urban = 0)
X_9 = Time savings (Yes = 1; No = 0)
X_{10} = Safety to use (Yes = 1; No = 0)
X_{11} = Ease of business transactions (Yes = 1; No = 0)
X_{12} = Facilitate evidence-based payment ((Yes = 1; No = 0)
X_{13} = Internet facilities (Access = 1; No access = 0)
β_0 = Intercept
$\beta_1 - \beta_{13}$ = Estimated parameters
e_i = Error term.

The bivariate Pearson Product Moment Correlation (PPMC) Coefficient (r) statistic is given as:

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{n(\sum x^2) - (\sum x)^2}\sqrt{n(\sum y^2) - (\sum y)^2}} \quad (2)$$

Where,
r = correlation coefficient;
n = number of pairs of data;
$\sum xy$ = sum of the product of paired scores;
$\sum x$ = sum of the agricultural value chain actors using e- banking;
$\sum y$ = sum of the agricultural value chain actors' access to savings;
$\sum x^2$ = sum of squared of the agricultural value chain actors using e-banking;
$\sum y^2$ = sum of squared of the agricultural value chain actors' access of savings.

RESULTS AND DISCUSSION

Socioeconomic characteristics of agricultural value chain actors

The socio-economic characteristics of the respondents were summarized in Table 1. The majority of the respondents (38.8%) were between the ages of 21 and 30, with only 7.5 percent (7.5%) over the age of 40. The respondents' average age was 48.9 years, indicating that the majority of them are still in their working years and may economically contribute to the growth of agricultural value chains by using modern saving technologies such as e-banking platforms. This could be owing to their knowledge of how to use the internet and other ICT technologies. This finding is in line with Paddachi *et al*. (2005)'s observation that the younger the generation, the more likely they will be accustomed to new technology breakthroughs than the older generation. Arable crop producers were the most common among the respondents, accounting for 57.5 percent, while livestock agripreneurs accounted for 42.5 percent. Males have a somewhat higher ratio than females, according to the findings. The study found that males made up 73.8 percent of the respondents, while females made up 26.3 percent. This finding is supported by Abor *et al* (2018), who found that men use e-banking more than women. With 55.0 percent of the respondents being married, and 45.0 percent being single, married people were the most common. Individuals who were members of a cooperative society dominated the poll, accounting for 97.5 percent of all respondents. According to the education statistics, 15.0 percent had received primary education, 57.5 percent had received secondary education, and 27.5 percent had received tertiary education, indicating that the respondents have received formal education and are thus predisposed to understand the use of e-banking platforms and how they operate in advancing savings for the furtherance of their business.

Table 1: Distribution of agricultural value chain actors' socio-economic profile (n = 80)

Socio-economic characteristics	Frequency	Percentage	Mean
Age (years)			**48.9**
21-30	31	38.8	
31-40	6	7.5	
41-50	22	27.5	
51-60	11	13.8	
60 and above	10	12.5	
Type of business			
Livestock production	34	42.5	
Arable crop production	46	57.5	
Sex			
Male	59	73.8	
Female	21	26.3	
Marital Status			
Married	44	55.0	
Single	36	45.0	
Membership of co-operation			
No	2	2.5	
Yes	78	97.5	
Education qualification			
Primary education	12	15.0	
Secondary education	46	57.5	
Tertiary education	22	27.5	
Business registration			
Yes	56	70.0	
No	24	30.0	
Target market			
Urban area	70	87.5	
Rural area	10	12.5	
Use of social media (Virtual)			
Yes	50	62.5	
No	30	37.5	
Monthly saving level			**21,276.38**
≤ 20,000	38	47.5	
20,001-40,000	20	25.0	
40,001-60,000	16	20.0	
≥ 60,000	6	7.5	
Use of e-banking platform			
Yes	80	100.0	
Household size			**5.62**
1-3	21	26.3	
4-6	46	57.5	
7-9	10	12.5	
10 -12	3	3.8	

Source: Field survey data, 2020

The study also found that more than half of respondents (70.0 percent) registered their businesses, with the remaining 30.0 percent not doing so. Respondents who sell their products to urban markets were the most prevalent in the study, accounting for 87.5 percent of the total, while respondents who sell to rural markets accounted for the remaining 12.5 percent. The majority of urban market targeting respondents should be required to use e-banking systems effectively to facilitate business financial transactions and savings. The respondents who virtually utilize social media for their business were the most prevalent in the study, accounting for 62.5 percent of the total, while those who do not use social media accounted for 37.5 percent. The respondents' average monthly savings was ₦21,276.38. The respondents who save less than ₦20,000.00 monthly were the most prevalent in the survey, accounting for 47.5 percent of the total, followed by 25.0 percent who saved up to ₦40,000.00 monthly and 7.5 percent who saved at least ₦60,000.00 monthly. The amount saving done by the respondents is not so large monthly and thus encourages the use of e-banking platforms in saving the cash monthly. This is important as most of the respondents does this as a way of avoiding the long queue in most banking halls which may discourage accessing savings. The respondents who used e-banking applications in savings were the most dominants with a percentage of 47.5% while 15.0% of the respondents used Quickteller for their savings. Around 58 percent of the respondents had a family size of 4-6, 26.3 percent had a family size of 1-3, and 3.8 percent had a family size of 10-12, indicating that the family size of 4-6 was the most prevalent in the study area and hence had the highest frequency.

Level of use of e-banking platforms in accessing savings closure

The mean responses of the agricultural value chain actors on their level of use of e-banking platforms in accessing savings closure is presented in Table 2.

Table 2. Mean responses of the agricultural value chain actors on their use of e-banking platforms in accessing savings closure (n= 80)

S/n	E-banking platform	Use Very often	Use Often	Use rarely	Use very rarely	Not use	Mean	Standard deviation	Remark
1	ATM services	48	25	2	1	4	4.40	1.294	Used
2	Banking apps	17	23	31	1	8	3.50	0.584	Used
3	Banking codes	3	7	31	20	19	2.44	0.396	Not used
4	Point of sale	4	5	12	52	7	2.34	0.483	Not used
5	Quickteller	50	9	12	3	6	4.18	1.114	Used
	Grand mean						3.37	0.770	Used

Source: Field survey data, 2020. Decision cut-point mean = 3.00

The result shows that the grand mean score of the responses of the respondents on their use of e-banking platforms for savings was 3.37 and is higher than the decision cut-point mean score of 3.00. This implies that on the average, the respondents used e-banking platforms in advancing accessing to their savings in the study area. Three (3) out of the five (5) items on Table 2 have mean score that is above 3.00 on a 5-point rating scale. This indicates that the respondents accepted items No.1, No.2 and No.5 which boarders on agricultural value chain actors on their use of e-banking platforms. This means that agricultural value chain actors in the study area employed e-banking platforms to advance access to their savings, such as Automated Teller Machine (ATM) services, Banking applications, and Quickteller. As a result, ATM services, banking apps, and Quickteller services are the most commonly used e-banking platforms by respondents for preserving their earnings in order to keep their business going. The respondents' frequent usage of ATM services, Banking apps, and Quickteller services could be owing to the ease with which these e-banking platforms are accessible, easy to use, understand, and save time when compared to other e-banking platforms. This finding validates Marhana (2012) that consumers view e-banking as better than branch banking because it saves time, reduces transfer costs, and that transactions can be carried out from home.

The level of use of e-banking platforms in accessing savings by agricultural value chain actors, as shown in Table 3, revealed that 62.5 percent of the respondents use e-banking platforms in accessing savings, followed by 25.0 percent who use e-banking platforms moderately, and those who use e-banking platforms inaccessibly accounted for the remaining 22.5 percent. This indicates that agricultural value chain actors in the study area make extensive use of e-banking platforms to access savings.

Table 3: Level of use of e-banking by agricultural value chain actors

Variables	Frequency	Percentage
High	42	52.5
Moderate	20	25.0
Low	18	22.5
Total	80	100.0

Source: Field survey data, 2020

Relationship between use of e-banking platforms and access to savings

The result of the Pearson product moment correlation coefficient of the relationship between use of e-banking platforms and access to saving by agricultural value chain actors in the study area is presented in Table 4 below.

Table 4: Pearson correlation coefficient of the relationship between use of e-banking platforms and access to saving by agricultural value chain actors

Variables	N	r	P-value	Sign
Banking codes	80	0.0397	0.7713	Ns
Banking apps	80	0.7586	0.0004	***
Quickteller	80	0.7054	0.0019	***
ATM services	80	0.7809	0.0010	***
Point of sale (POS)	80	0.6517	0.0243	**

Source: Field survey data, 2020. *** = Correlation is significant at the 0.01 level (2-tailed); ** = Correlation is significant at the 0.05 level (2-tailed); ns = not significant.

The result in Table 4 showed that there was a positive correlation existed between the use of banking applications and access to savings by agricultural value chain actors with a correlation coefficient of 0.7586, which is significant at 1% level. The Pearson correlation coefficients were between the range of 0.70 - 0.90 which is taken to imply the existence of a high (strong) correlation between two variables as stated by Ekwueme (2018). Therefore, the result indicated that a significant strong correlation exists between the use of banking applications and access to savings by agricultural value chain actors, an indication that increase in the use of banking applications and increased access to savings by agricultural value chain actors. Additionally, there was a positive correlation between the use of Quickteller and agricultural value chain actors' access to savings (with a correlation coefficient of 0.7054, which is significant at the 1% level), the use of ATM services and agricultural value chain actors' access to savings (with a correlation coefficient of 0.7809, which is significant at the 1% level), and the use of Point of Sale (with a correlation coefficient of 0.7809, which is significant at the 1% level) (with a correlation coefficient of 0.6517, which is significant at 5 percent level). According to Ekwueme (2018), Pearson correlation coefficients that ranged from 0.70 to 0.90 implies a high (strong) correlation between two variables while 0.41 to 0.69 implies a moderate correlation between two variables. As a result, the findings revealed that there is a significant strong correlation between the use of Quickteller and access to savings, as well as ATM services and access to savings by agricultural value chain actors, while the use of Point of Sale (POS) and access to savings by agricultural value chain actors has a moderate correlation. This presages that the use of Quickteller, ATM services and Point of sale (POS) is associated with access to savings among agricultural value chain actors in the study area. Therefore, the null hypothesis that there is no significant relationship with use of e-banking platforms and access to savings by agricultural value chain actors in southeast Nigeria is not upheld rather the alternative hypothesis that there is a significant relationship with use of e-banking platforms and access to savings by agricultural value chain actors in southeast Nigeria was accepted.

Determinants of use of e-banking platforms by agricultural value chain actors

The result of the ordered probit regression estimate of the determinants of e-banking platforms by agricultural value chain actors is presented in Table 5. The result shows that the log likelihood value of -179.31 indicates that the explanatory variables used in the ordered probit regression model are appropriate. The Chi-squared of 239.58 was significant at 1% level and shows that at least one of the parameters of the variables included in the ordered probit regression model for estimating the determinants of the use of e-banking platforms by agricultural value chain actors is different from zero. This means that the null hypothesis that all parameters equal to zero in the model is rejected.

Table 5: Ordered probit regression result of the determinants of use of e-banking platforms by agricultural value chain actors in the study area

Variables	Coefficient	z-ratio	Marginal effects				
			Prob. (Q = 0)	Prob. (Q = 1)	Prob. (Q = 2)	Prob. (Q = 3)	Prob. (Q = 4)
Sex	-0.37	-2.571**	-0.029	0.008	0.034	0.016	0.022
Age	-0.54	-2.488**	-0.023	-0.018	-0.029	0.011	0.017
Marital status	0.74	0.350	0.038	0.061	0.020	0.017	0.029
Level of Education	0.88	3.527***	0.027	0.039	0.042	0.031	0.048
Type of business	0.15	-0.762	0.063	-0.021	-0.029	-0.014	0.016
Membership of co-operation	0.23	2.897***	-0.025	0.043	-0.014	0.061	0.022
Business registration	0.14	-1.175	-0.012	-0.038	-0.041	0.027	-0.011
Target market	0.48	2.629**	0.044	-0.015	-0.028	0.042	0.055
Time saving	1.73	3.682***	0.076	0.029	0.019	-0.018	-0.041
Safety of use	0.13	-0.528	-0.024	0.016	-0.011	0.032	-0.013
Easy business transactions	1.03	4.624***	0.066	0.018	0.025	-0.015	0.051
Facilitate evidence-based payment	0.34	1.665	-0.033	-0.055	0.043	0.012	-0.046
Access to Internet facilities	0.69	3.414***	0.068	0.033	0.049	-0.056	-0.037
Constant	1.40	6.083***					
Pseudo R^2	0.76						
LR $Chi^2(13)$	239.58***						
No of observation	80						
Log likelihood	-179.31						

Source: Field survey data, 2020. ** Significant at 5% level; *** Significant at 1% level

Sex, age, level of education, membership of co-operation, target market, time saving, easy business transactions and access to internet facilities were the significant determinants of the use of e-banking platforms by agricultural value chain actors in the study area. At a 5% level of significance, there is a negative relationship between respondent sex and the use of e-banking platforms for accessing savings by agricultural value chain actors, indicating that female agricultural value chain actors are more likely to use various e-banking platforms to access their savings. According to the marginal effects results, the likelihood of female agricultural value chain actors using banking apps, Quickteller, ATM services, and POS increases by 0.8 percent, 3.4 percent, 1.6 percent, and 2.2 percent, respectively, while the likelihood of them using banking codes decreases by 2.9 percent. There is a negative relationship between age of the respondent and the use of e-banking platforms for accessing savings by agricultural value chain actors at 5% level of significance, indicating that the likelihood of using different e-banking platforms in accessing their saving by agricultural value chain actors decreases with increase in age.

The marginal effects result shows that the likelihood of using ATM services and POS by agricultural value chain actors increases by 1.1% and 1.7% respectively, while the probability of using banking codes, banking apps and Quickteller decreases by 2.3%, 1.8% and 2.9% respectively. There is a positive relationship between level of education of the respondent and the use of e-banking platforms for accessing savings by agricultural value chain actors at 1% level of significance, indicating that the likelihood of using different e-banking platforms in accessing their saving by agricultural value chain actors increases with increase in level of education. The marginal effects result shows that the likelihood of using banking codes, banking applications, Quickteller, ATM services and POS by agricultural value chain actors increases by 2.7%, 3.9%, 4.2%, 3.1% and 4.8% respectively. This finding is validated by that of Xu *et al.* (2020) who noted that level of education determines the use of e-banking for financial transactions. At 1% level of significance, there is a positive relationship between respondent membership of cooperation and the use of e-banking platforms for accessing savings by agricultural value chain actors, indicating that agricultural value chain actors who are members of a cooperative group are more likely to use various e-banking platforms to access their savings. According to the marginal effects results, the likelihood of agricultural value chain actors who are members of cooperation using banking apps, ATM services, and POS increases by 4.3 percent, 6.1 percent, 2.2 percent, respectively, while the likelihood of them using banking codes and Quickteller decreases by 2.5 percent and 1.4 percent respectively.

There is a negative relationship between target market of the respondent and the use of e-banking platforms for accessing savings by agricultural value chain actors at 5% level of significance, indicating that the likelihood of using different e-banking platforms in accessing saving by agricultural value chain actors increases with them targeting the urban market for their business. The marginal effects result shows that the likelihood of using banking codes, ATM services and POS by agricultural value chain actors when they target urban markets increases by 4.4%, 4.2%, and 5.5% respectively while the likelihood of them using banking applications and Quickteller decreases by 1.5 percent and 2.8 percent respectively. At 1% level of significance, there is a positive relationship between respondent time saving and the use of e-banking platforms for accessing savings by agricultural value chain actors, indicating that agricultural value chain actors are more likely to use various e-banking platforms to access their savings as it saves their time.

The marginal effects results show that the likelihood of agricultural value chain actors to use banking codes, banking apps and Quickteller due to their ability to save time increases by 7.6 percent, 2.9 percent, and 1.9 percent, respectively, while the likelihood of them using ATM services and POS decreases by 1.8 percent and 4.1 percent respectively. This finding is supported by Asongu *et al* (2018) that time saving attribute of e-banking platforms influenced their use to a great extent. There is a positive relationship between Easy business transactions of the respondent and the use of e-banking platforms for accessing savings by agricultural value chain actors at 1% level of significance, indicating that the likelihood of using different e-banking platforms in accessing saving by agricultural value chain actors increases as they make transactions to be easy. The marginal effects result shows that the likelihood of using banking codes, banking applications, Quickteller and POS by agricultural value chain actors due to easy of transactions increases by 6.6%, 1.8%, 2.5% and 5.1% respectively while the likelihood of them using ATM services decreases by 1.5 percent. This finding is supported by Asongu *et al* (2018); Abor, Amidu and Issahaku (2018), and Gosavi (2018) easy undertaking of transaction with e-banking influences their use.

There is a positive relationship between respondent access to internet facilities and the use of e-banking platforms for accessing savings at the 1% level of significance, indicating that agricultural value chain actors are more likely to use various e-banking platforms to access their savings, especially if they have access to internet facilities. According to the marginal effects results, respondents' likelihood of using banking codes, banking apps, and Quickteller increases by 6.8%, 3.3 percent, and 4.9 percent, respectively, as a result of their access to internet facilities, while their likelihood of using ATM services and POS decreases by 5.6 percent and 3.7 percent, respectively.

Motivations to the use of e-banking platforms

The mean responses of the respondents on what motivated them to use e-banking platforms for accessing savings is presented in Table 6 below. The result shows that the grand mean score of the responses of the respondents on their motivation to the use of e-banking platforms for accessing savings was 3.85 and is higher than the decision cut-point mean score of 3.00. This implies that on the average, the respondents were motivated to use e-banking platforms in advancing accessing to savings in the study area. All the ten (10) items on Table 6 have mean score that is above 3.00 on a 5-point rating scale. This indicates that the respondents accepted items No.1 through No.10 which boarders on motivations to the use of e-banking platforms by agricultural value chain actors. This implies that agricultural value chain actors in the study area employed e-banking platforms in advancing their access to savings due to its efficient tracking system, evidence-based payments (e-transfers), low risk of transaction, internet facilities, low financial misappropriation due to password security, safety in use, financial discipline, ease of business transactions, easy access to checking account balance and time saving of the e-banking platforms. This finding is supported by Ugwuja and Onavwie (2019); Issahaku *et al* (2018) and Gosavi (2018) that easy undertaking of e-transfers, low risk of transaction, security of e-banking platforms, their safety of use, and time saving in undertaking transaction were among the many reasons that motivates people to adopt e-banking.

Table 6: Motivations to the use of e-banking platforms by agricultural value chain actors

Motivation to the use of e-banking	SA	A	UN	D	SD	Mean	Std	Rmk
Efficient tracking system	10	30	18	15	7	3.26	0.53	Motivated
Evidence-based payments (e-transfers)	16	26	14	17	7	3.34	0.48	Motivated
Low Risk of transaction	7	46	15	7	5	3.54	0.91	Motivated
Internet facilities	29	17	12	14	8	3.56	0.67	Motivated
Low financial misappropriation due to password security	10	49	9	8	4	3.66	0.98	Motivated
Safety	27	38	7	4	4	4.00	0.91	Motivated
Financial discipline	28	40	4	4	4	4.05	0.98	Motivated
Ease of business transactions	49	19	4	4	4	4.31	1.28	Motivated
Easy access in checking account balance	51	17	4	4	4	4.34	1.34	Motivated
Time saving	55	13	4	4	4	4.39	1.45	Motivated
Grand mean score						3.85	0.95	Motivated

Source: Field survey data, 2020. SA = Strongly agree; A= Agree; UN = Undecided; D = Disagree; SD = Strongly disagree; Std = Standard deviation; Rmk = Remark.

CONCLUSION

Agricultural value chain actors in southeast Nigeria used e-banking platforms to facilitate savings closure, according to the study. The most widely used platform for agricultural value chain actors to access savings closure is the e-banking application platform. Agricultural value chain actors make extensive use of e-banking services. Sex, age, level of education, participation in a cooperative, target market, time savings, ease of business transactions, and access to internet facilities all played a role in agricultural value chain actors' use of e-banking platforms in the study area. The study recommends that agricultural products value chain actors receive ongoing training on how to use e-banking platforms to access their saved money, as this will increase their access to other financial services that are necessary to keep their enterprises sustainable.

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PROCEEDINGS

55th Annual Conference

Agricultural Society of Nigeria

25-29 Oct., 2021

Rufus Giwa Polytechnic, Owo Ondo State

"OWO MADE"

SUB-THEME 2

Crop Production, Protection, Seed Technology and Genetic Improvement

Tolerant Level of Cowpea Cultivars to Two Unrelated Legume Viruses in A Screen House Condition

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ABSTRACT
The field trial was conducted at the Teaching and Research Farm of the Faculty of Agriculture, Ahmadu Bello University (ABU), Zaria, Mokwa Station to evaluate the tolerant level of some cowpea cultivars to two unrelated legume viruses. Three independent trials were conducted simultaneously, for single and mixed infections of BICMV and CPMeV. The treatments evaluated were BICMV-infected, CPMeV-infected, BICMV + CPMeV infected. The treatments were laid out in a Completely Randomized Design (CRD) with three replicates. In each trial, eight cowpea cultivars were evaluated. Seeds were sown in polythene pots of good drainage containing sterilized soil of 8 kg. Procedure of inoculation was carried out. The seedlings were watered regularly throughout their growing period. Data were collected on number of pods, seed numbers and grain yield at harvest. Data on disease incidence, severity, growth and yield attributes were subjected to analysis of variance (ANOVA) using Statistical Analysis System. This experiment establishes that the cowpea cultivars tested are susceptible to single and double infections of BICMV + CPMeV. The study recorded a considerable stable and appreciable yield from IT97K-568-18. Therefore, IT97K-568-18 could be recommended to cowpea farmers as a guarantee against crop failure. They can also be used as sources of BICMV and CPMeV tolerant genes for breeding purposes.
Keywords: Cowpea, Grain yield, Infections, Tolerant, Viruses

INTRODUCTION

Vigna unguiculata L. Walp commonly known as cowpea is one of the most ancient crops known to man and one of the most important pulse crop globally (Anoliefo *et al*., 2006). Rural families that make up the larger part of the population of Africa derive from its production food, animal feed, alongside cash income. The crop can thrive in the Sahel zone, where the rainfall is less than 500 mm per annum (Dugje *et al*., 2009). It is drought tolerant and well adapted to sandy and poor soils. Cowpea seeds are important source of plant protein for man and feed for animals globally (Singh, 2011). The highest nutrient in cowpea seeds on analysis is protein accounting for 23% amongst other nutrients like water, fat carbohydrate and fibre (Singh, 2011). Cowpea is susceptible to a complex of insect pests and diseases and they attack the crop from vegetative stage to storage (Dugje *et al*., 2009). Virus diseases are the most damaging diseases of cowpea and represent significant proportion of losses regarding the potential value of the crop in sub-Saharan Africa. Estimated yield losses due to virus infection are between 10 and 100 % (Kareem *et al*., 2007). *Blackeye cowpea mosaic virus* (BICMV) an important virus disease of cowpea can cause a yield loss of 13 – 87 % under field condition depending upon crop susceptibility, virus strain and the environmental conditions (Alegbejo, 2005). Similarly, *Cowpea mild mottle virus* (CPMeV) is highly prevalent in cowpea fields causing severe yield losses (Abdullahi *et al.,* 2020). Cowpea plants may be infected by more than one virus disease, resulting in serious economic losses in agricultural production (Alegbejo, 2005). There are reports on mixed virus infections of cowpea occurring in Nigeria indicating that doubly infected plants will display increase in disease symptoms and in the accumulation of one or both of the viruses leading to double yield loss. Therefore, the aim of this study was to identify the sources of resistance to single and mixed effects of *Blackeye cowpea mosaic virus* (Potyvirus) and *Cowpea mottle virus* (Carmovirus) in the selected cowpea cultivars.

MATERIAL AND METHODS

The field trial was conducted at the Teaching and Research Farm of the Faculty of Agriculture, Ahmadu Bello University (ABU), Zaria, Mokwa Station (090211 N and 50135 E, 201 m above sea level) situated in the Southern Guinea Savannah Nigeria. The BICMV and CPMeV isolates used for this trial were obtained from the stock in the Virology Unit, IITA, Ibadan, Nigeria while cowpea seeds (Ife Brown, IT90K-277-2, IT96D-610, IT97K-499-35, IT97K-568-18, IT97K-573-2-1, IT98K-205-M8 and IT98KD-288) were selected because they have not been endorsed against the single and mixed BICMV and CPMeV viruses. The isolates are previously maintained on silica gels in vial bottles at room temperature. They were multiplied by propagating them in a susceptible cowpea cultivar “Ife Brown” through sap transmission before going to the field, for the purpose of being used later in the field for inoculation. Ife Brown seeds were sown in pots of 29.5 diameter and 38 cm deep containing sterilized soil. Twenty pots each placed in a wooden cage (to protect them from insect and contamination) for multiplying BICMV (10 pots) and CPMeV (10 pots) inoculum.

The sandy loam soil that was used for the study was sterilized before it was used to fill the polythene pots. Three independent trials were conducted simultaneously, for single and mixed infections of BICMV and CPMeV. The treatments evaluated were BICMV-infected (T_1), CPMeV-infected (T_2), BICMV + CPMeV infected (T_3). The treatments were laid out in a Completely Randomized Design (CRD) with three replicates. In each trial, eight cowpea cultivars were evaluated. Seeds were sown in polythene pots of good drainage containing sterilized soil of 8 kg. Procedure of inoculation was carried out as described by Abdullahi *et al,* (2020). The seedlings were watered regularly throughout their growing period. The control of insect pest and harvesting was carried out. Data collected include number of pods, seed numbers and grain yield at harvest and were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS, 2008) to verify if there are significance differences among the cultivars at $p \leq 0.05$. Significance of the difference between inoculated plants of each cultivar was determined using independent t-test. Where the F-test ratio is significant, means were separated using Least Significant Difference (LSD).

RESULTS AND DISCUSSION

Effects of single and mixed infections on yield parameters

All inoculated plants irrespective of the virus treatments did not produce well as poor yield was observed through the number of pods per plant, number of seeds per pod and grain/seed yield. The number of pods of plants differed significantly ($p \leq 0.05$). In BICMV infected plants, IT97K-568-18 produced the highest number of pods per plant (4 pods) while the lowest number of pods per plant (1 pod) was produced in Ife Brown. In CPMeV infected plants, IT97K-568-18 also gave the highest number of pods per plant (5 pods) and Ife Brown had the lowest number of pods per plant (1 pod). Similarly, in BICMV + CPMeV infected plants, IT97K-568-18 also produced the highest number of pods per plant (5 pods) just as it did when infected with CPMeV alone, followed by IT96D-610 (4 pods), meanwhile, IT90K-277-2 and Ife Brown produced the same and the lowest number of pods per plant (1 pod) (Table 1). The seeds obtained from the inoculated plants were malformed, shriveled and small irrespective of the virus treatment. In BICMV infected plants, IT97K-568-18 produced the highest number of seeds per pod (10) while IT98K-205-M8 and Ife Brown gave the lowest number of seeds per pod (4). In CPMeV infected plants, 97K-568-18 exhibited the highest number of seeds per pod (11) and the lowest number of seeds per pod (5) was obtained from IT90K-277-2. Also, in

BICMV + CPMeV infected plants, IT97K-568-18 and IT97K-573-2-1produced the highest number of seeds per pod (10) while the lowest number of seeds per pod of 5 was recorded from cultivars IT98KD-288 (Table 1).

In the three virus treatments, the cultivars with the highest seed numbers per plant also gave the highest grain yield. IT97K-568-18 had 218.3 kg/ha, 198.2 and 205.4 kg/ha in BICMV, CPMeV and BICMV + CPMeV infected plants respectively whereas Ife Brown had the lowest grain yield of 101.5 kg/ha in BICMV and CPMeV while IT97K-573-2-1 resulted to a low grain yield (99.9 kg/ha) in BICMV + CPMeV infected plants (Table 1).

Cowpea is an important pulse in sub Saharan Africa but its profitable production is greatly affected resulting to poor yields. This poor yields can be attributed to attacks by pest and infection by pathogenic micro-organisms especially viruses (Taiwo *et al*., 2007). Cowpea can be infected by one or more than one virus (related or unrelated) which results in disease symptoms and serious reductions in the growth and yields of cowpea (Kareem and Akinjogunla, 2008). The growth and subsequent yield of some cultivars can be likened to both single and double infections suggesting that the response of these cultivars to double infections was not stronger than the sum of the effects caused by each of the virus in single infection. This is contrary to the opinion of Taiwo (2003) who reported that double virus infections result in greater reduction in the growth and yield of single virus infections. Most cultivars produced pods and seeds of appreciable number but hardly gave appreciable yield which is in contrast to their initial satisfactory growth. The plants inoculated with BICMV alone were the most affected as they gave the lowest grain yield generally in studies. This is in agreement with the findings of Nsa and Kareem (2015) who reported that there are cases where single virus infections had more devastating effects on the crop than double infections involving that same virus.

CONCLUSION

This experiment establishes that the cowpea cultivars tested are susceptible to single and double infections of BICMV + CPMeV. The study recorded a considerable stable and appreciable yield from IT97K-568-18. This experiment confirms the impact of environmental conditions on the growth and yield of virus infected plants. Cowpea cultivars IT97K-568-18 could be recommended to cowpea farmers as a guarantee against crop failure. They can also be used as sources of BICMV and CPMeV tolerant genes for breeding purposes. Intensive biotechnological research that will result in the development of cowpea cultivars with multiple resistances to economical important viruses should be employed.

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Table 1: Number of pods, seed numbers and grain yield of cowpea cultivars infested with BICMV and CPMeV at Mokwa during the 2020 cropping season

	Number of pods per plant			Seed number per pod			Grain/seed yield (kg/ha)		
Variety	BICMV	CPMeV	BI + CP	BICMV	CPMeV	BI + CP	BICMV	CPMeV	BI + CP
Ife Brown	1c	1c	1f	4c	6b	6bc	101.5c	101.5e	193.9b
IT90K-277-2	2b	3b	1f	5bc	5c	7b	192.6b	129.5cd	200.0ab
IT96D-610	2b	2bc	4b	5bc	6b	6bc	199.3b	137.6cd	199.6ab
IT97K-499-35	2b	3b	3c	6b	6b	6bc	197.3b	125.5d	193.3ab
IT97K-568-18	4a	5a	5a	10a	11a	10a	218.3a	198.2a	205.4a
IT97K-573-2-1	2b	2bc	3c	6b	6b	10a	196.7b	143.5c	99.9c
IT98K-205-M8	2b	2bc	2e	4c	6b	6bc	199.2b	161.4b	192.9ab
IT98KD-288	2b	3b	2e	5bc	6b	5c	200.0b	138.1cd	200.1ab
SE+	0.2	0.31	0.19	0.46	0.53	0.54	3.63	4.8	7.28

Means with the same letter within the column are not significantly different (p ≤ 0.05) SNK grouping. BICMV: Blackeye cowpea mosaic virus, CPMeV: Cowpea mottle virus, BI+ CP: Blackeye cowpea mosaic virus + Cowpea mottle virus

Effects of Organic Fertilizer on Growth Performance of *Ixoralutea* in Jos Nigeria

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ABSTRACT
An experiment to assess the response of Ixora lutea to the different levels of cow dung was conducted at the Horticultural Nursery of the Department of Crop Production, University of Jos, Jos North, Plateau State, during the rainy season of 2019. The experiment consisted of four (4) treatments, 10, 20, 30 and 0g cow dung, applied to I. lutea in a Randomized Complete Block Design with five (5) replications. Data collected include number of nodes, height of sprout, number of leaves and number of secondary branches. Data collected were tabulated and subjected to the analysis of variance (ANOVA) and means were separated using Duncan Multiple Range Test at 5% level of probability with statistical package for social sciences (SPSS). Results obtained shows there was no significant difference in the number of nodes, height of sprout, number of leaves and number of secondary branches in response to the different treatment. Based on the result obtained, there is no need for the application of cow dung to Ixora lutea and if necessary, it should be applied moderately.
Keywords: cow dung, height of sprout, Ixora lutea, secondary branches

INTRODUCTION
Ixora spp is a well-defined genus of sub-shrubs, shrubs and small trees comprising about 400 taxa (Njenga, 2012) which are largely pan-tropical in distribution with the greatest diversity of species occurring in the Asian region. The *Rubiaceae* are the fourth largest angiosperm family after the *Compositae*, the *Orchidaceae* and the *Fabaceae* and consist of more than 10,000 species and 640 genera. The family has a cosmopolitan distribution but is predominantly tropical. The current sub-familial classification (Njenga, 2012) recognizes four subfamilies: The *Cinchoideae*, the *Ixoroideae*, the *Antirheoideae* and *Rubioideae*. The *Ixoroideae* consist of five tribes, one of which is the tribe *Pavetteae*, comprising 20 genera and about 1200 species. Among the *Pavetteae*, the genus *Ixora* is the largest and most widespread. The other tribes are *Gardenieae*, *Octotropideae*, *Aulacocalyceae* and *Coffeeae*. Two of the more well-known *Rubiaceae* genera are members of *Ixoroideae*: the economically important *Coffea arabica* and the often-cultivated Gardenia (Katarina and Birgitta, 2000). This trial was carried out to assess the response of *Ixora leutea* to different levels of cow dung and the possibility of enhancing its establishment.

MATERIALS AND METHODS
Experimental Site
Field experiment was carried out at the Horticultural nursery of the Department of Crop Production, University of Jos, Jos North, Plateau State located in 9.91667°N 8.89028°E of the Guinea Savannah agro-ecological area of Nigeria during the rainy season of 2019 to study the response of *I. lutea* to the different levels of cow dung. The area has coastal savannah vegetation with bimodal rainfall pattern with mean annual rainfall of 1324mm and average annual temperature of 22.8°C.

Sources of Planting Materials
The stems of *I. leutea* propagated were obtained from the Crop Production Department of the Federal University of Technology (FUT) Minna, Niger State, Nigeria.
Experimental Treatment and Design
The treatment consists of *I. leutea* planted at different levels of cow dung respectively as Cd1 (cow dung 10 grams), Cd2 (cow dung 20 grams), Cd3 (cow dung 30 grams) with one control per plot. The treatments were arranged in a 4×4 factorial in a randomized complete block design (RCBD) replicated four times.
Nursery Establishment
Nursery bed was raised at the Horticultural Nursery of the Department of Crop Production, University of Jos, Plateau State. The land was cleared using a hoe, and the nursery was fenced with a net to prevent human interference and keep out pests.
Data Collection
Data collected includes;

- Number of nodes, number of leaves and number of secondary branches collected by virtual observation of the plant and number of leaves, nodes and secondary branches recorded. While, height of spout, determine by measuring with a meter rule from the base of the sprout to the tip of the plant.

RESULTS AND DISCUSSION

Number of Nodes
The result obtained from the ranked data below shows that even though there was a significant difference in the third (3) week which was the week the first readings were taken, as the collection of the data progresses, no significant difference was observed till the very last week of the data collection. This shows that although *I. lutea* had a better response in the first week to CD1 and the remaining weeks showed no significant difference in the number of nodes observed. Though the highest mean was recorded from the control (7.9) followed by CD3 (7.1), then CDI (6.8) and CD2 (6.4) respectively. Therefore, an increase in the dosage of cow dung added to the plant does not give rise to a significant increase in the number of nodes.

Table 1: Response of *Ixora lutea* to Different Levels of Cow Dung on Number of Nodes

	CDI	CD2	CD3	CONTROL
RD1	3.8^{a}	1.8^{b}	2.6^{ab}	3.3^{ab}
RD2	4^{a}	2.7^{a}	2.6^{a}	3.3^{a}
RD3	6^{a}	5.1^{a}	5^{a}	5.8^{a}
RD4	6^{a}	5.1^{a}	5^{a}	5.8^{a}
RD5	6.4^{a}	5.5^{a}	5.9^{a}	6.2^{a}
RD6	6.5^{a}	5.5^{a}	6.3^{a}	6.5^{a}
RD7	6.6^{a}	5.6^{a}	6.4^{a}	7^{a}
RD8	6.6^{a}	5.8^{a}	6.9^{a}	7^{a}
RD9	6.6^{a}	6.1^{a}	7^{a}	7.6^{a}
RD10	6.6^{a}	6.1^{a}	7^{a}	7.6^{a}
RD11	6.8^{a}	6.4^{a}	7.1^{a}	7.9^{a}
RD12	6.8^{a}	6.4^{a}	7.1^{a}	7.9^{a}

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Height of Sprout
Height of sprouts recorded no significant difference between the treatments. However, CD1 has the highest mean (5.42), followed by CD2 (4.25), control (3.8) and the lowest is CD2 (3.59). This reveals that an increase in the dosage of cow dung applied to the plant does not give rise to a significant increase in the number of leaves.

Table 2: Response of *Ixora lutea* to Different Levels of Cow Dung on Height of Sprout

	CDI	CD2	CD3	CONTROL
RD3	0.39 [a]	0.24 [a]	0.21 [a]	0.25 [a]
RD4	0.86 [a]	0.67 [a]	0.48 [a]	0.47 [a]
RD5	1.43 [a]	1.16 [a]	0.95 [a]	0.93 [a]
RD6	1.98 [a]	1.64 [a]	1.3 [a]	1.35 [a]
RD7	2.55 [a]	2.02 [a]	1.65 [a]	1.78 [a]
RD8	3.11 [a]	2.45 [a]	2.07 [a]	2.14 [a]
RD9	3.64 [a]	2.9 [a]	2.43 [a]	2.56 [a]
RD10	4.27 [a]	3.37 [a]	2.8 [a]	2.96 [a]
RD11	4.93 [a]	3.81 [a]	3.18 [a]	3.51 [a]
RD12	5.42 [a]	4.25 [a]	3.59 [a]	3.8 [a]

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Number of Leaves

From the result in Table 3, there was no significant difference amongst the treatment. Though from the result control has the highest mean (24.8), followed by CD1 (24.7), then CD2 (24) and CD3 with the lowest mean. Therefore, the different levels of cow dung have no influence on the number of leaves. This reveals that an increase in the dosage of cow dung applied does not give rise to a significant increase in the number of leaves.

Table 3: Response of *Ixora lutea* to Different Levels of Cow Dung on Number of Leaves

	CD1	CD2	CD3	CONTROL
RD3	3[a]	2.9 [a]	3.2 [a]	3.8 [a]
RD4	4 [a]	3.7 [a]	3.8 [a]	4.2 [a]
RD5	8.9 [a]	7.8 [a]	8.9 [a]	10.6 [a]
RD6	10.8 [a]	11 [a]	10.1 [a]	11.6 [a]
RD7	14.3 [a]	12.2 [a]	12.5 [a]	12.7 [a]
RD8	17.5 [a]	15.1 [a]	14.9 [a]	14.9 [a]
RD9	20.2 [a]	18 [a]	17.3 [a]	17.1 [a]
RD10	21.5 [a]	19.5 [a]	18.4 [a]	19.6 [a]
RD11	23.6 [a]	21 [a]	20.3 [a]	22.8 [a]
RD12	24.7 [a]	24 [a]	23.1 [a]	24.8 [a]

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Number of Secondary Branches

Number of secondary branches recorded non-significant difference amongst the treatment. In spite of the non-significant difference observed, treatment that has the highest mean is CD1 recorded the highest number of branches (1.8), followed by CD2 (1.5), then CD3 (0.8) and the lowest is the control (0.4). Therefore, the different levels of cow dung have no significant influence on the number of secondary branches in *I. lutea.* This indicates that an increase in the dosage of cow dung applied does not lead to a significant increase in the number of secondary branches.

Table 4: Data for Number of Secondary Branches

	CDI	CD2	CD3	CONTROL
RD9	0.5 [a]	0.4 [a]	0 [a]	0.1 [a]
RD10	0.6 [a]	0.5 [a]	0.1 [a]	0;1 [a]
RD11	1.2 [a]	0.9 [a]	0.5 [a]	0.2 [a]
RD12	1.8 [a]	1.5 [a]	0.8 [a]	0.4 [a]

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Cow dung is an excellent organic fertilizer and has been used since the dawn of agriculture to increase production (Solomon, *et al.,* 2012) but in the case of this research; the reverse has been the case which corroborates with this statement manure is liable to significant nutrient losses through leaching and volatilization. The number of nodes, height of sprout, number of leaves and number of secondary branches was not significantly affected by the different levels of cow dung in *I. lutea*. his may be due to the following reasons: often bulky but low level of nutrients in organic fertilizers which is due to the fact that the nutrients are usually complex in organic chemical structure, slow rate in which nutrients are released into the soil therefore due to the early stage of growth of *I. lutea* it could not properly utilize the nutrients which corroborates the work of Olowoake and Adeoye (2013) who found that cow dung increase soil organic carbon, N, P, and K and the increase in soil acidity observed in soils fertilized with cow dung due to low calcium content or slow release of the nutrient content. The result obtained is in contradiction with the observation of Popoola *et. al*., (2018) who reported better performance in cow dung treated soils than ordinary top soil. In the context of this study, it can be concluded that there is no significant response of *I. lutea* to different levels of cow dung.

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Isolation and Identification of Fungi Responsible for Post-Harvest Rot of Sweet potato in Umudike

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ABSTRACT
Fungal decay of sweet potato harvested at National Root Crops Research Institute, Umudike was investigated for fungi responsible for tuber loss in storage. The tubers were collected from the sweet potato barn to isolate and identify fungal species responsible for the rots. Five (5) fungal isolates were found, they are Aspergillus niger, A. flavus, Fusarium oxysporum, Penicillium chrysogenum and Rhizopus stolonifer. Pathogenicity test was done and isolates such as R. stolonifer, A. niger and F. oxysporum were more pathogenic on healthy tubers. Twenty samples of deteriorated sweet potato samples were used for this study and freshly harvested tubers were used to test for pathogenicity to make sure that the isolated organisms were able to exact same spoilage activities on healthy tubers. Percentage occurrence of isolated fungi had A. niger 30%, A.flavus 25%, R.stolonifer 25%, F.oxysporum 10% and P.chrysogenum 10%. Inoculated tubers were examined and the nature of the rot varied with the pathogens.
Keywords: Ipomoea batatas, fungal pathogens, rots, pathogenicity

INTRODUCTION
Sweet potato (*Ipomoea batatas*) is a dicotyledonous plant and belongs to the family *Convolvulaceae*. It is usually large, tuberous and starchy with a sweet taste (Woolfe, 1992). It is a root crop cultivated in countries like Nigeria, Sierra Leone and Ghana. Sweet potato is the 3rd most important crop in Nigeria after yam; therefore, it is an important staple crop in many parts of Africa (Amienyo and Ataga, 2007). Sweet potato generally is grown for its storage roots which can be eaten raw, boiled, fried or made into chips (Hu *et al*., 2004, Onifade *et al*., 2004). In the tropics, estimate of 25% - 40% of Agricultural produce are lost due to poor storage methods (Hayma, 1982). These losses are as a result post-harvest handlings and storage resulting from physical, physiological and pathological factors or combination of any of the listed factors (Ogbo and Agu, 2014). Sweet potatoes are perishable after harvesting and they are subjected to damage during transportation, storage and marketing. It has a high water content which makes storage difficult and exposes it to microbial attack (Boot, 1994). Fungi are responsible for causing rot on sweet potato, these rots are of various categories such as black rot (*Ceratocystis fimbriata*), dry rot (*Aspergillus niger, A/ fumigates*), Stem rot (*Fusarium solani*) and soft rot (*Rhizopus stolonifer*) (Oyewale, 2004). Sweet potato can be stored for months and this can be achieved by curing for about 8 days which allows injured roots to heal. Curing allows wounded roots to heal and when healed can stay up to five months. Other methods include the traditional methods which involves burying in the ground has recorded a heavy loss owing to destructions by microbes, sprouting and decay of tubers. The objective of this work is to identify, isolate and characterize fungi associated with post-harvest loss of sweet potato and also carry out pathogenicity test on healthy tubers using the isolates from spoilt tubers to determine the extent of rot caused by these isolates.

MATERIALS AND METHODS

A variety of sweet potato cultivated at National Root Crops Research Institute Umudike was used for this study. Twenty spoilt tubers were obtained and taken for laboratory analysis. Healthy tubers were also subjected to pathogenicity test to determine the extent of severity on healthy tubers.

Isolation of rot causing fungi

The spoilt potato tubers were washed in a running sterile water, the rot tissue was cut, sterilized in 70% ethanol and approximately 2mm diameter were cut out from the rotten tissue and place on the solidified Potato Dextrose-Agar (PDA) medium. The plates were incubated at room temperature for 72 hours, fungal colonies were purified to obtain a pure isolate by sub culturing them into a freshly prepared PDA and growths were observed after 6 days.

Identification of Fungal Growth

The fungal growths observed on the plates were aseptically transferred into a freshly prepared PDA and incubated for 5 to 7 days. The colony morphology and pigmentation of the isolates were observed and recorded before they were sub cultured and kept for identification (Barnett and Hunter, 1972). The colony texture, spore formation and other morphological appearance of fungal colonies on agar culture medium were based on microscopic evaluation with reference to the manual of fungal atlas (Watanabe, 2002).

Pathogenicity test

Healthy tubers of the freshly harvested sweet potatoes were washed and sterilized in 70% ethanol. The pure cultures of the individual fungal isolates were introduced into the healthy sweet potato by creating a hole using a sterile syringe. After the inoculation, they were kept in a sterile polythene bags and incubated at room temperature for 14 days. After the incubation period, the sweet potato tubers were cut through to examine the rot. Three isolates were confirmed pathogenic on the healthy sweet potato tubers.

Statistical analysis

Data were subjected to analysis of variance and means separated using the least significant difference (LSD) method where significant difference between means of treatment at P = 0.05 were established (Steel and Torries, 1980).

RESULTS AND DISCUSSION

Five distinct fungal colony types were isolated from the rotten sweet potato tuber samples; *R. stolonifer, A. niger, A. flavus, F. oxysporum and Penicillium chryosogenum* with - *R. stolonifer, A. niger and A. flavus* considered being pathogenic on healthy tubers.

Table 1: Shows fungi isolated from spoilt sweet potato tubers

No of isolates	fungi isolated
1	*Aspergillus flavus*
2	*Penicillium chrysogenum*
3	*Fusarium oxysporum*
4	*Aspergillus niger*
5	*Rhizopus stolonifer*

Table 2: Percentage occurrence of fungi isolated

No .of isolates	Fungi	Percentage occurrence (%)
1	*Rhizopus stolonifer*	25
2.	*Aspergillus niger*	30
3	*Penicillium chrysogenum*	10
4.	*Aspergillus flavu*	25
5.	*Fusarium oxysporum*	10

Table 3: Shows the microscopic features and cultural features of the fungal isolates

Isolates	Cultural features	Microscopic features	Fungi
1	White to brown	Hyphae, sporangiospores	*Rhizopus stolonifer*
2	Powdery black	Conidia, conidiophores	*Aspergillus niger*
3	Green conidia	Radiated heads, colorless	*Aspergillus flavus*
4	Pale to brown	Mass of hyphae, macro conidia	*Fusarium oxysorum*
5	Blue-green	Branched conidia	*Penicillium chrsogenum*

These findings clearly indicate that fungi are responsible for spoilage of sweet potato tubers. *A. niger, R. stolonifer* and *A. flavus* played a more pathogenic role in sweet potato tuber spoilage. Some researchers have reported tuber rot to be caused by fungi in storage (Clark and Hoy, 1994, Onuegbu, 2002) which is also in agreement with the present findings. In some cases, fungi gain its entrance during harvesting and transportation to their storage sites. However, (Okigbo and Nmeka, 2006) also found out that at the time of harvest, most tubers maybe affected by pathogens from disease foliage or roots. It was observed that *A. niger and R. stolonifer* were the most frequently isolated fungi. The result of pathogenicity test indicated that fungi induced different levels of decay and *A. niger* being the most virulent fungus. Post harvest rot can also be due to low pH, moisture content and nutritional composition which make it prone to fungal attack (Olurinola *et al.,* 1992).

CONCLUSION

This work shows that fungi are the major cause of post harvest rot in storage. This can cause food shortage, scarcity and lead to low income source to farmers. Therefore, several control measures such as proper handling during harvesting, transportation, airy environment for storage, provision of good storage facilities should be placed in check for good storage of sweet potato tubers. It is also advisable that farmers adopt diseases control practices which are affordable to ensure sustainable sweet potato production.

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Functional Qualities of Water Yam (*Dioscorea alata*): A Review

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ABSTRACT
Yam tubers provide a substantial part of the world's food supply and are also an important source of animal feed. They are rich in energy, dietary fibre, minerals and antioxidants. The functional qualities of water yam (D. alata) include its mineral, nutritional and chemical properties and its importance to food, food products and industrial usage. These functional qualities are fundamentals that are essential for human nutrition and maintenance of certain physicochemical processes which are necessary to life. Dioscorea alata have been found to contain high carbohydrates and protein but low sugar content, mineral contents such as K, Na, P, Ca, Mg and Vitamin C have been shown to be rich in water yam. It also contains several bioactive components, such as water-soluble polysaccharides (WSP), diosgenin, alkaloids, saponins, tannins, flavonoids, phenols, glycosides, steroids, and dioscorin. This specie of yam has increased demand due to its low sugar content necessary for diabetic patients and elder people. This proposes that underutilized tubers can efficiently contribute to the nutritional requirement and food security.
Keywords: Yam, Dioscorea alata, water yam, Nutritional and mineral values, chemical properties, therapeutic potential

INTRODUCTION
Yam (*Dioscorea spp.*) is one of the major staple foods for the people of Nigeria and to a large extent for people in West Africa. West Africa accounts for about 95% of world production and 93% of the total yam production area (FAO, 2012). Out of the world production of over 30 million metric tons per annum, Nigeria alone produces 22 million tons annually. In spite of this high production, the demand for yam tubers in Nigeria has always exceeded its supply. There are six major yam species cultivated in West Africa namely*: D. rotundata*, *D. alata*, *D. dumetorum*, *D. cayenensis*, *D. esculenta* and *D. bulbifera*. *Dioscorea alata* is one of the major yam species in the family Dioscoreaceae. The two most important cultivated edible yams are white Guinea yam (*D. rotundata* poir) and water yam (*D. alata*) (Mattew *et al* 2003). *D. rotundata* is indigenous to West Africa and represents the most important species in terms of volume of production while *D. alata*, which was introduced to Africa from Asia in the 16th century, is the most widely cultivated species globally. Characteristics such as high yield potential ease of propagation, early vigour for weed suppression and storability of most cultivars has given it an edge for sustainable production. Disease that has pose a challenge such as anthracnose exerts a devastating impact on productivity of *D. alata* (Mattew *et al.,* 2003), though most improved varieties of this yam specie have recorded high yield despite the foliage attack by anthracnose disease. *Dioscorea alata* is very important in terms of food quality and when compared with other yam species is fraught with many problems which range from lack of genetic improvement, poor food quality in terms of dry matter content, biotic and abiotic factors which make it prone to pests and diseases. One of the major problems is low dry matter content, and attack by diseases such as anthracnose and pests such as yam beetles.

Dioscorea alata being the most largely distributed and cultivated species with a huge number of varieties. It has different common names such as Water yam and Greater yam. Water yam leaves are large, elongate, and heart-shaped. The leaves are glabrous, and twining stems which coil readily around a stake (Udensi *et al.,* 2010). Tubers produced by water yams are massive. They grow rapidly near the end of growing season. Single tubers are most common, but several are possible. The tubers are branched, vertical in growth, and may be deeply buried. The tuber shape is generally cylindrical. Tuber flesh is white and watery in texture (Jenit and Siddhuraju, 2017). This specie of yam has increased demand due to its low sugar content necessary for diabetic patients and elder people (Udensi *et al.,* 2010). Water yam contains high carbohydrates (around 77.95 - 82.88%) and protein (7.4%) but low sugar content. It also contains several bioactive components, such as water-soluble polysaccharides (WSP), diosgenin, alkaloids, saponins, tannins, flavonoids, phenols, glycosides, steroids, and dioscorin (Wanita *et al* 2021).

Carbohydrates foods that are easily converted and broken down to glucose after consumption have been classified as low glycemic index. Deborah *et al* 2020 have ranged GI of foods from 0-55(low), 56-69 (medium) and 70-100 (high), her study revealed both boiled and roasted water yam had low GI of 18.91-50.12 and 13.25-54.04 respectively, while fried water yam had medium GI of 24.33-69.16. High glycemic index foods have the proven to rapidly increase the blood glucose concentration after consumption and are not recommendable to diabetic individuals (Deborah *et al.,* 2020). Lower glycemic index foods on the other hand could be employed in the diabetic diets. Factors like variety, processing, cooking method, maturity etc. can influence the GI of a food. Acid thinned water yam can be used for industrial purposes such as yoghurt and starch production, Olugbenga (2016) and Banjo *et* al (2019) studied the potential of bitter yam and water yam peels as substrates for the biosynthesis of ethanol serving as alternative source of fuel. Water yam tuber and peels have proven to serve both as food and for industrial usage. This review aims to reveal importance of *D. alata* (water yam) by providing a report on the nutritional and chemical properties. In addition, highlights the therapeutic benefits and impact on human health associated with the consumption of the yam.

Nutritional and Mineral Values of *Dioscorea Alata* (Water Yam)

Minerals are metals and other inorganic compounds that are fundamentally essential for human nutrition and maintenance of certain physicochemical processes for the existence of a body. They play a critical role in the formation of skeletal structure, serving as essential co-factors for a number of enzymes and for the utilization of nutrients and enzymes which is responsible for digestion and absorption. Minerals are classified into three categories such as major, secondary and micro or trace minerals. P and K are major elements, Ca, Mg and S are secondary and B, Cl, Cr, F, I, Fe, Mn, Mo, Ni, Se, Na, V and Zn are under the category of micro, trace or rare Elements (Jenit and Siddhuraju, 2017). *Dioscorea* spp. contains a high level of secondary elements. According to Jenit and Siddhuraju (2017), the presence of essential minerals such as Na, K, Ca, P, Zn and Mn were observed in his study. His results indicated that phenolic compounds are the significant contributors to the antioxidant activity and concluded *Dioscorea* might be a promising natural antioxidant and could be very useful health food, as they enhance the antioxidant defence system. This is line with the investigation of Udensi (2008) who reported that mineral contents such as K, Na, P, Ca, Mg and Vitamin C were found in *D. alata* and he concluded they were of high levels indicating good sources of nutrition. In addition, consumption of these micro-nutrients rich foods helps to provide a strong immune system, thereby helping the body to absorb, utilize and digest required body nutrients.

The nutrient contents of some cultivars of *D. alata* were investigated by Wanasundera and Ravindran (1994). The average crude protein content of tubers was 7.4%. Starch content ranged 75.6-84.3%. Vitamin C content ranged from 13.0-24.7mg/100g fresh weight. He concluded, the results showed *D. alata* to be reasonably good sources of minerals. Twenty (20) varieties of *D. alata* was investigated by Wireko *et al* (2013) for their total dietary fiber (TDF), dry matter and amylase content as well as selected minerals. His studies showed that the TDF content varied from 4.20-11.00%.

The dry matter compositions from 19.10-33.80%, amylase 27.90-32.30% in Mg kg^{-1}. Mineral contents of the varieties he studied ranged from 10-10-17.60 for Zn, 10550-20100 for K, 83-131 for Na, 26-535 for Ca and 390-595 for Mg. Wireko's study identified varieties with higher amylase and TDF contents could be of use to diabetics and other health conditions due to their slower absorption rates. Low sodium but high potassium and TDF contents indicate the possible preventive role that *D. alata* could play in managing related chronic diseases. This shows the potential use of *D. alata* as a functional food to supplement the fiber and mineral needs of consumers. Baah (2009 a and b) also evaluated some *D. alata* varieties and his studies showed that the characteristics was relatively higher in *D. alata* varieties as compared to *D. rotundata*: moisture (72.2%), sugar (5.7%), protein (6.0%) and total dietary fibre (6.9%) contents; higher water binding capacity (163.3%), solubility (11.0%), and amylose (29.4%); breakdown (198.7 RVU), peak time (6.3 min) and pasting temperature (84.2 °C). However, dry matter (27.8%) and starch contents (68.4%), peak, setback, and final viscosities (215.7, 57.3 and 256.0 RVU respectively) were comparatively lower. Baah"s study on the nutritional and biochemical composition of *D. alata* also indicated that *D. alata* varieties could be good sources of nutrients to its consumers and could also be very useful in nutritional applications and diet formulations. A study by Obidiegwu *et al* (2020) revealed moisture content of *D. alata* cultivars to range from 64.9-87.8%, crude protein 0.6-18.7%, crude fat 0.23-5.28%, crude fiber 0.75-11.0% and ash 0.69-8.81%. Among the *Dioscorea* spp., *D. alata* has been reported to contain relatively high starch content when compared to others, up to 84.3% according to Obidiegwu *et al* (2020).

The variation in the starch content of *D. alata* recorded by some authors may be dependent on several environmental factors and agronomic practices, as well as the degree of maturity. Yam species like *D. alata* have been reported to have comparable higher protein levels. Mineral content may be influenced by environmental conditions such as soil composition, pH, elemental composition etc. However, processing can have led to considerable reduction in most of the minerals.

Chemical and Functional Properties

Proximate composition of *D. alata* includes Moisture, Ash, Crude protein, Crude lipids, Crude fibre, Carbohydrate and Energy value. Moisture content is used to determine the quality of food, increase the ease with digestion, absorption and the rate at which assimilation of food takes place within the body system. According to Jenit (2017), *D. alata* was found to have the highest moisture content (9.70%) compared to *D. pentaphylla* (8.69%), *D. oppositifolia* (7.31%) and *Pl. rotundifolius* (6.19%). High moisture content has positive influences, which can help to attain better activity for water dissolved enzymes and co-enzymes that are required in metabolic activities (Iheanacho, 2009). Protein is an essential nutrient, ranks second place after water in occupying most plentiful substance in our body. Among the raw tubers investigated by Jenit (2017), *D. alata* (7.78%) was found to have the highest content of protein followed by *D. oppositifolia* (5.68%), *D. pentaphylla* (5.53%) and *Pl. rotundifolius* (1.85%).

The crude fibre content of *Dioscorea* and *Pl. rotundifolius* tubers are ranged in 1.21-3.34%. *D. alata* (3.34%) showed the highest fiber content among other species. In all tuber species cooking increased the fiber content. Lipid content was found to be higher in *D. alata* raw tuber (3.20%) and the range of total lipid content observed was 1.51-3.20%. General lipid loss was registered during the processing of all the species of tubers. Starch is the main storage reserve carbohydrate found in many different plant organs especially many roots and tubers. The total content of carbohydrates in the tuber samples were ranged from 76.68 to 88.29% with variation between species/cultivars. Processing produced the least gain of carbohydrate content in the tubers. Earlier studies also indicate that starch is the predominant fraction of the yam tuber (*D. alata*-70 to 80%, *D. vilgaris*-73.9%) dry matter (Huang *et al.,* 2006 and Oko *et al.,* 2005).

Yam is a good source of energy and its tubers showed no significant variation in the gross energy values and falls in the range between 359.65 and 378.75 Kcal/100 g. Plant foods with above 12 % energy content have been considered as a good supply of proteins (Iheanacho, 2009). Some functional properties of *D. alata* varieties were reported according to Udensi (2008) which includes bulk density, water absorption capacity (WAC), wettability, gelation capacity. His study revealed the levels of bulk density of 0.64-0.76g/cm^3. High bulk density has shown to be important in flour reconstitution. The WAC is also an important parameter in food formulations.

The wettability showed the degree to which *D. alata* flour is likely to possess instant characteristics. The gelation capacity values obtained revealed that *D. alata* is not quite suitable in the formulation of fufu dough. This is in line with the study carried out by Bolanle *et al* (2013) where among the *D. alata* starches experimented on, Kesofunfun had the highest gelation capacity (LGC; 6%) compared to others, which formed firm gels at a concentration of 10% and above. He concluded the diverse gelation properties of the starches could be used as an advantage in different food applications; those with high gelling ability could be used in food such as jams and jellies and in foods where elasticity is desired while those with low gelling ability will be very useful as ingredient in processing complementary diet. On the chemical composition of all the varieties investigated by Udensi (2008), crude proteins with sweet potato base on the mean values. He concluded that the *D. alata* need not to be considered protein-poor. The fat levels across the varieties investigated were low. The carbohydrate content was high accounting for high energy calorie.

Wasiu *et al* (2016) fortified yam flour from *D. alata* with Distiller Spent Grain at 5–35% his result showed a significant increase ($P \leq 0.001$) in fat, ash, protein, total amino acids, total dietary fiber, and insoluble dietary fiber contents of the blends as distiller spent grain (DSG) increased except for starch and soluble dietary fiber contents, which decreased. The functional properties showed significant ($P \leq 0.001$) reduction methionine contents of the blends. He concluded, the DSG fortified yam flour contributed to quality protein intake in populations consuming yam as a staple, due to its indispensible amino acid content. Wanita *et al* (2021) worked on the quality improvement of yam flour (*D alata)* through the fermentation process. His study found: yam flour had an average moisture and ash content of 19% and 9.00%.

The fermentation with tape yeast produced the highest yield (20.40%). The highest amylose content (7.23%), protein (4.25%), viscosity (3.65 cp), carbohydrate (74.20%), and energy (319.81 kcal) were produced by fermentation in 12 hours with the Bi-Mocaf fermentor. Without fermentation, treatment formed the highest dietary fiber (18.27%) and fat content (0.780%). The processing into flour is expected to expand product diversification and increase the added value of yam tubers.

CONCLUSION

Dioscorea alata also known as water yam is of utmost importance in both food and non-food applications. Diosgenin, alkaloids, saponins, tannins, flavonoids, phenols, glycosides, steroids, and dioscorin are its bioactive compounds capable of influencing the cellular or physiological activities in humans as well as in animals. This specie of yam has been greatly preferred to others due to its nutritional contents especially on its low sugar content and the low glycemic index, this have favored diabetic and elderly group of people. *D. alata* cannot be said to be underutilized because so many have embraced the specie for several food applications such as Amala, formula fortification, it can be substituted for wheat.

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Effect of Two Major Land Cultivation Methods on Disease Incidence and Yield of Yam in Umudike, South-Eastern Nigeria

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ABSTRACT
The effect of effect of two major land cultivation methods was studied on the disease incidence and yield of yam in Umudike, south-eastern Nigeria in 2019/2020 cropping season. The experiment involved four varieties of yam and two land cultivation methods in randomised complete block design (RCBD) under rain fed conditions. Results showed that TDr 100003 had the incidence of yam anthracose disease which did not differ significantly from TDr 1400633 but differed from TDr 8902665, and Obioturugo (P<0.05) on both ridge and mound methods of land preparation. A similar trend was observed for yam virus disease on the two cultivation method. The yields of the different yam varieties were similar on both the ridges and mound cultivations showing that the yields of the yam and the incidence of the diseases on the yams were due to the genetic potentials of the yams and due to any of the cultivation methods. This indicates that both the use of ridges or mounds in the cultivation of yams did not make a difference in the performance of the yams but the inherent potentials of the yams which were not in the scope of the work. Therefore, this work recommended the use of ridging in the cultivation of yams in Nigeria.

Keywords: Anthracose, cultivation methods, incidence, virus disease, yam varieties

INTRODUCTION
Yams are cultivated in many parts of Nigeria. It is also found to exist in the wild within Nigeria. Both cultivation and storage of yam proceed with utmost attention to good husbandry. Fresh yams are known to have contributed significantly towards better health, nutrition, economy, general development (Obidiegwu and Akpabio, 2017). Yam is important food crop in Nigeria supplying millions with cheap caloric-energy food forms. The crop occupies an important position in the economic and social life of people living in West Africa (Nweke *et. al.*, 1991). Yam is the most important crop for human consumption. It is an important staple food, especially in tropical West Africa, due to its ability to flourish well under adverse ecological conditions. Yam is eaten daily by over 100 million people in Nigeria. For farmers growing the crop, yam represents one of the most important cash crops, where it can produce up to 200 metric tons per hectare after four growing seasons (Obidiegwu et al., 2020). Among the yams, the white yam, *Dioscorea rotundata* is the most widely cultivated and is believed to be indigenous to West Africa, probably from the forest zone of south Eastern Nigeria.

The introduction of water yam in Nigeria dates back to the times of the Portuguese arrival in Africa (Akinpelu *et al.,* 2009). Water yam or greater yam (*D. alata*) is the most widely distributed in the tropics and most cultivated by small holder farmers (Arnau *et al*., 2010). A smaller view of yam is that it is a vegetable that is used abundantly in the local dishes. The guests from other states and from abroad who come here to taste our delicacies, will attest to this fact. In the Yoruba language yam means 'doe', which stands for an important component in our diet. Yam flour or yam powder is made from dried and ground yam which is widely used in the making of different pounded confectionaries (Otegbayo *et al*., 2006). The importance of pest and diseases of yam is enormous. It leads to considerable loss in productivity and crop quality. Hence the importance of the importance of yam pests and diseases is huge. In the world of yam farming, there is a great threat from pests and diseases. Pests can destroy yam crops in fields as well as storage barns. Pests and diseases can damage the important food crop and may cause other losses that will certainly affect negatively the income of farmers. Understandably, to ensure a good yam harvest, farmers must follow proper pest and disease control to reduce incidence of pests and diseases (Amusa *et al*., 2003). Pests and diseases are among the most important factors militating against yam production in all yam growing areas of the world (Enyukwu *et al*., 2014).

The field and storage diseases include anthracnose which is regarded as the most widely spread of all the field diseases, while yam mosaic virus disease is considered to cause the most severe losses in yams. Rots including wet and dry rot is considered as the most devastating of all the storage diseases of yam and in many cases cause great losses in the field (Nwadili *et al*., 2012). Dry rot of yams alone causes a marked reduction in the quantity, marketable value and edible portions of tubers and those reductions are more severe in stored yams (Egesi *et al*., 2017). Different management strategies have been suggested for combating the field and storage diseases but none of these has been completely efficient in management of field or storage diseases of yam. Existing methods of pest control in yam production is based on the use of insecticides. The use of pesticides has negative impact on farmers and consumers. Pest control is one of the constraints to the improvement in yam production in Nigeria, which is the fourth most important food crop after rice, cassava and plantain (Adeniji *et al*., 2010). Development of integrated Pest management (IPM) programmes for the sustainable economic production of yam requires a comprehensive approach to pest management (Rathee *et al.,* 2018). Yam is a major staple food crop in Nigeria.

The major pests and diseases of yam in cultivated fields include weeds, insects and microorganisms. Unfortunately, the farmers do not fully understand the relationship between pests and diseases of yam with their environment and management practices. In this study, it has been emphasized that good method of control of agricultural pests and diseases through the use of land cultivation methods help to increase agricultural production significantly (Watson *et al*., 2002). The main method of controlling pests and diseases of yam is to ensure clean cultivation practices. This is done by ensuring the land where the yam is being cultivated for planting or growing is free of weeds, insect activities, rodents, earth worms, cut worms and mites (Edwards, 2004). Some of the most important factors in controlling pests and diseases of yam are the cultivation practices. Although there is no specific information on the control of nematodes, there are some general considerations which need to be kept in mind to control pests and diseases of yam (Abawi and Widmer, 2000).

Diseases of yam especially tuber rot (wet and dry rot) of yams cause marked reduction in the quantity, quality, marketable value and edible portions of tubers and those reductions are more severe in fields at different agro-ecological zones and in stored yams. This work is aimed to evaluate the disease incidence and severity under different ecologies and agronomic methods and determine field and cultural operations that favour reduced rot infestation in farmers' field and storage.

MATERIALS AND METHODS

Four yam varieties of *D. rotundata* and *D. alata* were planted in National Root Crops Research Institute, Umudike (NRCRI), Umudike, experimental field, a lowland rain forest zone of South-eastern Nigeria agro-ecozone (Agugo and Chukwu, 2009). The yams include two selected *D. rotundata* varieties (TDr1000003 and TDr1400633), one national check

(TDr8902665) and a popular variety of the locality (TDrObiaoturugo). The yams were planted in randomized complete block design with three replications containing four varieties of yam, two cultural methods (ridge and mound) in Umudike using the standard yam plant spacing of 1 m x 1 m apart with eight stands in a plot. Data were collected on vegetative and harvest parameters. Evaluations for rot incidence and some other diseases are on-going in the yam barn.

RESULTS AND DISCUSSION

The results in Table 1 showed that there is non-significant difference between planting yams on mounds and planting on ridges. This indicates that performance of yam did not differ due to the land preparation used as the land preparation using mound or ridge did not affect the yield. The incidence of two major diseases of anthracnose and virus were also not significant ($P \geq 0.1$) in the ANOVA (Table 1). This showed that the land preparation type does not affect the incidence of any of the two major diseases (Fig. 2). However, the incidence of the two diseases on yam in Umudike is attributed to the inherent potential of the yams. Fig. 3 showed that none of the land preparation type either ridge or mound made a difference on the yield of the yam varieties. As the yield of yam obtained from the two land cultivation types did not significantly ($P<0.05$), ridging method will be better recommended for farmers due to strong reasons as ease of making ridges using mechanical means other than making mounds using manual methods.

CONCLUSION

It is concluded in this work that using ridges or mounds does not make any significance in the expression of disease incidence on yam. Farmers therefore can use any of the land preparation method – ridge or mound for planting yams in Umudike as both are good for producing yam in relation to the size of yams targeted and total yield of yam.

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Table 1: ANOVA for yield, anthracnose and virus incidence

YIELD	Df	Sum sq	Mean sq	F value	Pr(>F)	
Ridge_Mound	1	0.49	0.49	0.354	0.56	
Varieties	3	82.8	27.6	19.934	1.19E-05	***
Ridge_Mound:Varieties	3	2.17	0.723	0.522	0.673	
Residuals	16	22.15	1.385			
Anthracnose_ incidence						
Ridge_Mound	1	0	0	0	1	
Varieties	3	62.7	20.89	0.302	0.823	
Ridge_Mound:Varieties	3	0	0	0	1	
Residuals	16	1106.7	69.17			
Virus_incidence						
Ridge_Mound	1	0	0	0	1	
Varieties	3	326.7	108.89	2.872	0.0689	
Ridge_Mound:Varieties	3	0	0	0	1	
Residuals	16	606.7	37.92			

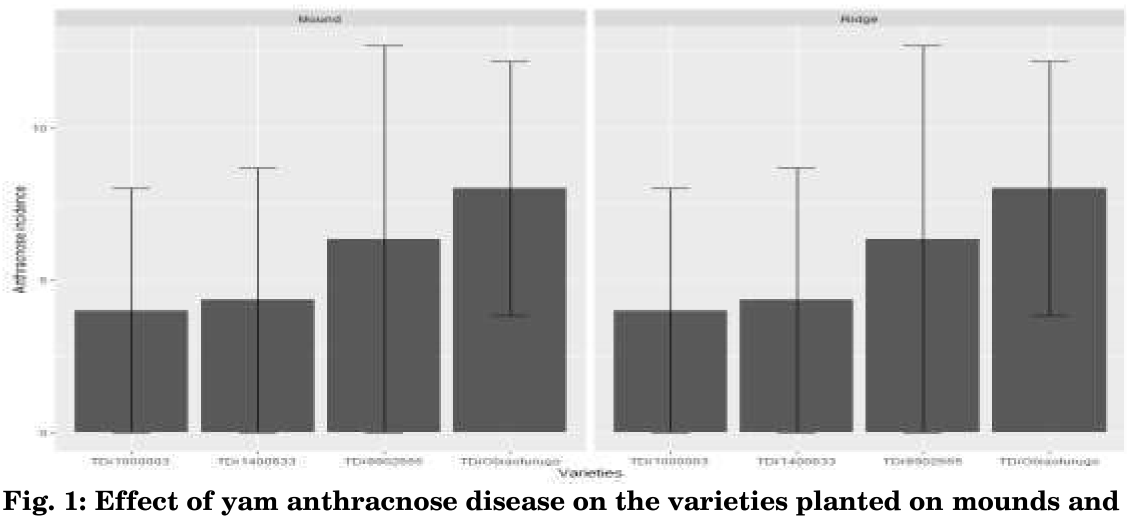

Fig. 1: Effect of yam anthracnose disease on the varieties planted on mounds and ridges

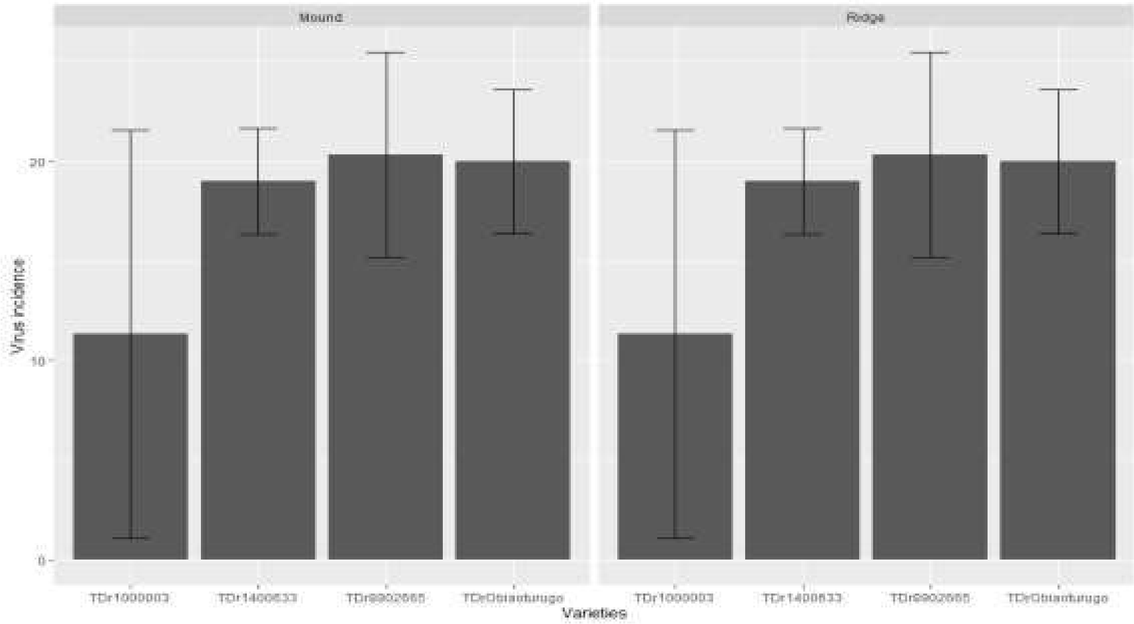

Fig. 2: Effect of yam virus disease on the varieties planted on mounds and ridges

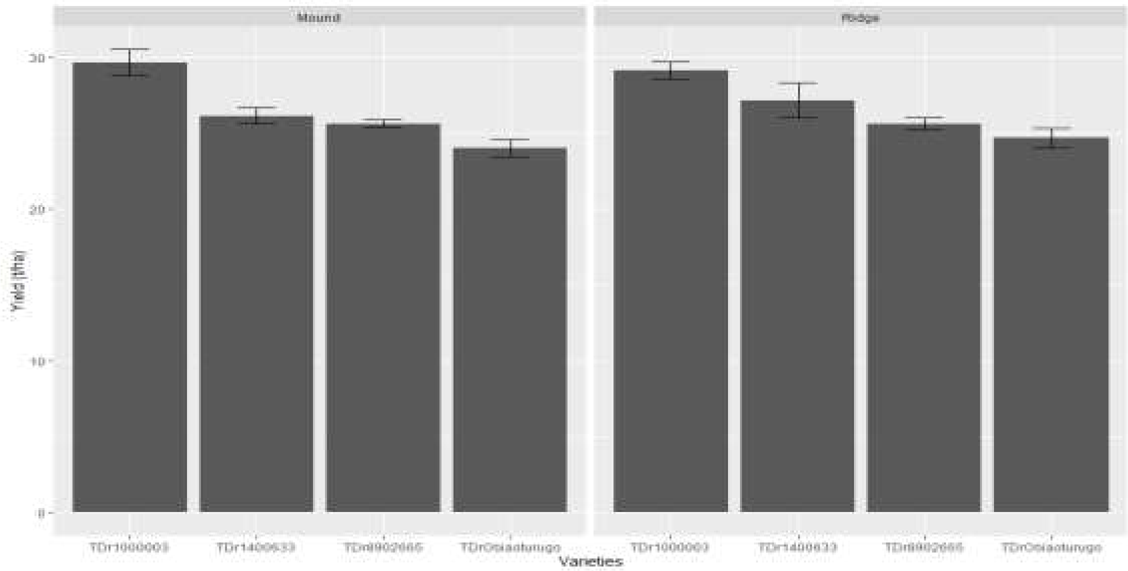

Fig. 3: Yield of yam varieties planted on mounds or ridges

Inheritance of Some Important Trait Indicators for Submergence Tolerance in Rice

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ABSTRACT
An experiment was conducted to determine the mode of inheritance of submergence tolerance in six basic rice generations of, P1, P2, F1, F2, BC1, and BC2 of a cross of FARO 44 x Swarna-Sub1. Dominance gene effects played major role in controlling the genetic variance in the trait indicators (plant height, days to 50% flowering, flag leaf length and flag leaf width) studied. The results indicated that the values of A, B, C and D scaling tests were not significant in the cross for plant height which indicated the absence of non-allelic interaction and the additive - dominance model being adequate to demonstrate the genetic variation in the inheritance of the studied traits. Additive effect [d] was not significant for flag leaf length and days to 50% flowering but was significant for plant height. Dominance effects [h] were positive and significant in the cross for flag leaf length and plant height except for days to 50% flowering which shows negative and non-significant values for dominance effects in the cross being investigated. However, the negative value of dominance [h] observed for some of the studied traits indicates that the alleles responsible for less value of traits had over dominant effect over the alleles controlling those with high values. The complex genetic behaviour, particularly dominance components, could be successfully exploited in later generation
Keywords: *Inheritance, Rice, Submergence, Tolerance*

INTRODUCTION
Rice, *Oryza sativa* L., (2n = 24) is an important cereal that belongs to the family Graminae and subfamily Oryzoideae. It is a staple food for half of the world's population but is faced with problems of drought and flooding due to present prevailing climate change conditions (IRRI, 2010). Among the several biotic and abiotic stresses affecting rice production, submergence has been identified as the third most important constraint because it has been reported to cause total yield loss (Sarkar *et al.,* 2006). Prolonged submergence is a major constraint to rice production, affecting over 15 M ha in South and South East Asia. (Singh *et al.,* 2009). Flooding is a serious constraint to rice plant growth and survival in rain fed lowland and deep water areas because it results in partial or complete submergence of the plant.

The average rice productivity of submergence-prone areas in eastern India is 0.5 - 0.8 t ha^{-1}, whereas it is about 2.0 t ha^{-1} for favourable rain fed lowlands, being much lower than the input-intensive irrigated system (5.0 t ha^{-1}). Africa is highly vulnerable to climate change (IPCC 2014) but data is scarce on the effect of floods on rice production in Africa. The area affected by flooding is expected to increase due to climate change. In Nigeria, approximately 70% rain fed lowland rice farms are prone to seasonal flooding which is a major challenge to rice production in some major rice producing states, and each year, rice farmers in these parts of the country lose their entire crop to flooding. During any given year, yield losses in Nigeria resulting from flooding may range from 10% to total destruction.

Recently, the extent of submergence stress has increased due to extreme weather events such as unpredicted heavy rains that have inundated wider areas across many states of the country. Among the most frequently and severely affected states in Nigeria are Kebbi, Niger, Kogi and Taraba states which together account for over 80% of lowland rice ecology in Nigeria (Akinwale *et al.,* 2012). However, these flood-prone ecosystems have enormous potential for more food production to meet the ever increasing demands for rice supply because of the predominance of good soils and freshwater resources (Ismail *et al.,* 2013). Submergence tolerance is controlled by a single major quantitative trait locus (QTL) on chromosome 9, along with a number of minor QTLs (Toojinda *et al.,* 2003). The major QTL, named Sub1 has a LOD score of 36 and an R2 value of 69% (Xu and Mackill, 1996), discovered to provide tolerance to complete submergence for up to 2 weeks. Sub1 gene enables rice to survive and more importantly, recover after flooding (Mackill *et al.,* 2012). The varieties with Sub1 gene has shown a yield advantage of 1 to 1.3 t/ha over the original varieties following submergence for a few days up to 18 days (Mackill *et al.,* 2012; Singh *et al.,* 2013).

Swarna-Sub1 yields twice than that of Swarna without Sub1 with about 15 days of submergence. The introduction of this Sub1 gene into commercial local adapted rice varieties would help to reduce yield losses experienced by lowland rice farmers. Therefore, this study was designed to transfer Sub1 gene to commercial variety of FARO 44 and then estimated the inheritance of some important traits indicators (plant height, internode length, internode width and days to 50% flowering) and gene effects for submergence tolerant rice.

MATERIALS AND METHODS

Two rice varieties, FARO 44 and Swarna-Sub1 were used in this study as parents. FARO 44 is the most widely grown commercial variety in Nigeria with medium height, medium duration, "A" type grain quality, good cooking and eating quality but submergence intolerant and Swarna-Sub1 is a submergence tolerant variety. The crosses were made in the wet season of 2018 between FARO 44 x Swarna-Sub1 to generate the F1. In the wet season of 2019, the F1 were backcrossed to the recurrent parent, FARO 44 (P1) and donor parent Swarna-Sub1 (P2) to generate backcross 1 and backcross 2 (BC1 and BC2) population while the rest F1 not used for the backcross were harvested at maturity as F2.

In the wet season of 2020, the generated six generations, namely, P1, P2, F1, F2, BC1 and BC2 were evaluated in a compact family block design with three replications at the Research Field of National Cereals Research Institute Badeggi. Twenty-one days old seedlings were transplanted in separate plot sizes of 2 M length, 20 × 20 cm inter and intra row spacing. The recommended agronomic practices were followed to raise healthy crops. The phenotypic traits were assessed on each individual entry in the segregating generations and observations were recorded for four important submergence trait indicators: plant height (PH), flowering time (DF), flag leaf length and flag leaf width. Ten (10) plants from both parents P1 and P2, 20 plants from F1, BC1 and BC2 and 200 plants from F2 generation per replication were sampled and data collected from them. Analysis of variance was carried out for all six generations. The inheritance pattern and distribution of frequency for submergence tolerance was carried out by χ 2 test. The means were computed for each generation of P1, P2, F1, F2, BC1 and BC2. The variance and corresponding standard errors of the means were computed from the deviations of the individual values from the pooled mean for each of the generation in each cross. The generation mean analysis was performed according to Hayman (1958) and Jinks and Jones (1958) for the estimation of genetic components of variation, epistasis model and gene effects in two steps;

(i) Testing for epistasis to determine the presence or absence of inter-allelic interaction through scaling test and

(ii) Estimation of gene effects, variances and the type of epistasis involved.

Scaling test for A, B, C and D scales as suggested by Hayman and Mather (1955) and Mather and Jinks (1971) was applied to test the adequacy of simple additive-dominance model. Utilizing the means of different generations, the values of A, B, C and D scales were calculated. The generation means were analysed by the method described by Hayman (1958) to provide information on the inheritance of observed traits. The generation means were used to estimate the six genetic parameters viz., m, d, h, i, j and l of digenic interaction model representing mean, additive genetic effect, dominance genetic effect, additive × additive gene interaction effect, additive × dominance interaction effect and dominance × dominance gene effects, respectively assuming that no linkage and no higher order gene interaction

Analysis of variance

The analysis of variance was calculated for the six generations of the specific cross of FARO 44 x Swarna-Sub1.

RESULTS AND DISCUSSION

Results showed significant differences for all the trait indicators investigated. It was evident from the analysis of variance that the lines showed significant difference for most of the trait indicators investigated except for flag leaf width (Table 1). The non-significance of flag leaf in rice lines for yield traits were also reported by Nessreen *et al.* (2020). Table 2 shows the estimates gene effect of the six parameters, i.e. additive [d], dominance [h], additive × additive [i], additive × dominance [j] and dominance × dominance [l] and means [m]. The mean effects were not significant for all studied traits in the cross, indicating that the traits were not quantitatively inherited. Additive effect [d] was not significant for flag leaf length and days to 50% flowering but was significant for plant height. Non-significance in these cases may be ascribed to large error variance. All the traits investigated for additive gene effects were negative. The negative or positive signs for additive effects depend on the choice of parents (P1) before the commencement of the breeding programme (Cukadar-Olmedo and Miller, 1997). Dominance effects [h] were positive and significant in the cross for flag leaf length and plant height except for days to 50% flowering which showed negative and non-significant values for dominance effects in the cross being investigated.

However, the negative value of dominance [h] observed for some of the studied traits indicates that the alleles responsible for less value of traits were over dominant over the alleles controlling those with high value and this is in accordance with the works of Iqbal *et al.* (2010); El-Badawy and El, (2012) and Shahrokhi *et al.* (2013). The results of the A, B, C and D scaling tests for assessing the validity of additive - dominance models were given in Table 2. The values of the A, B, C and D scaling tests were not significant in the cross for plant height indicating the absence of non-allelic interaction and the additive - dominance model was adequate to demonstrate the genetic variation and it is important in the inheritance of the studied trait in such cross. Days to 50% flowering showed significance for Scale B and non-significance for other scales while flag leaf length was significant for scale D of the scaling test. The traits investigated in relation to submergence tolerance in the study were significant in either one of the scales except for plant height. This indicates the existence of epistatic interactions between the genes involved. These results are in agreement with those obtained by AL-Ahmad (2004); Azizi *et al.* (2006) and Ishfaq (2011).

CONCLUSION

The traits examined in the study showed complex genetic behaviour. The simple selection procedure in the early segregating generation may not play significant role for the improvement of submergence traits. Dominance gene effects played major role in controlling the genetic variance in the trait indicators studied. The complex genetic behaviour, particularly dominance components, could be successfully exploited in later generation. It is suggested that selection for the improvement for submergence tolerance traits should be delayed to later generation of segregation population in rice. With regard to the negative values observed in most cases either with main effects [d] and [h] or epistatic interaction effects ([i], [j] and [l]), these might indicate that dominance was towards the less value trait and alleles responsible for less value of traits were over dominance over the alleles controlling high values.

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Table 1: Analysis of Variance for trait indicators investigated for submergence tolerant rice crosses of FARO 44 x Swarna- Sub1.

	Source	DF	SS	MS	F-value	Pr(>F)
Flag Leaf Width	**Block**	2	0.051	0.026	0.450	0.652
	Genotype	5	0.316	0.063	1.100	0.416
	Error	10	0.572	0.057		
	Total	17	0.939			
Flag Leaf Length	**Block**	2	11.862	5.931	6.250	0.017
	Genotype	5	90.632	18.126	19.090	0.000
	Error	10	9.495	0.950		
	Total	17	111.989			
Days to 50% Flowering	**Block**	2	0.963	0.481	0.190	0.830
	Genotype	5	1422.781	284.556	112.250	0.000
	Error	10	25.351	2.535		
	Total	17	1449.095			
Plant Height	**Block**	2	1.268	0.634	0.540	0.600
	Genotype	5	358.714	71.743	60.770	0.000
	Error	10	11.805	1.181		
	Total	17	371.787			

Table 2: Parameters of gene effects, types of epistasis and Scaling test for all studied traits in the cross.

gene effect	flag leaf length	days to 50% flowering	plant height	scalin g test	flag leaf length	days to 50% flowering	plant height
m	1.848	1.136	1.934	**A**	0.18	0.99	0.07
d	-0.168	-0.768	0.171	**B**	0.10	-0.01**	0.25
h	0.032	0.580	-0.013	**C**	0.26	0.38	0.40
i	-0.012	0.520	-0.116	**D**	0.01**	-0.52	0.12
j	0.065	0.788	-0.144				
l	-0.111	-0.661	-0.075				
type of epistasis	**D**	**D**	**D**				

[m]= Means, [d]= Additive, [h]= Dominance, [i]= Additive × additive, [j]= Additive × dominance and [l]= Dominance × dominance

Meaning and Appropriate Use of Some Terminologies for Cultivated Plants

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ABSTRACT

Due to the need to distinguish in more specific terms the status of plants, scientists have come up with many names such as crops, species, cultivars, cultigens, varieties, landraces, ecotypes, accessions, breeding lines, genotypes or events for plants depending on their status. When these terms are used interchangeably as many often do, they become very confusing to many stakeholders and may actually misrepresent the actual status of the plant. In this paper, I presented definitions which bring out the clear meaning of these terminologies and suggested when it is most appropriate to use them in the hope that it will help clear up some of the prevalent confusion in their use.

Keywords: Crops, Species, Cultivars, Cultigens, Varieties, Landraces, Ecotypes, Accessions, Breeding Lines, Events, Genotypes

INTRODUCTION

Providence has always conferred on man the prerogative of naming other organisms including plants. So man has always come up with scientific, common or local names for plants that he discovered which includes domesticated and wild ones. However, occasions arise when it is important to further distinguish in more specific terms the status of a plant. Cultivated plants are referred to as crops, species, cultivars, cultigens, varieties, landraces, ecotypes, accessions, breeding lines, events or genotypes depending on their status. Each of these terms represents a specific status of a plant. To that extent, each of these terms are distinct so when they are used interchangeably as many often do they become very confusing to many stakeholders and may actually misrepresent the actual status of the plant. As plant breeding continues to evolve, new terminologies continue to be churned out (Griesss, 2016). As scientists and other stakeholders, it is important to use these terminologies appropriately to minimize confusion and avoid misrepresentation. The importance of using appropriate terminology when referring to cultivated plants can therefore not be overemphasised. The need to avoid such confusion and misrepresentation, informs the object of this paper which seeks to clarify the most common terms used to describe the status of plants.

Appropriate Terminologies and Use

Various terminologies have been used to refer to crop plants. These include crops, species, cultivars, varieties, landraces, ecotypes, accessions, breeding lines, events or genotypes. It is plausible to expect more terminologies to be churned out as science continues to advance. In this section we shall present clear definition of each term and explain the most appropriate situation to use them.

Crop
Crop is a commonly used term in agriculture. A crop is a plant or plant product that can be grown and harvested for profit or subsistence. By use, crops fall into six categories: food crops, feed crops, fiber crops, oil crops, ornamental crops, and industrial crops (National Geographic, 2011). Crops may refer either to the harvested parts or to the harvest in a more refined state. Most crops are cultivated in agriculture or aquaculture. A crop may include macroscopic fungus (e.g. mushrooms), or macroscopic marine alga (e.g. seaweed). The term crop is of more or less general use. It can be used for all our food and cash crops including their cultivars, varieties and ecotypes

Species
Without going into technicalities which are beyond the scope of this paper, a species is simply defined as the largest group of organisms in which any two individuals of the appropriate sexes or mating types can produce fertile offspring, typically by sexual reproduction (Wikipedia, downloaded 26/09/2021). It is the basic unit of classification and a taxonomic rank of an organism, as well as a unit of biodiversity. All species (except viruses) are given a two-part name, a "binomial". The first part of a binomial is the genus to which the species belongs. The second part is called the specific name or the specific epithet. For example, *Dioscorea alata* is one of the many species in the genus *Dioscorea* with *alata* being the specific epithet for Water yam. The term species is of more technical usage especially when trying to highlight specific taxonomic differences between plants. For example, Cocoyam is made up of two species *Colocasia esculenta* and *Xanthosoma sagitifolium*. Yam is made up of many species including *Dioscorea esculenta, Dioscorea dumetorum, Dioscorea alata, Dioscorea bulbifera* and *Dioscorea cayenensis*

Cultivar
The word cultivar is a widely used term for most domesticated crops. It was coined in 1923 by an American Horticulturalist and Botanist Liberty Hyde Bailey (Bailey, 1923). Though he never explicitly stated the etymology, it is generally assumed to be a blend of two words namely cultivated and variety (Biology dictionary downloaded 19/09/2021). A cultivar is an assemblage of plants that (a) has been selected for a particular character or combination of characters, (b) is distinct, uniform and stable in those characters, and (c) when propagated by appropriate means, retains those characters (Brickell *et al*. 2009). In this regard most cultivated plants qualify to be addressed as cultivars.

Cultigen
The term cultigen (a combination of latin words cultus: cultivated, and gens: kind) was also coined by Liberty Hyde Bailey in 1918 but redefined in 1923 (Bailey, 1923) to mean plant or group known only in cultivation; presumably originating under domestication. Essentially, a cultigen is a plant whose origin or selection is primarily due to intentional human activity (Spencer and Cross, 2007). Classical examples of cultigens are Maize, Bananas. New species and genotypes of plants developed by conventional breeding and biotechnology also qualify to be called cultigens. The term cultigen is however not commonly used in Nigeria

Varieties
According to FAO (2009), a "Variety" means a plant grouping, within a single botanical taxon of the lowest known rank, defined by the reproducible expression of its distinguishing and other genetic characteristics. Article 1(vi) of the 1991 Act of the UPOV Convention defines "variety" as a plant grouping within a single botanical taxon of the lowest known rank, which grouping, irrespective of whether the conditions for the grant of a breeder's right are fully met, can be defined by the expression of the characteristics resulting from a given genotype or combination of genotypes, distinguished from any other plant grouping by the expression of at least one of the said characteristics and considered as a unit with regard to its suitability for being propagated unchanged (UPOV, 2010). From above definition it is clear that a variety

may not contain more than species, is wider than an officially released hence protectable variety. However, the most common usage of the term variety is for the officially released varieties.

Landraces
Merriam-Webster dictionary defines a landrace as a local variety of a species of plant or animal that has distinctive characteristics arising from development and adaptation over time to conditions of a localized geographic region and that typically displays greater genetic diversity than types subjected to formal breeding practices. Casanas *et al*., (2017) proposed a more inclusive definition of landraces, namely that they consist of cultivated varieties that have evolved and may continue evolving, using conventional or modern breeding techniques, in traditional or new agricultural environments within a defined eco-geographical area and under the influence of the local human culture. Generally, traditional cultivars not officially registered or released are known as landraces. For example, UG1 (yellow) and UG2 (Black) ginger are landraces. Similarly, NCe 001 (Cocoindia), NCe 002 (Edeofe green), NCe 003 (Edeofe purple), NCe 004 (Ede ofe giant), NCe 005 (Ukpong), NCe 006 (Ede gana) are some of the landraces of cocoyam.

Ecotypes
As a term, "ecotype" was originally coined by the Swedish botanist Gote Turesson in 1922 and has been widely used to describe "a genetically unique population that is adapted to its local environment" (Engelhard *et al*., 2011). Lowry (2012) explains that ecotypes are groups of populations, which are distinguished by a composite of variation in many traits and allele frequencies across loci over space. Because ecotypes are formed by multiple trait adaptations to many environmental variables that co-vary in space, they are best represented by the principle components of all trait variation. Ecotype are inter fertile as they are of the same taxonomic species; genetically distinct and inheritable; variations are permanent and irreversible and retain their variations and do not change even when cultivated in a natural habitat. When collections of a particular cultivar or landrace are made from ecologically different locations to which they have been variously adapted, we can call them ecotypes.

Accessions
An accession is a distinct, uniquely identified sample of seeds or plants, that is maintained as part of a germplasm collection (National Research Council, 1991). In plant breeding, an accession is a distinct, uniquely identifiable sample of seeds representing a cultivar, breeding line or a population, which is maintained in storage for conservation and use (FAO, 2021). Each accession is usually collected at one time from a specific location and is given a unique identifier, an accession number which is used to maintain associated information in the database (OPGC, 2021). Each accession is an attempt to capture the diversity present in a given population of plants. It is important to note that accessions maintained in a particular germplasm may contain duplicates of the same genetic material (e.g. a particular variety) that have been collected from different locations at different times and hence were given different accession numbers. From the foregoing, any plant material, cultivar, population, breeding line or a landrace can be called an accession. The term is best used to refer to such materials in a germplasm or gene bank.

Breeding Lines
Breeding lines refer to group of identical pure-breeding diploid or polyploid plants with unique phenotype and genotype that distinguished them from other individuals of the same species. Breeding Lines are given numbers by the breeder while doing breeding or some other experiment. The term is best used within the context of breeding environments

Genotypes

The term genotype was coined by the Danish botanist Wilhelm Johannsen in 1903. In a broad sense, the term "genotype" refers to the genetic makeup of an organism but in a narrower sense, the term can be used to refer to the alleles, or variant forms of a gene, that are carried by an organism. However, in plant breeding, a genotype is usually a crop cultivar/line/variety that is represented by a large group of individual plants with exactly the same genetic constitution or make-up. This is mainly because most crop cultivars are clones, inbred lines, or hybrids. A genotype in plant breeding does not refer to just a single individual, but to all individual plants belonging to the same cultivar and thus sharing the same genotype. This allows for true replication of a genotype in and across multiple environments, even at a single time point and thus without repeated measurements in time. (Schmidt *et al*., 2019). Thus the term genotype can be applied to a cultivar, variety, landrace or breeding line provided that the group of individual plants are of the same genetic constitution. However, the term genotypes are most often used in technical discussions and at experimental levels.

Events

The term 'event' with respect to plants came from the field of genetic engineering and is used mostly in reference to transgenic plants. A genetic modification (GM) event is defined by the insertion of DNA into the plant genome as a result of a single transformation process. Multiple DNA sequences may be inserted during a single transformation process. Thus, a single GM event may be characterized by the expression of one or more GM traits (Pilacinskia *et al.,* 2011). Events are differentiated by two factors: 1) what transgene was inserted, and 2) where on the chromosome it inserted and how many gene copies inserted at that locus. Usually, following transformation, lead events are regenerated into plantlets which are weaned and transferred to the field for regulatory trials prior to release of promising ones for commercial use.

CONCLUSION

Terminologies including crops, species, cultivars, cultigens, varieties, landraces, ecotypes, accessions, breeding lines, events and genotypes were clearly defined and their most appropriate usage suggested.

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Genotype by Environment Interaction of Some Lowland Rice (Oryza *Sativa* L) Varieties across Diverse Rice Growing Zones in Nigeria Using AMMI and GGE Biplot Models

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ABSTRACT

The quest for plant breeders to develop varieties that could be seen as stable across multi-environment cannot be overemphasized. Genotype by environment interaction and stability performance was investigated for grain yield of thirteen rice genotypes across six environments. The experiment was aimed at determining stable genotypes across different rice growing zones in Nigeria. The trial was laid out in a randomized complete block design with three replications across all the test environments. The experiments were conducted at the research stations of National Cereals Research institute Badeggi (Warri, Ibadan and Brinin-kebbi) and two Agricultural Development Project experimental site (Enugu and Abakaliki). The results indicated that there was significant difference at $p \leq 0.05$ for all traits measured for genotype, environment and genotype by environment interaction except for 1000 grain weight and panicle count. Additive Main effect and Multiplicative Interaction (AMMI) analysis showed that Interaction principal component axis 1 (IPCA1) and IPCA2 account for 83.2% and 11.9% of the total variation explained by genotype by environment sum of square respectively. Using AMMI stability value (ASV) and Yield stability index, genotype ART 1005-21-1-1-B (G9) showed to be the most stable. AMMI bipot identified G9 as the most stable genotype whereas, GGE biplot identified genotype ART 1002-10-1-1-1-B (G1) as the ideal genotype in the tested environment.
Keywords: Environment interaction, genotype, panicle count, Yield stability index

INTRODUCTION

Rice (*Oryza sativa* L.) is a staple food for nearly two third of the world population (Hashim *et al.*, 2021). Ninety percent of total rice production comes from Asia (Sharifi *et al.,* 2017). In Nigeria, rice has become a staple food for all classes of people unlike the past when it was only for people with high level of income (Matemilola and Elegbede, 2017). Rice is grown under different ecologies ranging from rainfed lowland, rainfed upland, irrigated upland, and irrigated lowland, deep-water to mangrove ecologies. Upland and deep-water rice production each accounting for 4 % of global rice production. Irrigated rice accounts for about 75 % of total rice production, while rainfed lowland account for about 17 % of world rice production (Dada *et al.,* 2013). The performance of any character is a combined result of the genotype (G) of the variety, the environment (E) and the interaction between genotype and environment (GE) (Leon *et al.,* 2016). GE interactions exist when the responses of two genotypes to different levels of environmental stress are not consistent. Genotype × environment (GE) interaction refers to different ranking of genotypes across environments and may complement the selection process and recommendation of a genotype for a targeted environment (Ebdon and Gauch, 2002; Gauch, 2006).

The Additive Main Effects and Multiplicative Interaction (AMMI) model is a hybrid analysis that incorporates both the additive and multiplicative components of the two-way data structure. The AMMI analysis uses analysis of variance (ANOVA) followed by principal component analysis (PCA) applied to the sums of squares allocated by the ANOVA to the G × E interaction (Akter *et al*., 2014). AMMI model extracts genotype and environment main effects and uses principal component analysis (PCA) to explain patterns in the Genotype by Environment interaction or residual matrix, which provides a multiplicative model and is applied to analyze the interaction effect from the additive Analysis of Variance model (Islam *et al*., 2014). The GGE biplots allow for the analysis of many characteristics of genotypes and environments, such as finding the best performance genotype for each environment, genotype stability, representative environment, and discriminating power of each environment (Donoso-Ñanculao., 2016). The development of high yielding rice varieties has been faced with some setbacks based on the complexity of yield, the breaking down of genotypes to biotic and abiotic stress and the impact of climate change. The development of stable varieties across environment or for target environment is of optimal national interest. Therefore, the objectives of this study was to evaluate the genotype by environment interaction of some selected lowland rice across diverse rice growing zones in Nigeria using AMMI and GGE biplot models

MATERIALS AND METHODS

The experiment was conducted during 2020 rainy season at the National Cereals Research Institute Badeggi (Southern Guinea savannah of Nigeria) and some of its outstations in Birnin Kebbi (Northern Guinea savannah), Ibadan (Derived savannah) and Warri (Rain forest). Other sites include Enugu (Derived Savannah), Abakaliki (Derived savannah) locations was at the ADP's (Agricultural Development Project) experimental sites.

All genetic materials were sourced from rice breeding gene bank of National Cereals Research Institute Badeggi. The following rice genotypes were used: ART 1002-10-1-1-1-B, ART 478-8-1-1-1-B, ART 387-2-1-1-1-B, ART 263-11-B-1-B-B, ART 397-3-2-1-1-B, ART 1005-21-1-1-B, ART 143-114-B-1-B-B, ART 314-14-B-1-B-B, ART 216-173-B-1-B-B, ART484-19-1-1-B, Basmati, FARO 44 (check) and FARO 52 (check). The rice genotypes and the environment were the treatments. The rice genotypes were fitted in a randomized complete block design across all environments. All agronomic practices (land preparation, nursery establishment, transplanting of seedlings after 21 days, weed control, fertilizer application and harvesting) were carried out following Standard Agronomic Practice for growing lowland rice as described by International Rice Research Institute (IRRI) and Africa rice. Data were collected on the following traits, Plant height, Number of tillers, Days to 50% flowering, 1000 grain weight (g), Panicle number and Grain yield per hectare. The combined analysis of variance across the environments were carried out on data collected using Statistical Tools for Agricultural Research (STAR) version 2.0.1 software, in order to determine the differences between genotypes across environment, within environments and the interaction between genotypes and environments Bartlett's test was used to assess the homogeneity of error variances prior to combine analysis over environments. Duncan's Multiple Range Test (DMRT) was used for mean separation. ANOVA from Additive Main Effects and Multiplicative Interaction (AMMI) and regression model were computed for grain yield. Genotype by environment interaction was quantified using pooled analysis of variance, which partitions the total variance into its component parts (genotype, environment, genotype by environment interaction and pooled error). The genotype by environment interaction analysis using Eberhart and Russell regression model was computed by using Plant Breeding (PB) tool version 1.3 statistical software. AMMI biplot and GGE biplot were used to determine which genotypes was most stable across the tested environments. AMMI stability value was computed using the formula as described by Tena *et al.,* (2019):

$$\text{ASV} = \sqrt{\left[\frac{\text{IPCA1SS}}{\text{IPCA2SS}}\quad (IPCA1score)\right]^2 + [\text{IPCA2score})^2}$$

Yield stability index (YSI) was calculated using the following formulae as described by (Adetiloye and Ariyo, 2020)
YSI= RASV +RY
RASV = Ranking using AMMI Stability value
RY =Ranking of yield.
Used with other parametric and non-parametric stability parameters to rank genotypes performance across test environment.

RESULTS AND DISCUSSION

Table 1 shows the mean square value of some traits measured. From the result, genotype, environment and genotype by environment interaction (GEI) were significantly different at $p<0.05$ for all traits measured except for panicle count and 1000 grain weight. This implies that the genotypes and the environment were different from one another. The presence of genotype by environment interaction was established because, GEI showed significant different at $P< 0.05$ probability level. The result obtained is in agreement with the findings of Abate *et al*. (2015) who reported high significant difference for genotype environment and genotype by environment interaction. Highly significant GEI implies that, different genotypes response differently to a specific environment or under different environmental condition, a genotype may not exhibit the same phenotypic performance. Akter *et al.* (2015) reported similar result where significant difference at $P< 0.05$ for genotype, environment and genotype by environment interaction for grain yield when genotype by environment and yield stability were carried out for some hybrid rice in Bangladesh.

Table 2 shows Additive Main effect and Multiplicative Interaction (AMMI) analysis of variance. AMMI helps in partitioning the genotype by environment interaction sum of square into different principal component Axis. From the table, the Interaction principal component Axis 1(IPCA1) accounted for 83.2 % of the total variation explained by genotype by environment interaction sum of square. While, IPCA2 accounted for 11.9 % of the total variation explained genotype by environment interaction sum of square. The first two principal components IPCA1 and IPCA2 were significant and sufficient to explain the G×E interaction. Krishnamurthy *et al*. (2021) reported similar result where IPCA1 explained 27.21 % of the total variation explained by genotype by environment sum of square while, IPCA 2, IPCA 3, IPCA 4 and IPCA 5 accounted for 20.41 %, 12.88 %10.33 % and 6.7 % respectively of the total variation explained by genotype by environment interaction sum of square when AMMI analysis was carried out to determine yield performance of some rice genotypes and specific adaptation to salt stress location in India. Shim *et al.* (2015) reported significant difference at $P< 0.05$ for IPCA1, IPCA2, and IPCA3 respectively. IPCA1 explained 45.7 % of the total variation explained by genotype by environment interaction sum of square, while IPCA 2 and IPCA 3 explained 31.0 % and 10.8 % of the total variation explained by genotype by environment interaction respectively. Also Das *et al.* (2010) reported significant difference at $p< 0.05$ for IPCA1. IPCA1 and IPCA2 accounted for 61.49 % and 25.00 % of the variation explained by genotype by environment interactions when Genotype by environment interaction, adaptability and yield stability were done for some mid early rice genotypes.

Table 3 indicated genotype ranking, using Additive Main effect and Multiplicative Interaction Stability Value (ASV) and Yield Stability index (YSI). The result shows that genotypes with low ASV had stable performance across all environments while genotypes with high ASV have specific adaptation to target environment. FARO 44 (Check) (G12) is the most stable genotype followed by ART 478-8-1-1-1-B (G9) and FARO 52 (Check) (G13) respectively. G1, G5 and G6 have specific adaptation to a target environment. Similar result was recorded by Adetiloye and Ariyo (2020), who reported genotype TGm 107 to be the most stable genotype followed by genotype TGm 570 and TGM 686 respectively. TGm 868, TGm 1209 and TGm 150 were said to have specific adaptation when genotype by environment interaction and stability analysis were performed for 43 accession of tropical soybeans. Using YSI genotypes with low yield stability index were the desirable genotypes. Genotype ART 478-8-1-1-1-B (G9) is the most stable genotype followed by ART 397-3-2-1-1-B (G8) and FARO 52 (G13) respectively. The result is in agreement with the findings of Adetiloy and Ariyo (2020) who reported TGm 107 and TGm 1200 as the most desirable genotypes when YSI was used to rank genotypes. From the AMMI biplot genotype G4, G6 G7, G9, G10, G12, and G13, had positive IPCA1 scores and high average grain yield but genotype G6 indicates specific adaptation to a target environment. Genotype G3, and G8 have negative IPCA1 scores but high average grain yield while genotype G12 and G11 had negative IPCA1 scores and low grain yield. Also the biplot indicated that genotype G9 was the most stable among the genotypes that were evaluated. Similar result was reported by Akter *et al.* (2015).

Zewedu *et al*. (2020) reported that, IPCA1 scores and sign reflect the magnitude of the contribution of both genotype and environment to genotype by environment where scores near zero were characteristics of stability, and where genotype with higher scores are consider to be unstable and to be having specific adaptation to target environment. Shojaei *et al.* (2021) reported similar result, where genotypes with positive IPCA1 scores and were high yielding were identified as the most stable genotype. G8 (Dc370) was the most stable high yielding genotype when yield analysis of some maize hybrid were carried out using AMMI and other parametric analysis in Iran.

Result presented in Figure 1 showed GGE biplot Genotype view G1 was the ideal genotype followed by G8, G9, G3 and G10. An ideal genotype was that genotype that was high yielding across all test environment and it was absolutely stable. This genotype was assumed to be the centre of the concentric circle the arrows point but such ideal genotype may not exist in reality but can be used as reference for genotype evaluation. A genotype is more desirable if is closed to the ideal genotype. Similar result was reported by Tena *et al.* (2019), that genotype G5 was the ideal genotype while genotype G3 and G10 followed respectively. Mohammed *et al.* (2013), reported similar result that an ideal genotype was the best performing genotype across all tested environment and that the genotype was be absolutely stable in performance. G10 was identified as the ideal genotype when AMMI and GGE biplot analysis was used for genotype by environment interaction studies in wheat.

Tefera (2018) recorded similar result in which G5 was the ideal genotype followed closely by G17, G19 and G25 when GGE biplot phenotypic stability analysis was carried out for some soybeans genotype.

CONCLUSION

Genotype ART 1002-10-1-1-1-B (G1) was the most stable across all environments while genotype G8, G9, G3 and G10 were referred to as desiring genotypes. Genotypes G6, G7, G11, G5, G1 and G10 shows static adaptation and may be selected for target environment. Further evaluation should be conducted across more rice growing areas in Nigeria, followed by farmer participatory trial.

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Table 1: Mean Square value of some lowland rice trait measured across different environment

Source of variation	50% days to flowering	80% days to maturity	Plant height (cm)	Tiller count/m^2	Panicle count/m^2	1000grain weight (kg)	Grain yield/ha (tons)
Genotype	115.561**	93.848**	1224.273**	6599.000**	7776.222	0.0043	1.7288**
Rep	3.350	27.491	48.081	272.850	565.774	0.0036	1.2596
Environment	757.574**	720.220**	11922.727**	688346.968**	310218.343	0.0011	25.372**
Genotype *environment	57.781**	65.972**	367.511**	11140.802**	13448.654	0.004	1.2514**
Error	1804.632	11.790	116.492	1852.439	1976.007	0.0045	0.2671

NB *** Highly Significance level at 0.01 level of probability*

Table 2: Additive Main effect and Multiplicative Interaction (AMMI) analysis of variance

Source of variation	Df	Sum of square	Mean square	% explained
Replication	2	2.5192	1.2596	
Genotype	12	20.7464	1.7289	
Environment	5	126.8589	25.3718	
Genotype*environment interaction	60	75.0883	1.2515	
Component 1	15	45.655111	3.043674	84.6
Component 2	13	5.260227	0.404633	12.0
Component 3	11	0.918825	0.083530	2.3
Component 4	9	0.648425	0.072047	1.0
Component 5	7	0.199543	0.028506	0.0
Error	154	41.1477	0.2672	

Table 3: AMMI stability value and Yield stability index Ranking

Genotypes	code	ASV	Rank	Mean	Rank	YSI
FARO 44 (Check)	G 12	0.907	1	2.41	10	11
ART 478-8-1-1-1-B	G9	1.281	2	2.828	3	5
FARO 52 (Check)	G13	1.354	3	2.497	8	11
ART 216 -173-B-1-B-B	G4	1.59	4	2.453	9	13
BASMATI	G11	2.106	5	2.297	11	16
ART 484 -19 -1-1-1-B	G10	2.146	6	2.79	4	10
ART 397-3-2-1-1-B	G8	2.182	7	2.995	2	9
ART 143 - 114 -B-1-B-B	G3	2.561	8	2.773	6	14
ART 1005-21-1-1-B	G2	3.097	9	2.61	7	16
ART 387-2-1-1-1-B	G7	3.258	10	2.183	13	23
ART 1002-10-1-1-1-B	G1	6.393	11	3.208	1	12
ART 263-11-B-1-B-B	G5	6.878	12	2.785	5	17
ART 314 - 14-B-1-B-B	G6	8.434	13	2.217	12	25

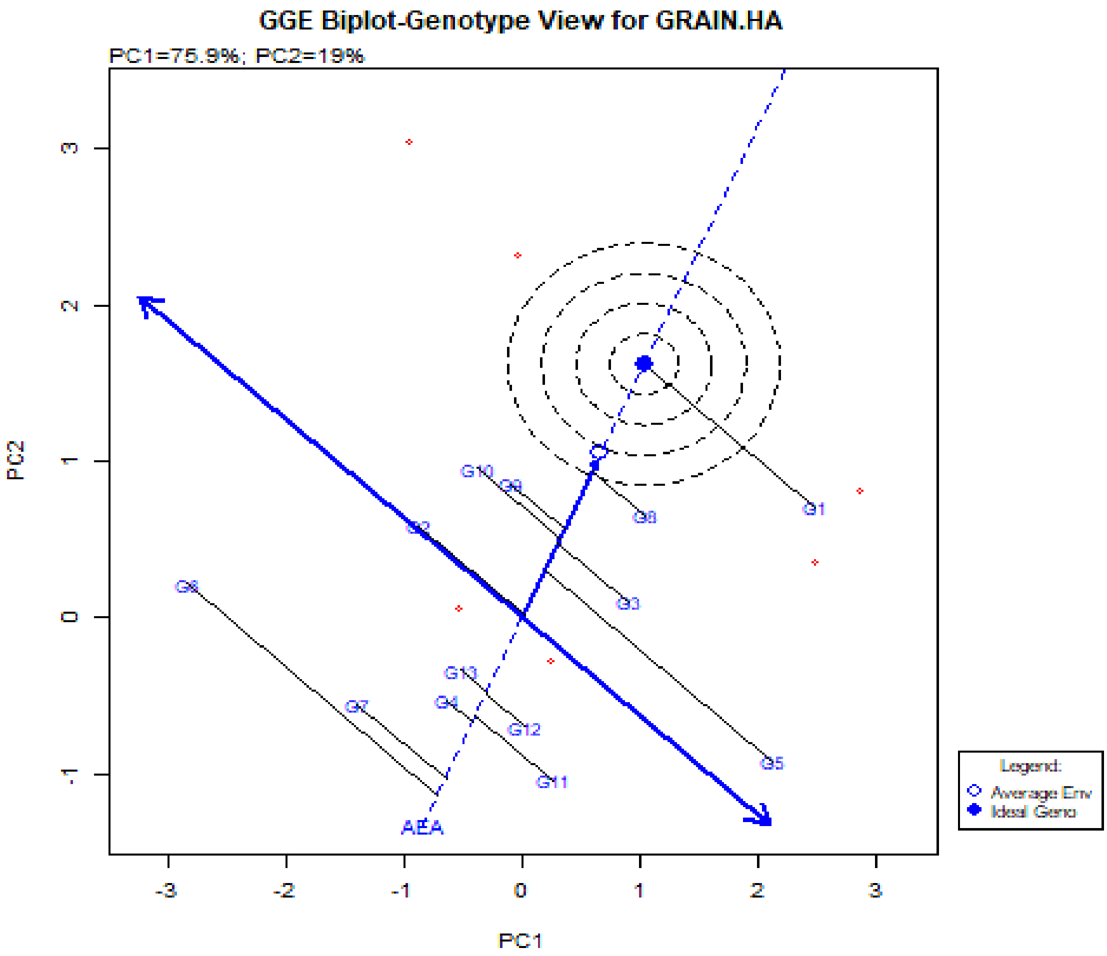

Fig 1: GGE Biplot-Genotype view

Breeding for Marginal Environments: An Important Consideration Towards Increasing Cassava Production in Nigeria

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ABSTRACT
Nigeria is the largest producer of cassava in the world with annual production of 59.49 metric tonnes (mt) in 2018. However, despite being the largest producer of cassava in the world more than 90% of cassava produced in Nigeria is consumed locally. Presently, Nigeria is not one of the major cassava exporting countries. To join the 'league' of the top cassava exporting countries, there must be a quantum leap in the Nigeria annual cassava production which will ensure that the local cassava needs are satisfied and substantial excess available for export. There is a strong relationship between the area of land harvested to cassava and annual cassava production in Nigeria. To increase the land available for cassava production, breeders must channel some efforts towards breeding cassava genotypes specifically for marginal environment such as salt affected soils and drought prone areas of the country, which accounts for over five million hectares of land in Nigeria. The approach of utilizing genotypes bred under conducive environmental conditions for cultivation on marginal environments may not be very effective towards attaining enough yield levels necessary for large scale exportation. Though released cassava varieties are often bred to be widely adapted, yield and yield-related traits are however often times affected by genotype-by-environmental (GxE) interactions. This drawback is usually highlighted when genotypes which perform highly in optimal environmental conditions fail to do so in sub-optimal environments. This paper thus, highlights the importance of developing cassava genotypes specifically suitable for marginal environments as a strategy towards increasing cassava production in Nigeria.

Keywords: Breeders, cassava genotypes, genotype-by-environmental, marginal environments

INTRODUCTION
Breeding for Marginal Environment
Cassava is the most important food-security crop in developing countries. It is efficient in carbohydrate production, and adapted to wide range of environments (Parmar *et al.,* 2017). Although cassava grows well in different environments, its production varies from genotype to genotype and one environment to another. This variability is attributed to inherent genotype properties, environment conditions, and genotype-by-environment interactions (Nduwumuremyi *et al.,* 2017). During varietal selection, breeders aim to select high-yielding genotypes which are stable across environments (Akinwale *et al.,* 2011). These genotypes, although stable across several environments, tend to face production challenges in marginal environments such as saline-laden soils. Salinity; a soil condition that affects up to 19 million hectares of land in sub-Saharan Africa, limits plant growth and productivity (Cruz *et al.,* 2017; Tully *et al.,* 2015). Inadequate management of irrigation water, coupled with intensive use of soluble fertilizers with high salt index has increased soil salinity (Cruz *et al.,* 2017). As 'prime', very good agricultural land keep getting limited due to soil salinity, farmers are forced to settle for these yield-limiting land areas, thus, further crippling cassava production. This

impediment can be managed through better control of irrigation water, use of organic-based fertilizers, and development of salt-tolerant cassava varieties. Breeding for marginal environments such as saline affected areas will help reclaim up to five million hectares of Nigerian land (Aderoju and Festus, 2016), which will go a long way to increasing cultivation area, and also increase in cassava production and productivity. Studies suggest a positive relationship between area harvested for cassava and cassava production (FAOSTAT, 2020).

Cassava Production in Nigeria

Nigeria currently holds the record of the largest producer of cassava in the world with annual production output of 59.49 mt in 2018 (Fig 1). The increasing importance of cassava among crops grown in Nigeria is not only connected to its increasing demand as food but also as food security (FAOSTAT, 2020). Nigeria is populated with about 200 million people and 7 in every 10 Nigerians consume at least, a product of cassava once a day (Eke-okoro and Njoku , 2012). Consequently despite being the largest producer of cassava in the world more than 90% of cassava produced in Nigeria are consumed locally (Ikuemonisan *et al.,* 2020).

Cassava Export

The world export of cassava is shown in Table 1; Nigeria is not amongst the leading cassava exporting countries because as has been reported earlier over 90% of the cassava produced in the country are consumed locally. To have excess for export after satisfying the local needs, there must be a pronounced increase in cassava production in Nigeria.

The annual cassava production and area harvested to cassava is shown in Fig 1. It could be surmised that there is a strong relationship between area harvested to cassava and annual cassava production. It therefore follows that increasing the area under cassava will increase cassava production in Nigeria. However favourable cassava growing areas are becoming limited. To increase land available for cassava production Nigerian farmers must make use of marginal lands such as salt affected soils and drought prone areas. These marginal lands, presently about five million hectares are increasing in extent because of climate change.

CONCLUSION

Nigeria is the world largest producer of cassava with close to 60 million tonnes a year. The country is not among the major cassava exporting countries because greater percentage of the production is consumed locally. For Nigeria to satisfy local cassava needs and have substantial excess for export, there must be pronounced increase in the country's cassava production, cassava farming must expand into marginal environments with appropriate cultivars developed by breeders for those environments. Such step will no doubt increase the country's cassava production substantially.

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Table 1: World Export of cassava (000' tonnes)

Country	2014	2015	2016	2017
			Flour and starch	
Thailand	7,919	7657	8446	8290
Viet Nam	788	1011	1055	1048
Cambodia	29	56	64	146
Others	333	316	183	93
			Chips and pellets	
Thailand	6927	7458	6411	6661
Viet Nam	2995	3607	3321	3200
Cambodia	808	1805	2182	2230
Others	150	150	181	137

Source: FAO Food Outlook 2018

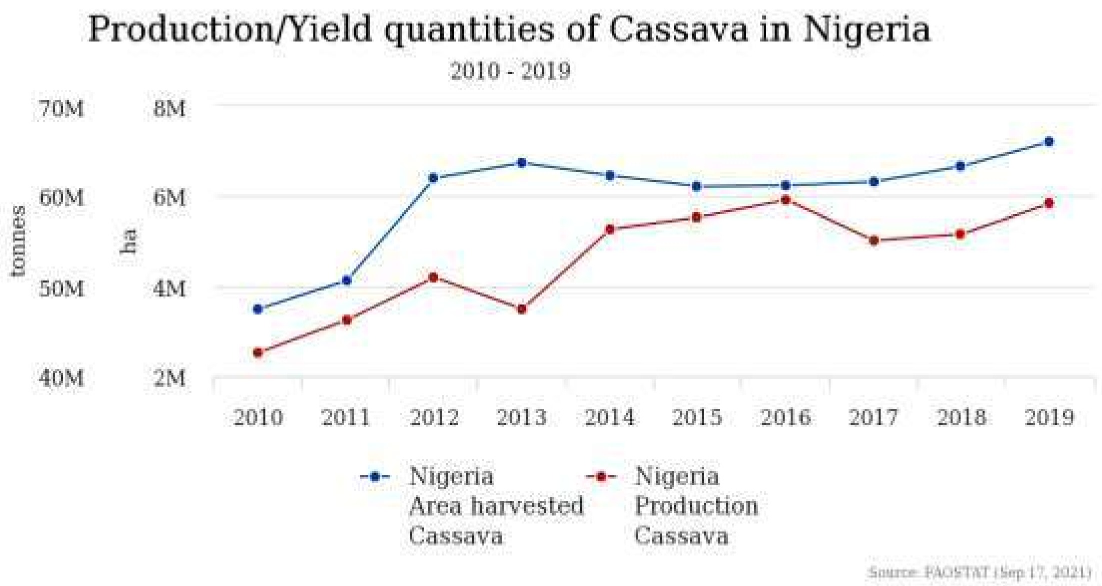

Fig 1. Area harvested to cassava and annual cassava production (2010 -2019) in Nigeria (Source: FAOSTAT, 2020)

Comparative Efficacy of some Plant Products against Cowpea Bruchid (*Callosobruchus maculatus* Fabricius) Infesting Cowpea *Vigna unguicuiculata*

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ABSTRACT

Cowpea (Vigna unguiculata) is an annual herbaceous legume from the genus Vigna. The legume pod borer, Maruca vitrata, is the main pre-harvest insect pest of the cowpea. Other important insect pests include pod sucking bugs, thrips and the post-harvest cowpea weevil, Callosobruchus maculatus. The objective of this study was to evaluate the efficacy of powders of four medicinal plants: Ginger (Zinigber officinale), Tumeric (Curcuma longa), Red pepper (Capscium annuum) and Pepper fruits (Dennettia tripetala) against Callosobruchus maculutus in stored cowpea seeds. The Experiment was conducted in Crop Science Laboratory of College of Crop and Soil Sciences, Michael Okpara University of Agriculture Umudike, Abia State, Nigeria. Culture stocks of C. maculatus were collected from infested cowpea seeds from the local markets within Umudike. They were maintained on cowpea in four large kliner jars, each with a capacity of 1kg. The kliner jars were covered with perforated lids and kept in an ambient environmental conditions. The insects were cultured in the laboratory. The jars were gently shaken every day to improve aeration. At 28 days after infestation (DAI) the bruchids were separated from the seeds by sieving through a 3 mm mesh. Treatments were four plant materials and Karate. A control was set up in which there was no treatment. Results of the study showed that percentage adult mortality was significantly higher ($P \leq 0.05$) at first week of application of the botanicals. At 7 days after treatment (DAT), the result showed that percentage of adult mortality was higher than that of second week after treatment. Percentage mortality progressively increased with time of exposure.

Keywords: Adult mortality, kliner jars, medicinal plants, time of exposure

INTRODUCTION

Cowpea (*Vigna unguiculata*) is an annual herbaceous legume from the genus *Vigna* (Singh *et al.,* 1997) Insect infestation is a major constraint to the production of cowpea, sometimes causing over 90% loss in yield (Jackai and Daoust, 1986). The legume pod borer, *Maruca vitrata* is the main pre-harvest insect pest of the cowpea and the cowpea bruchid *Callosobruchus maculatus* is the main post-harvest insect pest. Severe *C. maculatus*, infestations can affect 100% of the stored cowpea and cause up to 60% grain loss within a few months (Kang *et al.*, 2013). The larvae burrow their way into the seed, feeding on the endosperm. The weevil develops into a sexually mature adult within the seeds (Wilson, 1988). An individual bruchid can lay 20–40 eggs, and in optimal conditions each egg can develop into productively active adult in 3 weeks (Murdock *et al*., 2003; Mashela, 2012).

The most common methods of protection involve the use of insecticides, (Khalequzzaman and Chowdhury, 2003). Storage of cowpea grain over long periods, especially at small scale farming levels, is limited due to cowpea bruchids – *Callosobruchus maculatus* (F.). Their damage causes loss of weight, nutritional value and viability of stored grains. Larvae developing within the seeds do the largest damage. However, continuous use of chemical insecticides may lead to serious problems such as insecticide resistance. Non-chemical methods of bruchid control offer an attractive alternative because they do not leave chemical residues in the commodity give rise to resistance in the insect pest. Such methods include periodic exposure of the grains to the sun, coating seeds with cooking oils and mixing them with ash or sand (Busungu and Mushobozy, 1991). Botanical insecticides are promising alternative control measures to synthetic chemicals since they are economically and environmentally safe, less hazardous to humans and often less toxic to beneficial organisms. (Sharah and Ali 2008). Bamaiyi *et al*., (2006) reported that *Khaya senegalensis* seed oil significantly reduced the emergence of F1 and F2 progenies and reduced the damage to cowpea by *C. maculatus*. The performance of the oil was comparable to that of Pirimiphos methyl E.C. The objective of this study was to evaluate the efficacy of powders of four medicinal plants; Ginger (*Zinigber officinale*), Tumeric (*Curcuma longa*), Red pepper (*Capscium annuum*) Pepper fruits (*Dennettia tripetala*) against *Callosobruchus maculutus* in stored cowpea seeds.

MATERIALS AND METHODS

The Experiment was conducted in Crop Science Laboratory of the College of Crop and Soil Sciences at Michael Okpara University of Agriculture Umudike, Abia State. Umudike lies between latitude 5°29′N, Longitude 7°35′E (Chukwu, 2012) and 122m above sea level. Culture stocks of *C. maculatus* were collected from infested cowpea seeds from the local markets within Umudike. They were maintained in four large kliner jars. Each jar with a capacity of 1kg. The kliner jars were covered with perforated lids and kept in an ambient environmental condition. The insects were cultured in the laboratory. The jars were shaken every day to improve aeration. At 28 days after infestation (DAI) the bruchids were separated from the seeds by sieving through a 3 mm mesh. Treatments were four plant materials, Karate and a control. Ginger (*Zingiber officinale*), Tumeric (*Curcuma longa*), rhizomes were collected from National Root Crop Research Institute (NRCRI), Umudike while Red pepper (*Capsicum annuum*) and Pepper fruits (*Dennettia tripetala*), were purchased locally from Orie Ugba market in Umuahia North Local Government Area of Abia State and Karate (Lambdacyhalothrin) was bought from an agrochemical shop in Umuahia. The plant materials were air-dried for two weeks in a well-ventilated place. The plant materials were pulverized using a crown manual hand blender and were sieved through a 600mm mesh sieve to obtain uniform particle size. 50g of cowpea seeds were mixed in 200ml perforated plastic vials with 5g of each plant powder and covered with muslin cloth and held with rubber bands after introducing 10 weevils in each of the plastic vials.

RESULTS AND DISCUSSION

The result on effect of plant powders and Karate on the mortality of adult is presented in Table 1. Results obtained showed that percentage adult mortality was significantly higher ($P \leq 0.05$) at first week of application of the botanicals. At 7 days after treatment (DAT), the result showed that percentage of adult mortality was higher than that of second week after treatment. Percentage mortality progressively increased with time of exposure. The seeds treated with plant powders recorded significantly higher mortality of adult *C. maculatus*. At 7 DAT, there was significant difference in mortality in all treatments and control (20.10%) but Karate recorded significantly higher mortality (73.10%) while mortality of the treatment with *Z. officinale* (70.00%), *C. longa* (69.10%) and *D. tripetala* (70.00%) was not significantly different from each other. At 14 DAT, the mortality of *C. maculatus* was significantly ($P \leq 0.05$) lower. All the treatments did not differ significantly from each other. The control showed significant mortality at 14 DAT (49.10%).

At 21 DAT, the treatments and control were significantly different from each other. However, the least *C. maculatus* adult mortality occurred in the control treatments for the 7, 14, 21 and

28 DAT. The result showed that cowpea seeds treated with plant powders and Karate caused a significantly higher mortality within 14 DAT. All the treatments were toxic to the cowpea weevil when compared with the control. The *D. tripetala* was more effective among other treatments followed by *officinale* and *C. longa* which is the least significant. This result shows that the botanicals were effective in the control of *C. maculatus*. Similar effects of plant materials as insect protectants have been observed in the work of Asawalam and Dioka (2012). The result of the effect on progeny emergence is presented in Table 2. From the result, the progeny emergence in control was significantly higher (54.20) followed by *C. annuum* at (38.20), while *Z. officinale* had the least significant progeny emergence (19.80). Oviposition by *C. maculatus* was reduced in all treatments except in the control; this may be attributed to high mortality of the adult *C. maculatus* observed in the treated cowpea seeds. This agrees with reports that besides causing mortality of grain weevils, plant powders and oils also impair oviposition and progeny emergence (Udo and Harry, 2013).

The result obtained in this study is in agreement with the findings by Musa *et al*. (2009) that mixing of leaf powders of *Vernonia amydalina* and *Ocimum gratissimum* at equal proportion (50:50) caused 60.0% mortality of adult bruchid, reduced oviposition and suppressed adult emergence. The percentage grain damage in the control was significantly higher (59.50%) followed by *D. tripetala* (54.10%) *Z. officinale* recorded the lowest (46.50%) grain damage amongst the plant powders. The damage caused to the control was due to low mortality and high progeny emergence.

The result is presented in Table 2. There was a significant reduction in damage caused by the weevils to the treated cowpea seeds compared with the control. There was a corresponding reduction in the number of exit holes in treated cowpea seeds as a result of limited contact of the bruchid with the treated seeds especially those treatments that contain oil. This is in consonance with the work of Asawalam and Anaeto (2014). The effectiveness of the treatment to weight loss of cowpea seeds was not significant. The result is presented in Table 2. Results obtained indicate that, weight loss was significantly higher in *D. tripetala* at (64.30%) when compared with other botanicals control recorded (71.10%) which was significantly low in *C. longa* and *Z. officinale* treatments, were not significantly different from each other. Generally, weight loss in the plant powders was significantly low compared to the control. The result of germination of the cowpea seeds is presented in Table 2. Germination in the treated seeds was significantly higher than the untreated seeds.

The treated seeds recorded higher percentage germination while the control had the least percentage germination. This result showed that the weevil attack affected the germination in the control treatment. It also showed that plant materials tested against *C. maculatus* did not show any visible adverse effect on emergence capacity of the cowpea seeds. This result corroborates earlier work by Rahman and Tahkder (2006).

CONCLUSION

There is abundant evidence of poor insecticide education and abuse in Nigeria. In most villages in Nigeria, farmers apply overdoses of insecticides to effect rapid and immediate kill of the insect pests of cowpea. The study revealed that most of the botanicals powders were effective and had insecticidal activity similar to synthetic chemicals for the control of *C. maculatus*. The treatments significantly achieved high mortality of adult *C. maculatus* and significantly reduced weight loss due to its ability to inhibit oviposition by adult *C. maculatus* and hatchability of oviposited eggs hence the significantly lower number of progeny that emerged from the treatment with botanicals.

Therefore, these botanicals can be used as an alternative to synthetic chemicals for the control of *C. maculatus* in stored cowpea. Moreover, the local availability of these botanicals makes it easy for small holder farmers and reduces the cost of cowpea seed production. Also, these

botanicals are environmentally friendly and provide food safety in terms of replacing the more dangerous toxic synthetic insecticides.
However, further research work is needed in this regard to confirm the efficacy of these plant powders, and possibly formulation for the small holder farmers.

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Table 1: Effects of selected botanicals and karate on the mortality of adult *C. maculatus* at 4 weeks after treatment

	DAYS AFTER TREATMENT			
TREATMENTS	**7**	**14**	**21**	**28**
Zingiber officinale	70.00	94.60	97.00	99.29
Curcuma longa	69.10	94.40	97.00	99.34
Capscium annuum	60.10	90.10	95.10	98.75
Dennettia tripetala	70.00	92.30	94.80	98.75
Karate	73.10	96.40	99.10	77.00
Control	20.10	49.10	63.10	75.00
LSD (0.05)	18.20	9.41	7.56	5.90

Table 2: *C. maculatus* progeny emergence, Grain damage (%), Weight loss (%) and Germination (%) of cowpea seeds treated with botanical powders

TREATMENTS	**Mean Progeny Germination (%) Emergence (%)**	**Grain Damage (%)**	**Weight Loss (%)**	
Zingiber officinale	19.80	46.50	51.80	40.60
Curcuma longa	24.50	47.90	54.40	33.10
Capscium annuum	38.20	50.30	58.30	31.50
Dennettia tripetala	33.00	54.10	64.30	33.10
Karate	22.80	41.50	43.90	43.60
Control	54.20	59.50	71.10	26.20
LSD(0.05)	9.01	12.78	18.59	7.75

Effect of Different Tillage Practices on Selected Soil Properties and Proximate Composition of Sweet Potato Production

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ABSTRACT
The effect of different tillage practices on selected soil properties and proximate content of sweet potato (Ipomoea batatas (L.) were carried out in 2019 cropping season. The tillage treatments (bed, mound, flat, ridge and zero tillage) were arranged into randomized complete block design (RCBD) withthree3 replicates. Tilled plots of mounds and beds significantly ($p<0.05$) resulted in higher value of nitrogen and phosphorous compared to flat treatment with least value of 0.98gkg^{-1} and 8.10cmolkg^{-1} respectively. Tilled plot of beds recorded the highest value of cation exchange capacity (10.35) followed by plots of ridges (10.34) whereas plots of no tillage gave the least meant value (8.70). There was significant ($p < 0.05$) different in bacteria, fungi and nematode counts. The plots with no tillage and flat treatment gave the highest value of bacterial counts of 6.8 cfu/g and 5.3 cfu/g soil respectively, whereas bed treatment recorded the least value. The fungi population was also highest in plots of no tillage while plots of mounds recorded the least value of 3.9. cfu/g soil. The nematode population was higher in plots of no tillage and mounds while bed treatment recorded the least value. The results also showed that the sweet potato are significantly rich in protein and carbohydrate content, and low in fat content among beds, mounds and ridges practices. Therefore, sweet potato requires tillage practices for sustainable agriculture.

Keywords: Sweet potato, Tillage, Soil properties, Proximate content, Microbial population

INTRODUCTION
Sweet potato (*Ipomoea batatas* Lam) is an important staple food crop in many parts of the tropics which can be used for either domestic or industrial purposes. Globally, it is ranked the seventh most important food crop after wheat, rice, maize, Irish potato, barley and cassava (Collins, 2004). Sweet potato is rich in vitamin A, B_5 B_6, C, riboflavin, copper, potassium, pantothenic and folic acid. They are also a good source of dietary fiber, starch, carbohydrate, protein, polyphenols and anthocyanins. The storage roots have great food quality, and an excellent source of anti-oxidants and beta-carotenes. The crop can be produced mostly in Asia countries followed by Africa (FAO, 2012). In Nigeria, sweet potato is produced exclusively by peasant farmers. The productivity of the crop has been tremendously challenged by inappropriate soil management practices such as tillage, and lack of knowledge on the type and rate of fertilizer needed by the crop. Appropriate tillage systems improve aeration, water transmission, root growth and nutrient uptake. Tillage is the post clearing physical manipulation of soil aimed at modifying its structure, and can control weeds. It induces soil nutrients to be released faster (Ojeniyi, 1992). Some farmers use various tillage systems for sweet potato production. Tillage affects soil properties as observed from research results on soils in several parts of Africa where it was seen to affect soil aggregate, temperature, water infiltration, retention, microorganisms and earthworms. These microorganisms, earthworms and others are disturbed and most times are killed during tillage practices especially when

using heavy equipments to till the soil. Soil tillage by use of heavy duty equipment and implements, and even farm animals often result to soil compaction, which hardens the soil and deplete the infiltration characteristics, reduces the fertility of the soil, increase soil bulk density and root penetration resistance, and reduces crop yield. The continuous use of soil in tropical areas without recourse to conservation practices often constrained the soil ecosystems beyond their natural capacity, consequently leading to reduction in soil productivity and sustainability (Jongruaysup *et al.*, 2003). Therefore, the present study tends to fill in that gap by conducting an investigation into the tillage systems effect on the selected soil properties and nutritional composition of sweet potato production.

MATERIALS AND METHODS

The research trial was conducted at the research field of National Root Crop Research Institute (NRCRI), Igbariam Substation and Federal College of Agriculture, Ishiagu in 2019 cropping season. The experimental field was cleared of vegetation, and tilled with hoe. Composite soil samples (0–20 cm) were collected and analysed for chemical and microbial characteristics. The experiment was replicated three times in a Randomised Complete Block Design, with five (5) treatments: T_1 (Bed); T_2 (Mounds); T_3 (Flat); T_4 (Ridge); T_5 (zero tillage). The vines of improved sweet potato variety TIS 87/0087 were planted on the seedbed at a spacing of 0.5m x 0.5m. The proximate composition of sweet potato such as Moisture content; Ash content; Protein content; Fat content; crude fiber and Carbohydrate content were determined (AOAC, 1997). The soil chemical properties; soil texture; soil pH (in 1:2.5 H_2O); total carbon content, total nitrogen; available phosphorus, cation exchange capacity, exchangeable bases (K, Na, Ca and Mg) were determined. Soil bacteria and fungi were estimated with 10-fold serial dilution plate technique whereas nematode was estimated with USDA Nematode extraction technique (Bray *et al.*, 1945). The data collected were subjected to analysis of variance (ANOVA) and the treatment means were separated using Duncan's multiple range test at 5% probability level.

RESULTS AND DISCUSSION

The results of chemical properties of the pre-studied soil are presented as seen in Table 1. The Table 2 showed that the effect of treatment on total nitrogen and available phosphorus revealed that there was significant ($p < 0.05$) different among the different tillage practices. The no tillage treatment gives the highest mean value of 1.25 and 8.25 respectively due to less loss through immobilization, volatilization, denitrification and leaching. Available Phosphorus and K were higher under no tillage treatment probably due to higher soil organic carbon level and surface applied K and P fertilizers.

The highest increase of organic carbon (0.67% and 0.61%) was observed under no tillage and bed treatments. This may be due to untilled soil which increased the build-up of soil organic matter, resulting in high organic carbon which reflects as reduced rate of leaching in the soil profile (Malhi *et al.*, 2001). The results in Table 3 revealed that overall amounts of bacteria and fungi significantly decreased in No Tillage system, because of the stimulating effects for microbial growth; due to uniformly distributed residues in the arable layer, and increase in the rate of supplied oxygen to soil micro sites. In addition, ridge and mound treatments often destroy soil structure, allowing for faster mineralization of soil organic matter whereas no tillage can improve soil aggregation by the proliferation of bacteria population, and fungal hyphae that contribute to macro aggregate formation (Dalia *et al.*, 2013). The proximate composition of sweet potato (*Ipomoea batatas*) as seen in Table 4 showed significant difference among the tillage systems.

The mound and ridge practices recorded the highest value of moisture content (71.87 and 71.85) respectively. The fresh sweet potato had a moisture content of 77.8% which can be significantly attributed to cultivation practices and genetic composition of sweet potatoes. The carbohydrate contents were significantly affected by different tillage treatments which have the highest value of 24.50 in bed practices. FAO (2001) reported 28% for fresh sweet potato due to factors like varieties and stage of maturity of the roots. The protein content ranged from 2.19% to 2.70%, and was significantly higher in bed practices and least in no tillage systems. The typical total protein content of sweet potato is as low as 1.5% fresh weight, and as high as 5% dry matter content. The dietary fiber ranged from 0.34% and 0.40% among the different tillage practices. FAO (2001) also reported 1.2%. This may be attributed to cultivation practices, and other factors like environment and geographical areas.

CONCLUSION

Tillage practice is very essential for sweet potato production, as it aids in the absorption of essential plant nutrients from the soil. In the study, tilled plots of mounds and beds significantly ($p<0.05$) resulted in higher value of nitrogen, phosphorous and cation exchange capacity compared to other tillage systems. Tillage systems improved the activity of microbial organisms leading to the improved fertility of the soil for crop production. The results also showed that the sweet potato are significantly rich in protein and carbohydrate content, and low in fat content among beds, mounds and ridges practices. Therefore, it is concluded that sweet potato requires tillage for optimum productivity of sweet potato for sustainable agriculture.

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Table 1: Pre-planting Soil chemical characteristics

Soil Properties	Values
Texture Class	Sandy Loam
pH	5.4
Org. Carbon	0.48
T.Nitrogen(gkg-1)	0.042
Avail. Phosphorus(cmolkg-1)	8.53
Exch. Bases	
Na	0.04
K	0.06
Ca	2.20
Mg	1.00
Exch. Acids	0.80
CEC	10.20

Table 2: Effects of different tillage practices on selected soil chemical properties

Treatment	pH	Org. carbon(%)	T. Nitrogen (gkg-1)	Avail.P (cmolkg-1)	K	CEC
T_1	5.00	0.61	1.12	8.20	0.07	10.35
T_2	5.00	0.56	1.20	8.25	0.05	10.22
T_3	5.40	062	0.98	8.30	0.06	8.75
T_4	5.10	0.59	1.11	8.25	0.04	10.34
T_5	5.40	0.67	1.25	8.59	0.09	8.70
LSD	N.s	0.12	0.10	0.01	0.01	0.03

Table 3: **Effects of different tillage practices on soil microbial (Bacteria, Fungi and Nematode) population**

Treatment	Bacteria (cfu/g soil)	Fungi (cfu/g soil)	Nematode (vnc 100/g soil)
T_1	3.5	4.6	3.0
T_2	3.7	3.9	3.2
T_3	5.3	5.9	5.0
T_4	3.9	4.0	4.5
T_5	6.8	6.0	10.7
LSD (0.05)	0.41	0.45	0.47

Table 4: Tillage practices on Proximate Composition of sweetpotato

Treatment	Moisture(%)	Protein(%)	Fat(%)	Crude fiber(%)	Ash(%)	Carbohydrate(%)
T_1	70.97	2.70	0.25	0.40	1.17	24.50
T_2	71.85	2.20	0.17	0.36	1.19	24.24
T_3	71.27	2.41	0.26	0.48	1.18	24.41
T_4	71.87	2.36	0.30	0.54	1.29	23.55
T_5	70.95	2.19	0.24	0.34	1.25	23.28
LSD	0.45	0.74	0.14	0.09	0.05	0.39

Field Trial of Different Weed Control Measures on the Yield of Fluted Pumpkin (*Telfairia occidentalis* Hook F.) in Dadin Kowa, Gombe State

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ABSTRACT

A field study was conducted during the 2019 rainfed cropping season to evaluate the effect of different weed control measure on the yield of fluted pumpkin (Telfairia occidentalis) in Dadin-Kowa; Gombe State. The parameter measured were vine length, number of leaves and weight of harvests. The experimental design was Randomized Complete Block Design (RCBD) with four (4) treatments and three (3) replicates. The four treatments were: T1- Chemical, T2 - Manual, T3 - Cover crop, T4 - Control. The findings of the study indicated the following: T3 (Cover crop) gave the highest mean value of vine length with 56.2 cm followed by T2 (manual) with 49.7 cm. T1 (Chemical) had the mean value of 49.3 cm while T4 (Control) had the least with 49.0 cm. There were no significant differences in the vine length. On the number of leaves, T3 (Cover crop) gave the highest mean value of 27.2 cm while T4 (control) had the least mean value of 25.2 cm. For the weight of harvest, T3 (Cover crop) gave the highest mean value of 5.4 kg while T4 (control) gave the least value of 2.4 kg respectively. Analysis of variance showed that significant differences was only observed between treatments in the number of leaves and weight of harvest. It was observed that different weed control measure had effect on the yield of fluted pumpkin. Cover crop and manual weeding control measures are recommended as sustainable option for weed management in fluted pumpkin (Telfairia occidentalis) production.

Keywords: Weed, Control Measures, Growth, Yield, Fluted Pumpkin

INTRODUCTION

Weeds compete with crops for space, nutrients, water and light. Smaller, slower growing seedlings are more susceptible than those that are larger and more vigorous. Weeds also vary in their competitive abilities and according to conditions and season. The presence of weeds does not necessarily mean that they are damaging a crop, especially during the early growth stages when both weeds and crops can grow without interference. However, as growth proceeds they each begin to require greater amounts of water and nutrients. Estimates suggest that weed and crop can co-exist harmoniously for around three weeks before competition becomes significant. One study found that after competition had started, the final yield of onion bulbs was reduced at almost 4% per day. (Bleasdale and Salter, 1991). This study was carried out to compare the response of this different weed control measures on the growth and yield of *Telfairia occidentalis*.

MATERIALS AND METHODS

Description of the Sturdy Area

The study was carried out at the experimental site of the Federal College of Horticulture, Dadin Kowa in Yamaltu/Deba Local Government area of Gombe State during the 2019 rainfed cropping season. Dadin – Kowa is between Latitude 10^0 08′N to 10^0 30′N and Longitude 11^0

15′E to 11^0 40′E. The area is categorized to be part of the semi-arid and hot tropical climatic conditions with some humid months and the maximum temperatures could reach over 33.5^0C during the dry seasons. The average annual rainfall ranges from 440.4mm to 1406.3mm. High mean air temperatures are recorded during the months of March to May, 30.3^0C to 31.6^0C. Temperatures drop down considerably with onset of the rainy seasons with mean minimum temperatures reaching 22 ^{0}C - 23^0C (UBRBDA, 2018).

Experimental Design and Treatment Application

The experimental design was Randomized Complete Block Design (RCBD) with four (4) treatments and three (3) replicates. T_1 - use of herbicides (chemical- combined Primextra/Paraquat), T_2 - manual using hoe and cutlass at 3 weekly intervals, T_3 - cultural method by use of cover crop (potato vines), T_4 - No weeding (control).

Agronomic practices

The field was prepared by clearing the grasses with cutlass and removing the grasses and stump. The land area for the experiment is 13m by 16m, with 12 plots of 4m by 2m each giving a total of $208m^2$. The total experimental field took 96 stands of *Telfairia occidentalis* seeds where data was collected and analyzed. Weeding was done according to the specification of the experimental trial.

The test crop *T. occidentalis* landrace was obtained from National Horticultural Research Institute Okigwe Substation (NIHORT) Mbato, Okigwe Local Govt Area of Imo State.

Data Collection and Statistical Analysis

Data were collected on the growth parameters (vine length and number of leaves) at 4,6 8 and 10 weeks after sowing (WAS) and yield (kg) at harvesting was done at 6 and 12 weeks after planting. Data collected was analyzed using analysis of variance (ANOVA) according to the procedure for randomized complete block design and significant treatment means were separated and compared using fisher's least significant difference (FLSD) and all inherence were made at 5% level of probability according to Obi (2002).

RESULTS AND DISCUSSION

Effect of Treatment on Vine Length (cm) of Fluted Pumpkin

The mean vine length of fluted pumpkin (*T. occidentalis*) at 4, 6, 8 and 10 WAP on Table 1 shows that treatment 3 (use of cover crop) had the highest mean value (56.2cm) followed by Treatment 2 (manual weeding) (49.7cm). Treatment 1 (herbicide application) had the least mean value (49.3cm) while treatment 4 (control) had the least with 49.0cm. The analysis of variance indicated significant difference at 6WAP. However, in absolute terms, the use of cover crop (potato vine) as weed control measure was more effective in suppressing weed population. This is because the cover crops improve and enhances the soil nutrient by sustaining soil moisture, improve soil microbial activities, reduces surface runoff and leaching; enhances the decomposition of soil organic materials which invariably improve yield. Treatment 3 (cover crop) has highest vine length which normally determines the leaf yield in *T. occidentalis*. This result conforms to similar studies by Kafi *et al*. (2005); Moreby and Southway (1999).

Effect of Treatment on number of leaves of Fluted Pumpkin

The mean number of leaves of fluted pumpkin (*T. occidentalis*) at 4, 6, 8 and 10 WAP as shown on Table 2 indicated that Treatment 3 (cover crop) had the highest mean value (27.2), closely followed by Treatment 2 (manual) (26.2). Treatment 1 (herbicide) had the least mean value (25.2). The analysis of variance indicated significant difference at 6 WAP. These results conform to similar studies by Kafi *et al*. (2005); Moreby and Southway (1999).

Effect of Treatment on weight of harvest (kg) of Fluted Pumpkin at 4, 6, 8 and 10 WAP

Mean weight of harvest of fluted pumpkin (*Telfairia occidentalis*) at 6 and 12 WAP shows that Treatment 3 (cover crop) had the highest mean value (5.4kg) followed by treatment 2 (manual) (3.1kg). Treatment 1 (chemical) had the least mean value (2.4kg). The analysis of variance indicated significant difference at 6 WAP only. These results conform to similar studies by Kafi *et al*., 2005 and Moreby and Southway, 1999.

CONCLUSION

The findings of this study showed that the application of the Treatment 3 (use of cover crop) followed by Treatment 2 (manual weeding) are more effective in suppressing weed infestation and thus enhanced the performances of fluted pumpkin on the field. Based on the results of this study, it is recommended that the farmers should adopt and promote the use of cover crop and /or manual weeding in controlling weed either solely or combined during field production.

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Upper Benue River Basin Development Authority {UBRBDA}, Dadin Kowa Area Office (2018) *Geographical Description of Dadin Kowa, Gombe State.*

Table 1: Effect of Treatment on Vine Length (cm) Of Fluted Pumpkin at 4, 6, 8 and 10 WAP.

Treatment	4WAP	6WAP	8WAP	10WAP	∑×	×
T1	20.7	46.33	56.67	72.66	196.36	49
T2	21.3	50.33	48.5	78.66	198.79	49.7
T3	20	57.33	67.33	80.33	224.66	56.2
T4	14	49	61.67	72.67	197.34	49.3
F-LSD NS	NS	0.052	NS			

F-LSD - fisher's least significant difference, NS -Not significant

Table 2: Effect of Treatment on number of leaves of Fluted Pumpkin at 4, 6, 8 and 10 WAP.

Treatment	4WAP	6WAP	8WAP	10WAP	∑×	×
T1	10.3	26.66	35.66	35.66	100.62	25.2
T2	12	36	33.43	33.43	104.73	26.2
T3	12	38	34.66	33.33	108.99	27.2
T4	11	29	33.33	34.66	100.66	25.2
F-LSD	NS	0.048	NS	NS		

F-LSD - fisher's least significant difference, NS -No significant

Table 3: Effect of Treatment on weight of harvest (kg) of Fluted Pumpkin at 6 and 12 WAP

Treatment	**6WAP**	**12WAP**		∑×	×
T1	1.8	3.2	5.0	2.5	
T2	2.2	4.0	6.2	3.1	
T3	3.6	7.2	10.8	5.4	
T4	1.5	3.2	4.7	2.4	
F-LSD	0.86	NS			

F-LSD - fisher's least significant difference, NS -No significant

Agronomic Response of Sweet Potato (*Ipomea batatas* {L.} Lam) to Different Levels of Vine Pruning in Dadin-Kowa, Gombe State

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ABSTRACT
Field experiment was conducted to study the agronomic response of sweet potato to different levels of vine pruning in Dadin-Kowa, Gombe State, Northeastern Nigeria during the 2019 rainfed cropping season using Randomized Complete Block Design (RCBD). Sweet potato vines were subjected to two cutting regimes: Treatment 1 was pruned at 8 weeks after planting (WAP) only while treatment 2 was pruned at 8 and 10 weeks after planting (WAP). The control plot was treatment 3 and unpruned. The result of the experiment indicated that treatment 3 (control) gave the highest mean vine length across the weeks, this was followed by treatment 1 (pruned once) while treatment 2 (pruned twice) gave the least mean vine length across the weeks. Also, treatment 2 gave the highest tuber yield. The results of the study indicated significant differences between the growth and yield parameters. From the findings of this study, pruning sweet potato vines is recommended to farmers so as to improve tuber yield.
Keywords: Pruning, Growth, Yield, Sweet Potato

INTRODUCTION
Cultural operations on plants are aimed at eliciting different response from the crop. Such may include: ornamentation or beautification, improve flowering, tuber and fruit component or overall yield. Several cultural operations exist in horticultural crop management; among which are: staking, spacing, intercropping, pruning *et cetera*. Pruning is a field operation aimed at removing unwanted epical bud, branches and lengthy vines in potato and other horticultural field crops. This cultural practice can take place at any given time depending on the responses the researcher or farmers intend to elicit. Removing shoots from ground level up to the first fork below the first flower as in tomato has been noted (Davis and Estes, 1993; Olson and Simonne, 2007; McGraw *et al*., 2007). Because different cultivars have varying plant architecture and growth habits, the effect of this practice on potato can widely vary. Short determinate cultivars might require only minimal pruning, whereas the opposite might be necessary for vigorous and trailing cultivars (Olson and Simonne, 2007). McGraw *et al*., (2007) indicated that pruning vines helps maintaining the balance between vegetative and reproductive biomass. The study differs about the effect of pruning on tomato and will suggest that pruning could increase yield of determinate cultivars. A properly pruned and supported single-stem tomato plant presents all of its leaves to the sun.

Most of the sugar produced is directed to the developing fruit, since the only competition are few single growing tips. The result is large fruits that are steadily produced. If more stems were allowed to develop, some of the soil nutrients will have been shared to develop stems that was pruned, and the large fruits will not have been produced (Olson and Simonne, 2007). Other production practices like spacing could interact with pruning on their effects on potato yields such as increasing net returns when: plants were either spaced less than 25 inches apart and were pruned early; or when plants were spaced 25 to 30 inches apart and were either pruned early or not pruned (Davis and Estes, 1993). In potato production, pruning of vines is not a common practice. This study seeks to investigate the agronomic response of sweet potato to different levels of vine pruning with a view to contribute to knowledge in this field of horticulture.

MATERIAL AND METHODS

Experimental Site

The study was carried out at the experimental site of the Federal College of Horticulture, Dadin Kowa; Gombe State during the 2019 rainfed cropping season. Dadin – Kowa,Yamaltu/Deba local government area of Gombe State in the north east of Nigeria. Dadin – kowa is between Latitude 10^0 08'N to 10^0 30'N and Longitude 11^0 15'E to 11^0 40'E. The area is categorized to be part of the semi-arid and hot tropical climatic conditions with some humid months and the maximum temperatures could reach over 33.5^0C during the dry seasons. The average annual rainfall ranges from 440.4mm to 1406.3mm. High mean air temperatures are recorded during the months of March to May, 30.3^0C to 31.6^0C (UBRBDA, 2018).

Experimental Design and Treatment Application

The experimental design used was randomized complete block design (RCBD) with three (3) treatments and three (3) replications. Treatment 1 (T1) represented single pruning, treatment 2 (T2) represented double pruning while treatment 3 (T3) represented the control. The land area for the experiment is 12m by 12m, with 9 plots of 4m by 2m each. The total experimental field took 135 stands of sweet potatoes vinelets, where data was collected and analyzed.

Agronomic practices

The site was cleared and pulverized mechanically with disc plough and disc harrow to make a comfortable seed bed. Basal application of organic manure (cured poultry manure) was done during ploughing at the rate of 400kg per hectare to make nutrient readily available in the soil for the crop. The vines were collected from an improve variety (*Caruso*) of sweet potato from the NRCRI, Umudike, Abia State and planted at the spacing of 30cm x 30cm along and between rows. The planting was done late in the evening and irrigated to avoid stress from the heat of sun and to enhance rapid establishment because of the arid region nature of the experimental site. The first phase of the pruning was done 4 weeks after planting. The following parameters were measured at 4, 6, 8 and 10 weeks after planting (WAP): Length of potato vines (cm), number of leaves and weight of tuber yield (kg).

RESULTS AND DISCUSSION

The Effect of the Treatments on Vine Length of Potato

Table 1 shows the mean vine length of potato at 4, 6, 8 and 10 weeks after planting (WAP). The results in the table revealed that treatment 3 (control) gave the highest mean vine length at 4, 6, 8 and 10WAP with mean values of 277.67 cm, 1630.00 cm, 1522.00 cm and 1724.00 cm followed by treatment 1 (single pruning) with mean values of 303.00 cm, 1354.67 cm, 1301.00 cm and 1610.67 cm at 4, 6, 8 and 10 WAP. Treatment 2 (double pruning) gave the least vine length of 251.33 cm, 1440.00 cm, 1321.00 cm and 1469.33cm at 4, 6, 8 and 10 WAP. The table also revealed that there were significant differences among the treatments across the weeks**.**

The Effect of the Treatments on Number leaves of Potato

Table 2 shows the mean leaf number at 4, 6, 8 and 10WAP. The result indicated that treatment 3 (control) gave the highest mean leaf number of 376.00, 448.33, 567.00 and 832.33 across the weeks, this was followed by treatment 1 (single pruning) with 358.67, 437.00, 462.33 and 825.00 while treatment 2 (double pruning) gave the least mean leaf number with 335.33, 365.33, 367.33 and 766.67 across the weeks. The result also revealed that there were significant differences among the treatments at 8 and 10 weeks after planting only.

Yield of Potato (kg) After Harvest

Table 3 shows the mean yield of potato (kg) after harvesting. The result revealed that treatment 2 (pruned twice) gave the highest mean yield/(kg) with a mean yield of 6.10kg, this was followed by treatment 1 (pruned once) which gave a mean yield of 4.87kg while treatment 3(control) gave the least mean (2.93kg) at harvest. This analysis also indicated that there was significant difference ($P<0.05$) among the treatments. This result conforms to similar studies from Olson and Simonne (2007); McGraw *et al*., (2007) where they averred that pruning vines helps maintaining the balance between vegetative and reproductive biomass with resultant improved tuber yield.

CONCLUSION

Pruning sweet potato twice gave the highest yield, followed by single pruning. Following this results, it is ascertained that pruning is a useful cultural practice that should be done to enhance the yield of sweet potato and should be recommended to farmers.

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Table 1: The Effect of the Treatments on the Mean Vine Length of Potato (cm)

Treatment	4WAP	6WAP	8WAP	10WAP
T_1	303.00	1354.67	1301.00	1610.67
T_2	251.33	1440.00	1321.00	1469.33
T_3	277.67	1630.00	1522.00	1724.00
LSD (0.05)	21.85**	6.91**	72.50**	94.42**

****, ** & * Significant at 1% 5% and 10% alpha level*

Table 2: The Effect of the Treatments on the Mean Number Leaf of Potato

Treatment	4WAP	6WAP	8WAP	10WAP
T_1	358.67	437.00	462.33	825.00
T_2	335.33	365.33	367.33	766.67
T_3	376.00	448.33	567.00	832.33
LSD (0.05)	NS	56.47*	92.50**	NS

****, ** & * Significant at 1% 5% and 10% alpha level*

Table 3: Mean Yield of Potato (kg) After Harvest

Treatment	Mean yield of potato
T_1	4.87
T_2	6.10
T_3	2.93
LSD (0.05)	1.09**

Diversity Studies Among Polycross-derived Sweet Potato Progenies for Root Yield, Flesh Colour and Sweet Potato Virus Disease Severity

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ABSTRACT

In order to understand the inherent diversity among polycross-derived progenies for use in cultivar development, seventy (70) progenies developed from seven (7) parents in an isolated location were evaluated at the National Root Crops Research Institute, Umudike Experimental Field using randomised block design and two replications. While ANOVA showed that wide variation exists among the evaluated polycross-developed half-sib genotypes for root yield, yield components and severity to sweet potato virus disease and fresh root rot (p<0.01; 0.001), principal component analysis revealed that number and weight of marketable roots, total root weight (kg/plot) and root yield (t/ha) were the most important traits that influenced the variability among the genotypes by influencing 36.51% of the observed variation in PC1. Sweet potato virus disease (SPVD) severity and root rot severity characterised by 17.99% variation in PC2. In conclusion, this work shows that the polycross method is robust in developing progeny population with wide variability for root yield, important yield components as well as the disease resistance traits. The study will also assist sweet potato breeders in the choice of breeding methods to adopt in the development of new sweet potato varieties.

Keywords: disease resistance traits, fresh root rot, marketable roots, polycros, sweet potato breeders

INTRODUCTION

Sweet potato (*Ipomoea batatas*) is an important root crop with adaptability to a wide range of ecological conditions ranging between 0-3000m above sea level, and 40^0N and 40^0S of the equator (Troung *et al*., 2011). It is a highly heterozygous crop (Chang *et al*., 2009), and has wide genetic variability for almost all important traits among the available genotypes (Islam *et al.,* 2002). To develop new genotypes that combine good attributes, hybridization of selected parents is important to develop segregating population upon which effective selection is dependent. Hybridization is usually carried out through hand pollination or random, open pollination schemes (Blum *et al.* 2009). However, due to the weaknesses of the production of too few botanical seeds through hand crossing, and the development of many inferior progenies when random open pollination among hundreds of parents is used, the use of polycross mating technique that seeks to combine the efficiency of open pollination in developing large number of botanical seeds and the effectiveness of the hand pollination in increasing the frequency of desirable alleles was proposed by Jones (1965). The mating scheme has been used extensively in Taiwan to develop important cultivars (Tseng *et al*., 2002), and it is common in many sub-sahara African countries, even in breeding for difficult traits like drought tolerance (Simion, 2018). Its main weakness, however, is its limited suitability for genetic studies. Many breeders have shied away from its genetic studies, and it is difficult to access genetic information that will aid effective sweet potato breeding for most traits through this method. Studying the diversity within a population developed through a mating scheme is an important step in the use of the mating scheme for genetic studies and varietal development. This work, therefore, aims at studying the diversity within a population of progenies developed from polycross mating scheme to enhance the use of polycross scheme in sweet potato breeding.

MATERIALS AND METHODS

Seventy (70) half-sib progenies and their parents were evaluated at the National Root Crops Research Institute, Umudike Experimental Field using randomized complete block design with two replications. The progenies were planted on 2 m x 3 m (6 m^2) plots with planting distance of 1.0 m x 0.3 m, giving plant density of 20 stands per plot. First weeding was done at 4 WAP after which 400kg/ha NPK 15:15:15 fertilizer was applied. Rouging of weeds was carried out at 8 WAP to keep the field clean. The trial was harvested at four months after planting. Data were collected on number of marketable roots, weight of marketable roots (t/ha), total root weight, root yield (t/ha), severity of sweet potato weevil (*Cylas puncticollis*) damage, severity of root rot and storage root flesh colour. Data collected were subjected to analysis of variance (ANOVA) using the GLM procedure of SAS 9.2 version software. The genotypes were considered as fixed while replication was considered random. The genotype means were separated using the standard error. Principal Component Analysis (PCA) based on correlation matrix was also performed using SAS software.

RESULTS AND DISCUSSION

All the evaluated half-sib genotypes developed through the polycross scheme showed wide variation for root yield, yield components and resistance to diseases such as sweet potato virus disease and fresh root rot (Table 1). The existence of genetic variation within a population for important agronomic traits is a pre-requisite for selection (Madawal *et al*., 2015). The wide variation indicates that the polycross scheme can produce highly segregating progeny population. The principal component analysis (Table 2) showed the important traits that are most responsible for the variation observed among the genotypes. Yield and yield component traits (number and weight of marketable roots (t/ha), total root weight and storage root yield (t/ha)) were mostly responsible for the 36.51% of the total variation among the polycross progenies observed in PCA 1. The disease traits (SPVD and root rot) were largely responsible for the 17.99% variance of PCA 2. Knowing that the observed wide variability among the progenies is driven by the key traits is an indication that effective varietal development is possible through the polycross system.

Figures 1a and 1b show the relationships between the half-sib genotypes and the traits (root yield, flesh colour and sweetpotato virus disease (SPVD) severity). The progenies seem to cluster according to root flesh colour with white/cream fleshed progenies largely clustered differently from the yellow- and orange-fleshed genotypes (Figure 1a). Most of the yellow-fleshed progenies clustered around the tip of mean root yield, showing that many of the yellow progenies were high yielding, while the orange-fleshed polycross progenies, clustering close to SPVD severity. The white fleshed progenies opposite the quadrant of SPVD severity seem to be the most SPVD-resistant group of the progenies. The unique clustering of the orange-fleshed progenies around the SPVD severity quadrant is an indication of a probable direct or indirect relationship between beta-carotene (which is the dominant carotenoid responsible for the orange colour of the flesh) and susceptibility to SPVD. This relationship has not been reported before. The observations from this study will help refine the strategies being deployed in the development of SPVD-resistant orange flesh sweet potato (OFSP) varieties by breeders. Overall, the roles of flesh colour and the metabolites that confer the various colours on sweet potato root flesh in root yield formation and SPVD resistance need to be closely studied.

CONCLUSION

The polycross mating scheme is an effective scheme in the developing progeny population with wide variability. Root yield and yield components largely influenced the observed variability, while SPVD and root rot severity also moderately influence phenotypic variation among polycross-derived progenies. The development of progenies with varying root flesh colour, high root yield and highly resistant genotypes through the polycross technique is possible, and this can lead to the development and release of new varieties through the mating scheme. The observed relationship between root flesh colour and resistance to SPVD in sweet potato needs to be further studied.

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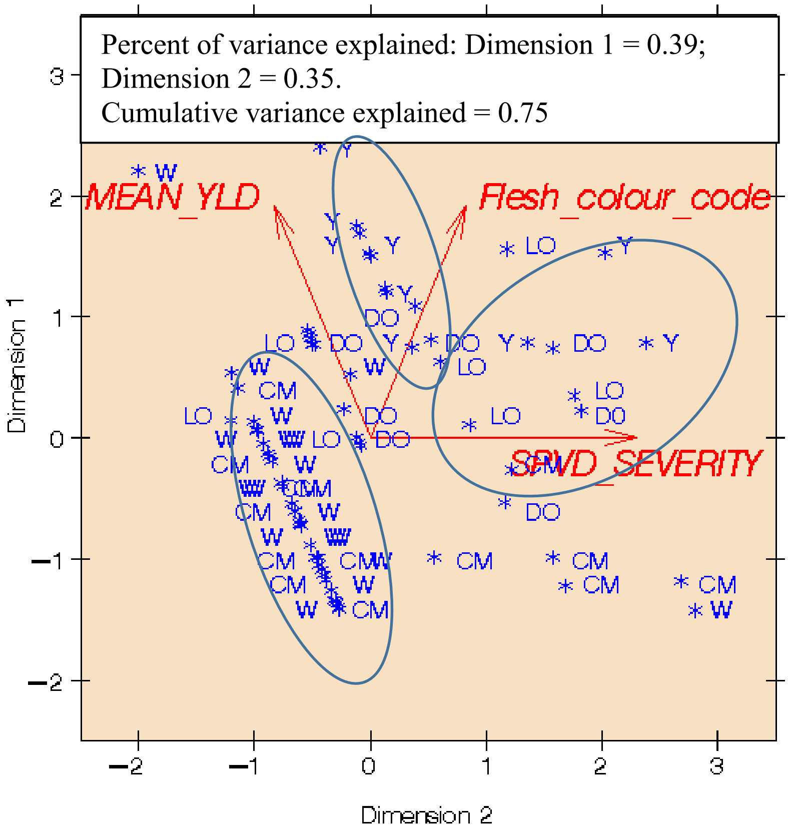
Table 1: Means squares of the analysis of variance of important yield components and disease severity of polycross-derived half-sib sweet potato progenies

SV	Df	Mean squares					
		Number of marketable roots	Weight of marketable roots (t/ha)	Weight of total roots	Root yield (t/ha)	SPVD severity	Root rot severity
Geno	69	156.6752***	26.1004***	4.8951***	31.6201**	1.1844**	0.4189**
Rep	1	1.6304	6.2305	0.0790	4.5917	0.0011	0.0072
Error	69	44.5488	13.2193	1.4797	15.8947	0.4928	0.1811

SV = Sources of variation; Df = Degrees of freedom; Geno = Genotype; Rep = Replication
*** = significance at 0.01 probability level; *** = significance at 0.001 probability level*

Table 2: Principal component analysis of traits of half-sib progenies of sweet potato evaluated under normal Umudike, Abia State growing season

Trait	PCA 1	PCA 2	PCA 3	PCA 4
SPVD Severity	-0.1279	**0.5466**	**-0.3706**	0.1826
Number of marketable roots	**0.4362**	0.0567	-0.0400	0.0116
Weight of marketable roots (t/ha)	**0.4016**	0.1883	-0.0741	**-0.4048**
Weight of total roots	**0.4651**	0.1031	-0.0426	-0.0672
Root yield (t/ha)	**0.4274**	0.1603	-0.0604	**-0.3091**
Root rot severity	-0.0202	**0.4052**	**0.5725**	0.0575
Eigen values	4.0165	1.9789	1.7580	1.3479
Variance proportion	0.3651	0.1799	0.1598	0.1225
Cumulative variance	0.3651	0.5450	0.7049	0.8274



Dimension 1

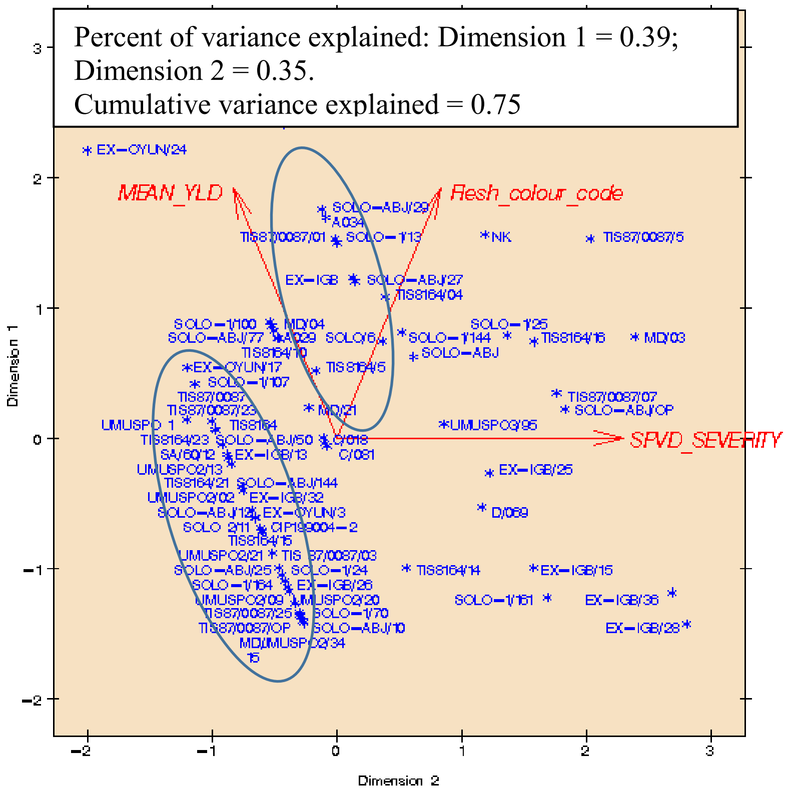


Figure 1a and b: Biplot analyses showing the relationships between root yield, flesh colour and sweet potato virus disease severity. Fig. 1a shows each progeny's flesh colour while Fig. 1b shows the specific progeny represented by the flesh colour in Fig. 1a.

Evaluation of Promising Sweet Potato Genotypes for Root Yield and Pest Tolerance Attributes under the Savannah Transition Agro-Ecology

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ABSTRACT

In order to estimate the performance of newly developed sweet potato genotypes for adaptation to the Savannah transition ecology, 52 newly developed breeding lines were evaluated for their agronomic and pest tolerance attributes at the National Root Crops Research Institute, Iresi Outstation Experimental Field using randomised block design and two replications. ANOVA showed that wide variation exists among the evaluated breeding lines for root yield, yield components and Cylas spp. weevil damage with the coefficient of variation >30%. The marketable roots contributed more to the root yield than the unmarketable roots which is a positive result as big roots are more preferred for processing compared to small-sized roots. Nineteen genotypes with fresh root yield above 15 tons/ha under no fertilizer condition, and with varied root flesh colours (orange/deep orange - 10.53%; light orange - 36.84%; yellow/deep yellow - 15.79%; light yellow - 10.53%; and white/cream - 26.32%) were selected for further trials. Varieties from these selected genotypes should be able to meet the needs of varied end-users where root size, root yield and flesh colour are of importance.

Keywords: Sweetpotato genotypes, root yield, flesh colour, Savannah transition ecology

INTRODUCTION

Sweet potato (*Ipomoea batatas*) is an important food security crop in many tropical countries, especially in sub-Sahara Africa. It is a crop with adaptability to a wide range of ecological conditions ranging between 0-3000m above sea level, and 40^0N and 40^0S of the equator (Troung *et al*., 2011). The crop has wide genetic variability for almost all important traits (Islam *et al.*, 2002). In Nigeria, it is one of the most important root and tuber crops with annual production of 4.03 million metric tonnes (FAOSTAT, 2018). It is adapted to all agro-ecologies, though with varying production intensity and cultivar performance. As consumers' and processors' trait requirements continue to change due to the market demands dynamic; and biotic and abiotic challenges continue to change due to the effects of climate change, the development of new varieties will be a continuous activity in order to address the new emerging challenges. The presence of location differentia in the performance of genotypes, as reported by Ebem *et al*.(2021) and others, demands that new genotypes need to be evaluated in an area where it will be planted. This work, therefore, aimed at evaluating newly bred sweet potato genotypes for agronomic performance under the Savannah transition ecology.

MATERIALS AND METHODS

Fifty-two developed sweet potato genotypes were established at Iresi, Osun State (Savannah transition ecology) using randomised complete block design (RCBD) with two replications. Each genotype was planted on a plot of 2m x 3m comprising 20 stands per plot with spacing of 1.0m x 0.3m. The vines were cut at four-nodes length and planted on the crest of the ridges.

First weeding was carried out at 4 weeks after planting (WAP) with supplemental rouging at 8 WAP. No fertilizer was added. The trial was harvested at 16 WAP. Data collected included: number and weight (kg/plot) of marketable and unmarketable roots, total root yield and *Cylas* spp damage. The data collected were subjected to analysis of variance using the GLM procedure of the SAS software (SAS Institute, 1992). Means were separated using $FLSD_{0.05}$.

RESULTS AND DISCUSSION

The significant ($p<0.05$) mean squares of the traits and the coefficient of variation of >30% in Table 1 show that wide variability still exists among the genetic materials for these important productivity traits. Such wide variability at this breeding stage has been previously reported by Vimala et al. (2011). It is of importance also that the marketable roots contributed more to the root yield than the unmarketable roots as big roots are more preferred for manual processing compared to small-sized roots (Afuape, 2016). Table 2 shows the performance of selected 19 genotypes with fresh root yield above 15 tons/ha with no fertilizer application. These selected genotypes comprised the following flesh colours: two (10.53%) orange/deep orange; seven (36.84%) light orange; three (15.79%) yellow/deep yellow; two (10.53%) light yellow; and five (26.32%) white/cream (Figure 1). This varied root flesh colour will help in catering for the needs of varied end-users where root size, root yield and flesh colour are of importance.

CONCLUSION

Promising genotypes have been identified. The selected 19 genotypes will be further evaluated in advanced yield trials in multi-locations. The food and nutritional attributes of these genetic materials will also be determined.

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Table 1: Mean squares of the analysis of variation among 53 sweetpotato genotypes evaluated for fresh root yield, yield components and weevil damage under the savannah transition ecology of Iresi, Osun State

Sources of variation	Degrees of freedom	Traits						
		No. of marketable roots	No. of unmarketable roots	Weight of marketable roots (kg/plot)	Weight of unmarketable roots (kg/plot)	**Root yield (t/ha)**	Cylas spp incidence	Cylas spp severity
Replication	1	12.1905	0.5833	12.2439	0.0053	623.6916	0.0122	0.1957
Genotype	51	86.5715***	62.5356***	7.7622***	0.0724***	119.3472**	0.2051ns	0.1679ns
Error	42	21.9222	18.8516	2.4095	0.02122	50.0339	0.2622	0.1201
Total	94							

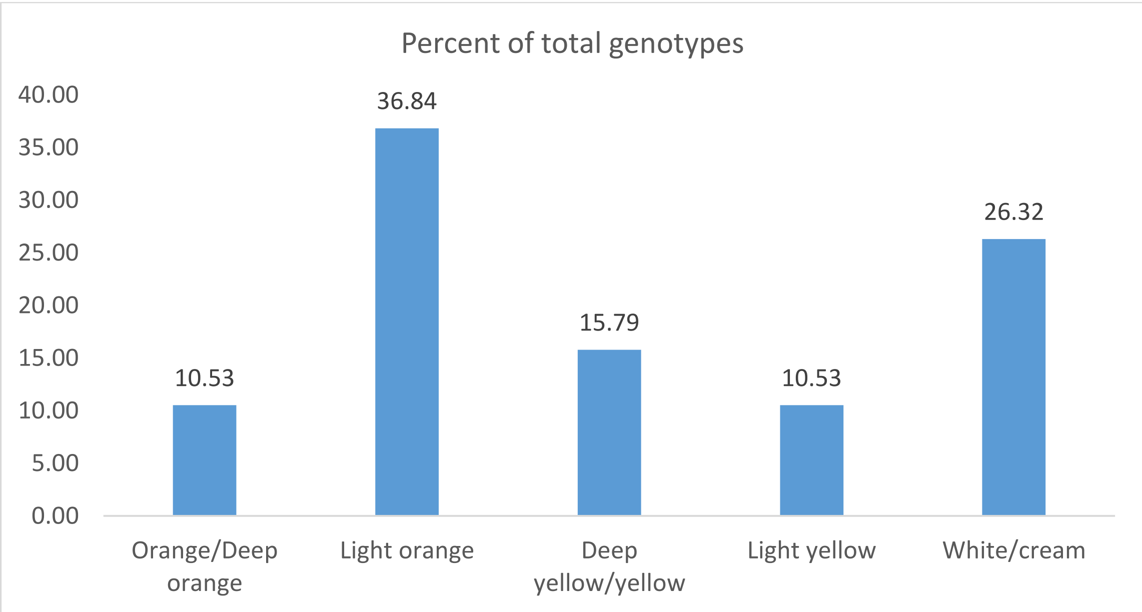

Figure 1: Flesh colour analysis of selected sweetpotato genotypes evaluated under the savannah transition ecology of Iresi, Osun State

Table 2: Selected sweetpotato genotypes with root yield performance above 15 tons/ha evaluated under the savannah transition ecology of Iresi, Osun Sate

Genotype	No. of marketable roots	No. of unmarketable roots	Weight of marketable roots (kg/plot)	Weight of unmarketable roots (kg/plot)	**Root yield (t/ha)**	*Cylas* spp incidence	*Cylas* spp severity	Root flesh colour
TIS87/0087/03-37	20.00	16.50	5.25	0.56	**30.24**	1.00	1.00	Orange
F4XM2/01-26	9.00	6.00	6.25	0.26	**29.60**	1.00	1.00	White
Solo-Abuja/29-02	18.00	17.00	5.90	0.67	**29.00**	1.50	1.50	Light ora
OP/4	10.38	3.08	4.58	0.07	**26.50**	2.01	1.95	Deep yell
EX-IGBARIAM/22	19.50	14.50	6.40	0.61	**24.79**	1.00	1.00	Light ora
F4XM2/5	21.00	13.00	5.85	0.50	**23.06**	1.00	1.00	Light ora
F5XM1/3	5.38	7.08	2.38	0.31	**22.06**	1.01	0.95	Light ora
F1XM1/57-15	9.00	10.50	4.25	0.26	**21.41**	1.00	1.00	White
TIS8164/21-03	11.00	3.00	4.55	0.19	**19.41**	1.00	1.00	White
PROGENY 1	17.00	10.50	6.15	0.36	**18.28**	1.00	1.00	Light ora
OP/3-06	9.00	10.00	3.10	0.44	**17.98**	1.00	1.00	Yellow
F1XM1/64-01	15.00	14.00	4.15	0.72	**17.65**	1.00	1.00	Light yell
F1XM1/04-02	21.00	4.50	5.95	0.26	**16.96**	1.00	1.00	Deep ora
OP/2	6.00	2.50	2.80	0.12	**16.90**	1.00	1.00	Yellow
F1XM1/04-03	18.38	18.08	3.48	0.25	**16.72**	1.01	0.95	Light ora
MD 12/ (I/5)	18.50	14.00	4.50	0.54	**16.61**	1.00	1.00	Light ora
F1XM1/64	1.38	0.08	1.58	-0.01	**16.06**	1.01	0.95	Light yell
F1XM1/57-32	2.50	1.00	1.44	0.08	**15.47**	1.00	1.00	White
OP/1-34	2.50	0.00	1.65	0.00	**15.28**	1.00	1.00	White
SOLO-GOLD (Check)	8.50	6.50	2.40	0.30	7.67	1.50	1.50	Deep ora
Mother's Delight (Check)	19.00	7.00	6.98	0.32	30.61	1.50	1.50	Deep ora
$FLSD_{0.05}$	9.46	8.77	3.13	0.29	14.29	1.03	0.70	
CV	48.67	52.75	53.06	47.08	54.03	44.98	31.03	
Grand Mean	9.62	8.23	2.93	0.31	13.09	1.14	1.12	
Population range	0.38–24.50	0.00–28.50	0.10–8.42	0.00–0.89	0.76-30.61	0.99–2.50	0.95–2.50	

FP1 = Mother's Delight; FP4 = Kwara; FP5 = CIP199034.1; M1= TIS8164; M2 = TIS87/0087; MD = Mother's Delight

Growth, Productivity and Mineral Composition of Grain Amaranths (*Amaranthus cruentus L.*) Fertilized with Composted Cocoa Pod Powder and *Chromolaena odorata* leaves

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ABSTRACT

A field experiment was conducted during the 2020 cropping season at Landmark University Teaching and Research farm, Omu Aran (Latitude 8' 8^0 N and latitude 5' 6^0 E) located in the derived savanna zone of Nigeria, to determine the growth, productivity and mineral composition of grain amaranths (Amaranthus cruentus L.) fertilized with composted cocoa pod powder and composted Chromolaena leaves. Treatments consists of 100% Composted Chromolaena leaves (CCL), 100% composted cocoa pod powder (CCPP), 100% Composted Chromolaena leaves (CCL) + 100% composted cocoa pod powder (CCPP), 50% Composted chromolaena leaves (CCL) + 50% composted cocoa pod powder (CCPP), NPK Fertilizer and the control. The experimental was laid out in Randomized Complete Block Design (RCBD) and replicated three times. The following field parameters were taken, plant height, number of branches and stem girth at 2, 4 and 6 weeks after sowing (WAS). The mineral elements of the leaves were also determined. Results showed that vegetative parameters (plant height, number of branches and stem girth) of grain amaranth increased with application of NPK fertilizer and at higher rates of the two organic amendments combined. Results also showed that application of the two amendments increased the mineral composition of the leaves. Therefore, Application of 100% CCL + 100% CCPP is recommended in the study area considering the negative environmental effect, high cost and scarcity of inorganic fertilizer.

Keywords: Composted chromolaena, composted cocoa pod powder, Grain amaranth, Vegetative parameters

INTRODUCTION

Grain Amaranth *(Amaranthus cruentus* L.) belongs to the family Amaranthaceae and of the order Caryophyllales, it is a cosmopolitan genus of annual or short-lived perennial plants. Grain amaranth is a nutritious vegetable and contains relatively high amounts of protein, 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). Grain amaranth has the potential to substitute expensive animal protein because of its comparable protein quality and quantity (FAO, 2003). Soil fertility needs for grain amaranth production varies significantly depending on rainfall amounts and distribution (Mposi, 1999). Akinrinade (2006) described soil fertility degradation as the second most serious constraint to food security in Africa. Soil fertility is declining at an alarming rate due to the limited use of organic and/or mineral fertilizers, depletion of soil nutrients by continuous cropping without the use of fertilizers, soil erosion and farmer's inability to acquire fertilizers due to the escalating market prices limiting its usage. In order to overcome the declining trends in soil fertility which includes proper utilization of organic fertilizers which should provide some of the solution to plant requirement therefore more emphasis is to be placed on technologies and strategies to integrate the use of both mineral and organic fertilizer. This study was therefore conducted to determine the performance and quality responses of grain amaranth to sole and combined application of composted cocoa pod powder and composted *Chromolaena odorata* leaves in a bid to optimize cost, yield and productivity.

MATERIALS AND METHODS

The experiment was conducted during the 2020 cropping season at the Landmark University Teaching and Research farm, Omu Aran (Latitude 8' 8 0 N and latitude 5' 6 0 E) located in the Derived savanna zone of Nigeria. It has annual rainfall pattern which extends between the month of April and October and it ranges between 600 mm-1200 mm, with peak rain in May-June and September-October, while the dry season is between November and March. Composted cocoa pod powder and composted chromolaena leaves were used as nutrient sources. The Cocoa pod husk were collected from a cocoa farm in Edidi, sundried for 3days and milled while fresh fresh chromolaena leaves were collected from the Teaching and Research Farms, Landmark University and was chopped into pieces with cutlass. The two materials were composted separately with poultry manure in a ratio of 5:1 fresh weight, in a perforated 250 l capacity plastic drum and the mixture was then allowed to decompose for 3 weeks. The contents of the plastic drum were sprinkled with water and stirred thoroughly at 3 days intervals to allow for uniform decomposition.

The land was ploughed once and harrowed twice to give a fine tilts after which beds were made into 2m × 2m with an alley of 0.5m between each bed and between each replicate. Treatments consists of 100% composted chromolaena leaves (CCL), 100% composted cocoa pod powder (CCPP), 100% composted chromolaena leaves (CCL) + 100% composted cocoa pod powder (CCPP), 50% composted chromolaena leaves (CCL) + 50% composted cocoa pod powder (CCPP), NPK Fertilizer and the control. The equivalent of 100%, 50% and 120 kg ha^{-1} of the treatments per experimental plot are 4 kg, 2 kg and 48 g respectively. The experiment was laid out Randomized Complete Block Design (RCBD), replicated three times. Physio-chemical properties of the soil and nutrients composition of the amendments were determined before application. Composted cocoa pod powder and leaves of chromolaena were incorporated into the soil two weeks before planting to give room for mineralization; while N.P.K 20:10:10 inorganic fertilizer (120 kg ha^{-1}) was applied at 2 weeks after sowing (WAS) by side placement 8 cm away from the base of the plant. Seeds were sowed by drilling at an inter row spacing of 60 cm and later thinned down at intra-row spacing of 10 cm to give a plant population of 166, 667 stands per hectare. At two weeks after planting, weeds that emerged were manually uprooted through hand pulling.

Fresh vegetable leaves were harvested 6 WAS by pulling the plants from the soil. Harvested plants were weighed and taken to the laboratory for the determination of its mineral composition. The followings are the parameters taken during the study: plant height, number of branches, stem girth, marketable yield and mineral composition. All data collected were subjected to analysis of variance (ANOVA) using Statistical Analysis Software S.A.S 9.4 (2013). Treatment means were compared using Duncan Multiple Range Test (DMRT) at 0.05 level of probability.

RESULTS AND DISCUSSION

Physical properties and nutrient status of the experimental soil

The pre-planting soil analysis is as shown on Table 1. The pH of the soil was strongly acidic, the nitrogen content of the soil was very low, the available phosphorus was high, and the exchangeable K was at moderate while the exchangeable Na, Ca, and Mg are all suitable. The organic matter is adequate. The soil is high in sand with relatively low values in both silt and clay; hence the textural class is Sandy loam. The Zn values for the two years' analyses were also found to be below the recommended critical level as suggested by WHO/FAO (FAO/WHO 2010).

Mineral composition composted cocoa powder and composted leaves of Chromolaena odorata

Table 2 shows the chemical composition of the organic materials used as amendment. Composted cocoa pod powder had a lower C: N ratio but higher nitrogen, phosphorus, magnesium, calcium, copper, iron and zinc concentration.

Effect of composted cocoa pod powder, composted leaves of Chromolaena odorata and NPK fertilizer on plant height of grain amaranth

At all sampling periods, plant height varied significantly with different rates of soil amendment, with the highest value obtained at application of NPK which was statistically similar with the application of 100% CCL + 100% CCPP while the least plant heights were obtained from the control which was statistically similar to 100% CCL only at 4 WAS (Table 3). This study revealed that application of organic amendments increased vegetative parameters and competes favourably with application of inorganic fertilizer. The complementary effect of both organic amendments could be attributed to nutrients availability to the plants. It could also be as a result of low fertility status of the native soil. Similar study conducted by Ayeni, (2008), and Odedina *et al* (2003) revealed that organic materials increased soil organic matter, N, P, K, Ca, and Mg hence increase in plant vegetative growth. The presence of nitrogen in both amendments in addition to the soil nitrogen could be adequate which may be responsible for the increase in vegetative parameters. Magnesium (Mg) is present in the two amendments in varying amounts and it is known to be present in chlorophyll and essential for photosynthesis. This could also be responsible for increased vegetative parameters. Several researchers have revealed that organic manuring increases the vegetative growth and biomass production effectively (Roy *et al*., 2010; Dinesh *et al*., 2010)

Effect of composted cocoa pod powder, composted leaves of Chromolaena odorata and NPK fertilizer on Number of branches, stem girth and marketable of grain amaranth

Table 4 revealed that number of branches increased significantly with application of NPK and also with increased application of organic fertilizer. Application of NPK and 100% CCL + 100% CCPP gave a significantly similar number of branches while the least value for number of branches was obtained in the control which was statistically similar with the application of 100% CCL. A statistically wider stem girth was obtained at the application of NPK fertilizer. Application of 100% CCL + 100% CCPP also increased stem girth which was statistically different from other treatments, while least stem girth was observed in control (Table 4). Increased number of branches and wider stem girth could be as a result of presence of phosphorus which is one of the major nutrients required by crops in relatively large amounts at the early stage of growth for optimum production. This is in line with the work of Shehu *et al*. (2010) who found that supply of phosphorus fertilizer is usually associated with increased root density and proliferation, which aid in extensive exploration and supply of nutrients and water to the growing plant parts, resulting in increased growth and yield traits, thereby ensuring more seed and dry matter yield. Results in Table 4 also revealed that, plots treated with organic amendment had higher values for nutrient composition. This could be due to enhanced nutrient availability in the soil leading to increased uptake by grain amaranth. This might be due to the positive effect of the amendments on the soil chemical composition and plant nutrition (Hassan *et al.,* 2014)

CONCLUSION

The results revealed that plant height, number of branches, stem girth and nutrient composition varied significantly with soil amendment. Application of 100% CCL + 100% CCPP compete favourably with application of NPK fertilizer on grain amaranth. Application of 100% CCL + 100% CCPP is therefore recommended in the study area considering the negative environmental effects, high cost and scarcity of in-organic fertilizer.

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Table 1: Physico-chemical properties of the initial soil

Parameter	pH	N%	P (mg/kg)	K (cmol/kg)	Mg (cmol/kg)	Ca (cmol/kg)	Zn (mg/kg)	O.M %	Textural class
Soil	4.29	0.107	9.15	0.13	0.32	1.95	0.35	2.04	Sandy loam

Table 2: Mineral composition composted cocoa powder and composted leaves of *Chromolaena odorata*

Amendments	N%	P%	K%	Mg%	Ca%	C:N	Cu%	Fe%	Zn%
Composted cocoa pod powder (CCPP)	9.18	3.62	1.22	4.8	14.0	10.3	0.65	0.14	3.46
Composted chromolaena leaves (CCL)	6.08	2.95	2.52	1.16	2.41	14.5	0.35	0.11	0.33

Table 3: Effects of soil amendments on plant height (cm) of grain amaranth

Treatments	Plant height (cm)		
	2WAS	4WAS	6WAS
Soil Amendment (t/ha)			
100% CCL	18.83c	27.14c	55.38c
100% CCPP	27.49b	53.72b	80.47b
100% CCL + 100% CCPP	45.40a	70.40a	95.40a
50% CCL + 50% CCPP	24.40b	46.74b	67.80c
NPK	48.92a	75.92a	102.92a
Control	11.53d	26.39c	41.20d

Means in a column under any given treatment followed by the same letter(s) do not differ significantly at 0.05 level of probability using the Duncan Multiple Range Test (DMRT)

Table 4: Effects of soil amendments on number of branches per plant, stem girth and mineral composition of grain amaranth

	Number of Branches	Stem Girth (cm)		Mineral composition (ppm)				.
Treatments	At Harvest	4WAP	6WAP	N	P	K	Ca	Mg
Soil Amendment (kg N/ha)								
100% CCL	4d	1.78d	1.75d	1.90b	780.44c	1032.72c	1.67b	0.80c
100% CCPP	9c	2.06c	2.34c	1.85b	735.25c	1081.25c	1.65b	0.76c
100% CCL + 100% CCPP	12a	2.32b	2.50b	2.05a	845.75a	1130.20a	2.30a	1.15a
50% CCL + 50% CCPP	7c	1.99d	2.13d	1.80b	740.44c	1032.31c	1.70b	1.02b
NPK	14a	2.52a	2.68a	2.20a	820.73b	1110.00b	1.22c	0.45d
Control	2d	0.95e	1.19e	0.70	310.45d	991.10d	1.02c	0.40d

Means in a column under any given treatment followed by the same letter(s) do not differ significantly at 0.05 level of probability using the Duncan Multiple Range Test (DMRT)

Contribution of Non-Cereal Energy Crops to Food Security in Nigeria

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ABSTRACT
An attempt has been made to review the contributions of non-cereal energy crops to food security in Nigeria. The paper established that non-cereal energy crops are crops besides, cereals and legumes which are grown mainly for energy. They comprise cassava, sweet potatoes, Irish potatoes, yams and banana/plantain. The overdependence on cereals and legumes for food security could be lessened by the adequate inclusion of these non-cereal energy crops because these crops have the ability to produce adequate food sources, some of which are exported, they are nutrient packed in terms of vitamins and minerals, very high in anti-oxidants and low in cholesterol. The paper noted that although there could be issues of pressures from climate change, soil erosion, biodiversity loss, consumers' changing tastes of food, outbreak of pests and diseases, reduced protein content, lack of quality crop cultivars and current national global insecurity, hybrids should be planted, government empowerment to farmers, mechanized agriculture and crop fortification as well with proteinous foods are recommended as the way forward in the contribution of non-cereal energy crops to human nutrition and food security in Nigeria.
Keywords: Non-cereal energy crops, contribution, human nutrition, food security

INTRODUCTION
Non-cereal energy crops are crops besides cereals and legumes which are grown mainly for energy. They comprise cassava, sweet potatoes, Irish potatoes, yam and bananas. Others include plantain, taro and eddoe. Although the main nutritional function of these non-cereal energy crops is largely carbohydrate at subsistence and local levels, the protein could be high as they form a great amount of total food intake (Norman *et al*., 1995).

a) Cassava (Manihot esculentus)
Apart from the value, Akparobi (2017) regarded cassava as a goldmine for sub-Saharan Africa. Cassava is used mainly as meal (garri), flour, fufu, starch and tapioca. Dried cassava roots are sent to Europe and other countries for making starch and used as raw material for glucose or power alcohol. Cassava is used as stock feed to feed pigs, horses, cattle and poultry. Milk could be added to it and given to cattle. This helps to increase milk production and yield which helps fatten cattle and pigs. Young cassava leaves are eaten as vegetables, also grown as an export crop. Cassava has many varieties depending on maturing periods; cotton-leaved cassava and sessile-leaved cassava, cooking well and keeping well, good for fufu, starch or cassava meal etc. Cassava can also be classified as sweet and bitter varieties. While the bitter has more bitter juice in the root, the sweet has sweet juice. Bitter species grow taller; take longer time to get matured and produce larger roots and heavier crops than sweet cassava. The starchy roots are major source of food for more than 700 million people all over the world. Cassava ranks third in the order of stable food crops in developing countries after rice and maize. Nigeria is the highest producer of cassava with over 41million metric tons per annum (Akparobi, 2017).

b) Yam (Discorea spp)
Yam (*Discorea* spp) occurs throughout the tropics and subtropics. In Africa including Nigeria, it is very abundant. Various varieties are evident in sub-Saharan Africa including white yam, yellow, greater or water, lesser bulbil bearing and three leaved yam (Irvine, 1979). Yams are nutrients packed. For example, yams are rich in fiber, minerals and vitamins. They enhance brain function, ease the signs of menopause, could have cancer fighting functions, reduce inflammation and help in blood sugar control. Yam also has health benefits including the treatment of intestinal disorders, gall bladder pains, rheumatoid, arthritis and rich in energy. It forms a stable food, useful industrially in the manufacture of multi-faceted adhesives, yam starch, yamarita, pounded, baked yam and cheese yam powder (Tobih, 2017; Aro *et al.,* 2021).

c) Sweet potato (Ipomea batatas)
A minor crop of many West African countries but abundant in most southern areas like Mali and Senegal and in the Northern parts of Nigeria, Ghana and Sierra Leone. Three varieties (white, red and yellow) are commonest. We also have the purple sweet potato. Sweet potato has a lot of health benefits such as control of diabetes, cancer, heart diseases, obesity, macular degeneration (Anedo *et al*., 2021). Sweet potatoes are mostly grown as annual, although treated as a perennial tuber. Sweet potatoes are also nutrient packed root vegetable that comes in colours. They are rich in fiber and anti-oxidants that ensure healthy gut and brain function. It makes the skin softer and younger because of its richness in beta carotene. Sweet potatoes are good for kidneys and ensure weight loss. They are called superfoods (Anedo *et al.,* 2021; Igbojionu and Chimaroake, 2021; Uchechukwu, 2021). Nigeria is ranked world largest producer of yam. Nigeria produces about 60% in global production (Tribune, November 27, 2019). Nigeria produces 3.93 metric tons of sweet potatoes (*Ipomea batatas).*

d) Banana (Musa acuminata)
Regarded as the world's largest herb, banana helps to strengthen food security and reduce poverty levels in various developing countries including Nigeria. It is rich in minerals, fibre, energy source, vitamins B and C. Nigeria is one of the largest banana and plantain producer. Many varieties are available including Eastern African highland banana and locally consumed ones. In Nigeria, it is an export plant product. It serves as a food source accepted throughout ages, gender and socio-economic groups (Pander *et al.,* 2014). Table 1 shows the comparative protein yield of non-cereal energy crops in Nigeria while Table 2 presents the influence of rainfall on the contribution of non-cereal energy crops in the region of Nigeria.

e) Irish potatoes – They are an inexpensive source of carbohydrate and are rich in minerals, vitamins, anti-oxidants, excellent in issues bordering on internal and external inflammation in the digestive system. Candies and confection are made from them, prevents scurvy because there are rich in vitamin C.

f) Cocoyam (Colocasia esculenta and Xanthosoma mafaffa)**:** These are ancient food crops similar to maize. They are widely distributed in West African countries and the starchy underground stems are corms. It is a root vegetable for their petiole, leaves and corms. It is regarded as an undervalued or utilized plant and a neglected staple carbohydrate food (Ojeifo, 2017).
Use: It is used in a range of indigenous foods. It is rich in B6 hence helps to control high blood pressure and helps to protect the heart. It is rich in fibre hence regulates bowel health, lowers cholesterol levels and reduces blood sugar levels. Cocoyam has better nutritional qualities when compared with other root and tuber crops like cassava and yam. It is a versatile staple crop used for as weaning food. The leaves have various purposes including the flowers of *C. esculenta* and *X. sagittifolia* impact captivating flavours and aroma to cooked food and soups while their cornels are used as popular soup thickners (Etukudo, 2000).
Cocoyam leaves: Boost immunity, prevents cancer, eye benefits, aids digestion, loaded with anti-oxidants and low in cholesterol. They are perennial plants grown as annuals. The soft

variety is used as soup thickeners and yam-like variety is eaten with pepper sauce. Types of cocoyam include taro, small taro, *Colocasia gigantea* and Eddoe.

Ways non-cereal energy crops can contribute to human nutrition and food security
The population of the world quoted as 7.8 billion as at 2020, is increasing at a progressive and alarming rate and food security is also a growing issue because providing food at a secured level is getting beyond every country. The over dependence on crop plants (Agbogidi *et al*., 2019) and legumes (Agbogidi *et al*., 2021) is also a challenge. It is against this background that an attempt has been made to provide information on how non-cereal energy crops can be used to cushion the effects of food insecurity in Nigeria. Some of the crops considered there are cassava, yams, sweet potato, Irish potato, banana/plantain. It is observed that with keen interest in these crops and commitment to their production, the issue of food insecurity could be considered a thing of the past because these crops have the ability to produce food sources, some of which are exported to other countries, they are rich in nutrients, anti-oxidants and of health benefits.

Pillars of food security are food availability, food access, food utilization and stability hence food is a fundamental need for survival and productivity (Akinyefun, 2018). Ogisi (2014) noted that cassava ranked the most important crop for Delta and Edo states farming households and Ogisi (2014) further established that cassava formed the base of farming system in Delta State even where yam is the staple food. Non-cereal energy crops are rich in carbohydrate both for sustenance and local sale. Besides, these crops are high yielding and are locally adapted to the climates of Nigeria. Energies and resources should be channeled to their production to ensure adequate food security and alleviate poverty among the Nigerian people (Okoh, 2015). Aggressive education on the benefits of non-cereal energy crops in human nutrition must be carried out stemming from their high levels of anti-oxidants and reduced cholesterol levels which confer an added advantage to their uses as food security crops. Nigeria is still reported to have a high reliance on food import hence malnutrition in the whole country and rural areas are susceptible to chronic food shortages, malnutrition, unbalanced nutrition, erratic food supply, poor quality foods, high food costs as well as total lack of food. The covid-19 has even worsened the hunger situation by impacting the supply, availability and prices.

Challenges of using non-cereal energy crops in reducing food security
1. Increasing pressures from climate change, soil erosion and biodiversity loss as well as from consumers changing tastes of food.
2. The outbreak of pests and diseases continue to pose their own issues on their production.
3. Reduced protein content in the crops limits their consumption when compared to legumes (Agbogidi *et al*., 2021).
4. Urban influx due to large scale rural-urban migration. This reduces the workforce. Even those who studied agriculture in school do not want to venture into farming because they see it as a dirty profession. They have forgotten that the food availability is the foundation for survival, life and productivity.
5. Pressure on limited land resources leading to destruction of vital forest resource and overexploitation of arable land. Teeming population affects food shortages hence food resources are declining.
6. Current National/global insecurity and challenges of food security. The activity of herdsmen leads to loss of lives (the real farmers), destruction and abandonment of agricultural farmlands hence posing serious threat to food security.
7. Unavailability of quality crop cultivars leads to yield reductions. Similarly, environmental conditions including climate change, water stresses, energy insecurity as well as anthropogenic factors.
8. Non-involvement of youths in real agricultural activities (Egbule, 2016).

The way forward

Agroforestry crops for improved food security include the intercrop of food crops like plantain, cocoyam, cassava and yam. Other forms of agroforestry include agrisilviculture (crop and trees), Silvopastoral (pasture, animals and trees) and Agrosilvopastoral (Crops, pastures and trees). Agroforestry brings improvement in the socio-economic, ecological conditions, enhancement of crop diversity and reduces dependency on natural forests. It also serves as a sustainable climate smart agriculture of farms, reduces their greenhouse emissions and improves productivity (Okunomo, 2019) and increasing in agricultural production. The usefulness of trees and soil cannot be overemphasized. The role of trees in soil improvement is a well-known and the distinctive role of trees in traditional farming system is as old as planet earth. Besides, agroforestry is seen as a way of efficient soil management that favours the growth of crop plants including non-energy cereal crops.

Other ways of non-cereal energy crops can be increased to alleviate food insecurity including maintenances of home gardens, shifting cultivation, farming/cropping and yams, sweet potato, banana and plantains are the regular plants planted in home farms/garden (Etukudo, 2009).

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Table 1: Comparative protein yield of some tropical food crops

Crops	Average tropical yield (tha-1)	Protein content (%)	Average protein yield (kgha-1)
Cassava	9.63	1.80	154
Sweet potato	5.86	1.6	94
Yams	7.00	2.0	140
Banana	13.00	1.0	143

Source: Norman et al. (1995)

Table 2: Influence of rainfall on the contribution of non-cereal energy crops to energy and protein intake in different regions of Nigeria

% of total intake	Northern Nigeria (750mm rainfall)	Western Nigeria (1,250mm rainfall)	Eastern Nigeria (1850mm rainfall)	Southern Nigeria (2,050mm annual rainfall)
Cereals				
Total energy intake	17.2	53.3	68.3	74.4
Total protein intake	9.80	41.3	65.4	68.5

Source: Norman et al. (1995)

Response of Moringa (*Moringa oleifera* Lam) to Varying NPK Fertilizer and Poultry Manure Rates

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ABSTRACT
Field experiments were conducted in 2018 and 2019 rainy seasons at the Research Farm of Nuhu Bamalli Polytechnic, Zaria ($11^0 11^{1\,N}$ $7^0 38^E$) and 686 m above sea level in Northern Guinea Savannah Ecological Zone of Nigeria, to study the response of Moringa to NPK Fertilizer and Poultry manure rates. The treatments consisted of four levels of NPK Fertilizer (0, 60, 120, and 180 kg/ha) and poultry manure (10, 15, 25 and 35 kg/ha) in factorial combination, laid out in Randomized Complete Block Design (RCBD) replicated three times. Data were collected on plant height, number of branches per plant, and total leaf yield. The result of the study showed that poultry manures rates of 25 t/ha significantly ($p \leq 0.05$) produced more leaf yield compared with other treatments in both 2018 and 2019 wet seasons. However, in 2018 wet season NPK fertilizer at both rates had no significant effect on fresh leaf yield. Therefore, applications of poultry manure at the rate of 25 t/ha can be utilized by farmer in the study area for maximum Moringa leaf yield.
Keywords: Response, Moringa, NPK Fertilizer, Poultry manure

INTRODUCTION
Moringa (*Moringa oleifera* Lam) is one of the worlds' most nutritious crops and has been used to mitigate malnutrition, especially among infants and nursing mothers. In many parts of West Africa, the leaves are important leaf vegetables (Awwalu, 2018). The leaf can be eaten fresh, cooked or stored as dried powder for many months without refrigeration and reportedly without loss of nutritional value (Faheyi, 2005, Kalb and Kuo, 2002). *Moringa* grows well in most soils without addition of fertilizer once established the extensive and deep root system of *Moringa* is efficient in mining nutrients from the soil (Palada and Chang, 2003). However, the tree has been found to respond well to mulch, water and fertilizer. It is reported that application of organic and inorganic fertilizer was found to increase yield up to three fold (Radovich, 2009, Fuglie and Sneeja, 2010). Despite the importance of Moringa, farmers in the study area do not pay much attention to the production and processing of this promising crop hence the growth and yield is low or very poor. If given proper attention, *Moringa* will be a promising source of nutrients and income to the farmers (Abdullahi and Adamu, 2019). There is need therefore to investigate the most economically easy and viable ways of nutrient rich food substance for the resource poor rural dwellers. Fertilizer application is essential for profitable *Moringa* Production. This study was therefore designed to evaluate the response of *Moringa* to varying NPK fertilizer levels and poultry manure in the study area.

MATERIALS AND METHODS

The experiments were conducted during 2018 and 2019 rainy seasons at Research Farm of Nuhu Bamalli Polytechnic, Zaria, located at latitude ($11^{0}\ 11^{1}\ N$), longitude ($07^{0}\ 38^{1} E$) and 686m above sea level.

Treatments and Experimental Design

The treatments consisted of four levels of NPK Fertilizer (0, 60, 120 and 180 kg/ha) and four levels of poultry manure (10, 15, 25 and 35 t/ha). The treatments were factorially combined and laid out in a Randomized Complete Block Design (RCBD), replicated three times. Data collected include plant height, number of branches per plant and fresh leaf weight.

Data Analysis

The data collected was subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1976). Treatment means were separated using Duncan Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Table 1 showed the effect of NPK fertilizer and poultry manure (PM) rates on plant height of *Moringa* in 2018 and 2019 wet seasons. Application of NPK fertilizer had significant ($p \leq 0.05$) effect on plant height at 6 and 9 weeks after sowing (WAS) in both seasons. Application of NPK rate at 120kg ha^{-1} significantly produced taller plants in both years. Poultry manure applied had significant ($p \leq 0.05$) influence on plant height as taller plants were recorded at 6 and 9 WAS from plots applied with $25th^{-1}$ in 2018. However, in 2019 taller plants were observed where 35 t/h^{-1} was applied. Interactions among the treatments were not significant. Table 2 showed the effect of NPK fertilizer and poultry manure rates on number of branches per plant. At 3 and 6 WAS, application of NPK at 180kg ha^{-1} significantly gave higher ($p \leq 0.05$) number of branches. In 2019 both the NPK and poultry rates had no significant effect on number of branches per plant throughout the sampled period. Interaction between treatments were not significant. The effect of NPK fertilizer rates and poultry manure on total fresh yield of Moringa is presented in Table 3. In 2018, there were no significant differences on total fresh leaf weight at different NPK fertilizer rates applied. However, poultry manure applied manifests a significant influence on fresh leaf yield. It was observed that application of 25t/ha significantly produced higher fresh leaf yield in 2018 and 2019 respectively. Interactions among factors were not significant.

Moringa grows well on soil without addition of fertilizer. Once established the extensive and deep root system is efficient in mining nutrients from the soil. However, several researchers have observed significant influences of NPK fertilizer and poultry manure on growth and yield especially in parameter such as plant height, number of branches per plant and total fresh leaf. The result of this finding revealed that NPK rate at 120kgN ha^{-1} significantly increased plant height, number of branches and total leaf yield. This may be attributed to the role of NPK and poultry manure in enhancing growth and development of the crop. This result is in line with findings of Radovich (2009); USDA (2011) and Sneeja (2010). The non-significant effect recorded on total fresh yield when NPK rates were applied, might be attributed to the native soil fertility of the experimental site and the ability of Moringa to grow and yield well in most soil without addition of fertilizer.

CONCLUSION

Based on the findings from this study, applications of poultry manure at the rate of 25 t/ha can be utilized by farmer in the study area to maximize Moringa leaf yield.

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Table 1: Effect of NPK fertilizer and Poultry Manure Rates on Plant Height of *M. oleifiera* during 2018 and 2019 Wet Seasons

	2018			2019		
Treatment	**3 WAS**	**6 WAS**	**9 WAS**	**3 WAS**	**6 WAS**	**9 WAS**
NPK 0Kg/ha	8.4	16.9c	40.5c	10.6	18.26c	34.7c
NPK 60Kg/ha	9.2	21.6bc	51.0b	10.4	17.7c	33.4c
NPK120Kg/ha	9.5	24.8ab	70.9ab	9.2	24.3b	34.1c
NPK 180Kg/ha	9.2	23.1bc	53.9b	11.2	23.2bc	43.8bc
SE+	**0.785**	**2.447**	**3.433**	**1.186**	**4.500**	**8.422**
PM 5t/.ha	9.8	29.lab	159.7a	10.2	29.3ab	54.4abc
PM 15t/.ha	8.3	25.9ab	63.oab	9.9	31.4abc	56.4abc
PM 25t/.ha	8.6	32.6a	85.3a	8.5	37.7ab	64.4ab
PM 35t/.ha	10.2	29.6ab	83.3ab	8.0	38.6a	78.4a
SE+	**0.785**	**2.447**	**3.433**	**1.186**	**4.500**	**8.422**
Interaction NPK x PM	NS	NS	NS	NS	NS	NS

Means followed by same letter(s) within same column are not statistically different at P = 0.05 Level of Probability using DMRT. NS = Not Significant at (P≤0.05)

Table 2: Effect of NPK Fertilizer and Poultry Manure Rates on Number of Branches of *M. oleifiera* during 2018 and 2019 Wet Seasons

	2018			2019		
Treatment	**3 WAS**	**6 WAS**	**9 WAS**	**3 WAS**	**6 WAS**	**9 WAS**
NPK 0Kg/ha	5.0	7.3b	6.3	6.0	5.3	6.3
NPK 60Kg/ha	5.7	8.7ab	6.7	6.3	6.0	6.7
NPK120Kg/ha	5.3	8.3ab	6.3	6.3	6.0	7.3
NPK 180Kg/ha	5.7	7.3b	13.0	6.3	6.0	7.0
SE+	**0.376**	**0.448**	**2.299**	**0.345**	**0.579**	**0.502**
PM 5t/.ha	4.7b	8.3ab	7.3	6.3	7.0	7.0
PM 15t/.ha	4.7b	8.0ab	7.0	6.3	6.0	7.3
PM 25t/.ha	5.3ab	8.0ab	7.3	6.0	7.0	8.0
PM 35t/.ha	6.0a	9.3a	8.0	7.0	6.7	8.0
SE+	**0.370**	**0.448**	**2.299**	**0.345**	**0.579**	**0.502**
Interaction NPK x PM	NS	NS	NS	NS	NS	NS

Means followed by same letter(s) within same column are not statistically different at P = 0.05 Level of Probability using DMRT. NS = Not Significant at (P≤0.05)

Table 3: Effect of NPK Fertilizer and Poultry Manure Rates on Total Fresh Leaf Yield of *M. oleifiera* during 2018 and 2019 Wet Seasons

Treatment	2018	2019
NPK 0Kg/ha	0.60	0.37d
NPK 60Kg/ha	0.70	0.37d
NPK 120Kg/ha	0.73	0.47cd
NPK 180Kg/ha	0.73	0.53bcd
SE ±	**0.197**	**0.187**
PM 5t/ha	1.13bc	1.13ab
PM 15t/ha	1.00bc	0.77abcd
PM 25t/ha	1.87a	1.33a
PM 35t/ha	1.53ab	1.07abc
SE ±	**0.197**	**0.187**
Interaction NPK x PM	NS	NS

Means followed by same letter(s) within same column are not statistically different at P = 0.05 Level of Probability using DMRT. NS = Not Significant at (P≤0.05)

Isolation and Identification of Fungi responsible for Post-harvest Rot of Sweet Potato in Umudike

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ABSTRACT
Fungal decay of sweet potato harvested at National Root Crops Research Institute, Umudike was investigated for fungi responsible for tuber loss in storage. The tubers were collected from the sweet potato barn to isolate and identify fungal species responsible for the rots. Five (5) fungal isolates were found, they are Aspergillus niger, A. flavus, Fusarium oxysporum, Penicillium chrysogenum and Rhizopus stolonifer. Pathogenicity test was done and isolates such as R. stolonifer, A. niger and F. oxysporum were more pathogenic on healthy tubers. Twenty samples of deteriorated sweet potato samples were used for this study and freshly harvested tubers were used to test for pathogenicity to make sure that the isolated organisms were able to exact same spoilage activities on healthy tubers. Percentage occurrence of isolated fungi had A/ niger 30%, A. flavus 25%, R. stolonifer 25%, F. oxysporum 10% and P. chrysogenum 10%. Inoculated tubers were examined and the nature of the rot varied with the pathogens.

Keywords: Ipomoea batatas, fungal pathogens, rots, pathogenicity

INTRODUCTION
Sweet potato (*Ipomoea batatas*) is a dicotyledonous plant and belongs to the family *Convolvulaceae*. It is usually large, tuberous and starchy with a sweet taste. It is a root crop cultivated in countries like Nigeria, Sierra Leone and Ghana. Sweet potato is the 3rd most important crop in Nigeria after yam; therefore, it is an important staple crop in many parts of Africa (Amienyo and Ataga, 2007). Sweet potato generally is grown for its storage roots which can be eaten raw, boiled, fried or made into chips (Hu *et al*.,2004, Onifade *et al*., 2004). In the tropics, estimate of 25% -40% of Agricultural produce are lost due to poor storage methods (Hayma, 1982). These losses are as a result post-harvest handlings and storage resulting from physical, physiological and pathological factors or combination of any of the listed factors (Ogbo and Agu, 2014). Sweet potatoes are perishable after harvesting and they are subjected to damage during transportation, storage and marketing. It has a high water content which makes storage difficult and exposes it to microbial attack (Boot, 1994). Fungi are responsible for causing rot on sweet potato, these rots are of various categories such as black rot (*Ceratocystis fimbriata*), dry rot (*Aspergillus niger, Aspergillus fumigates*), Stem rot (*Fusarium solani*) and soft rot (*Rhizopus stolonifer*) (Oyewale,2004). Sweet potato can be stored for months and this can be achieved by curing for about 8 days which allows injured roots to heal. Curing allows wounded roots to heal and when healed can stay up to five months. Other methods include the traditional methods which involves burying in the ground has recorded a heavy loss owing to destructions by microbes, sprouting and decay of tubers. The objective of this work is to identify, isolate and characterize fungi associated with post-harvest loss of sweet potato and also carry out pathogenicity test on healthy tubers using the isolates from spoilt tubers to determine the extent of rot caused by these isolates.

MATERIALS AND METHODS

A variety of sweet potato cultivated at National Root Crops Research Institute Umudike was used for this study. Twenty spoilt tubers were obtained and taken for laboratory analysis. Healthy tubers were also subjected to pathogenicity test to determine the extent of severity on healthy tubers.

Isolation of rot causing fungi

The spoilt potato tubers were washed in a running sterile water, the rot tissue was cut, sterilized in 70% ethanol and approximately 2mm diameter were cut out from the rotten tissue and place on the solidified Potato Dextrose Agar (PDA) medium. The plates were incubated at room temperature for 72 hours, fungal colonies were purified to obtain a pure isolate by sub culturing them into a freshly prepared PDA and growths were observed after 6 days.

Identification of Fungal Growth

The fungal growths observed on the plates were aseptically transferred into a freshly prepared PDA and incubated for 5 to 7 days. The colony morphology and pigmentation of the isolates were observed and recorded before they were sub cultured and kept for identification (Barnett and Hunter, 1972). The colony texture, spore formation and other morphological appearance of fungal colonies on agar culture medium were based on microscopic evaluation with reference to the manual of fungal atlas (Watanabe, 2002).

Pathogenicity test

Healthy tubers of the freshly harvested sweet potatoes were washed and sterilized in 70% ethanol. The pure cultures of the individual fungal isolates were introduced into the healthy sweet potato by creating a hole using a sterile syringe. After the inoculation, they were kept in a sterile polythene bags and incubated at room temperature for 14 days. After the incubation period, the sweet potato tubers were cut through to examine the rot. Three isolates were confirmed pathogenic on the healthy sweet potato tubers.

Statistical analysis

Data were subjected to analysis of variance and means separated using the least significant difference (LSD) method where significant difference between means of treatment at P = 0.05 were established (Steel and Torries, 1980).

RESULTS AND DISCUSSION

Five distinct fungal colony types were isolated from the rotten sweet potato tuber samples; *R. stolonifer, A/ niger, A. flavus, F. oxysporum and Penicillium chryosogenum* with *R. stolonifer, A. niger and A. flavus* considered to be pathogenic on healthy tubers. These findings clearly indicate that fungi are responsible for spoilage of sweet potato tubers. *A. niger, R. stolonifer and A. flavus* played a more pathogenic role in sweet tuber potato spoilage. Some researchers have reported tuber rot to be caused by fungi in storage (Clark and Hoy, 1994, Onuegbu, 2002) which is also in agreement with the present findings. In some cases, fungi gain its entrance during harvesting and transportation to their storage sites. However, (Okigbo and Nmeka, 2006) also found out that at the time of harvest, most tubers maybe affected by pathogens from disease foliage or roots. It was observed that *A. niger* and *R. stolonifer* were the most frequently isolated fungi. The result of pathogenicity test indicated that fungi induced different levels of decay and *A. niger* being the most virulent fungus. Post-harvest rot can also be due to low pH, moisture content and nutritional composition which make it prone to fungal attack (Olurinola *et al.,* 1992).

CONCLUSION

This work shows that fungi are the major cause of post-harvest rot in storage. This can cause food shortage, scarcity and lead to low income source to farmers. Therefore, several control measures such as proper handling during harvesting, transportation, airy environment for storage, provision of good storage facilities should be placed in check for good storage of sweet potato tubers. It is also advisable that farmers adopt diseases control practices which are affordable to ensure sustainable sweet potato production.

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Table 1: Fungi isolated from spoilt sweet potato tubers

No of isolates	fungi isolated
6	*Aspergillus flavus*
7	*Penicillium chrysogenum*
8	*Fusarium oxysporum*
9	*Aspergillus niger*
10	*Rhizopus stolonifer*

Table 2: Percentage occurrence of fungi isolated

No. of isolates	Fungi	Percentage occurence
1	*Rhizopus stolonifer*	25
2.	*Aspergillus niger*	30
3	*Penicillium chrysogenum*	10
4.	*Aspergillus flavu*	5
5.	*Fusarium oxysporum*	10

Table 3: Microscopic features and cultural features of the fungal isolates

Isolates	Cultural Features	Microscopic Features	Fungi
1	White to brown	Hyphae, sporangiospores	*Rhizopus stolonifer*
2	Powdery black	Conidia, conidiophores	*Aspergillus niger*
3	Green conidia	Radiated heads, colorless	*Aspergillus flavus*
4	Pale to brown	Mass of hyphae, macro conidia	*Fusarium oxysorum*
5	Blue-green	Branched conidia	*Penicillium chrsogenum*

Variability of Cassava Accessions in Terms of Fresh Root Yield and Total Carotenoids Contents at Two Cropping Seasons among Pro-Vitamin A Cassava(*Manihot esculenta* Crantz) Acessions in Ibadan

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ABSTRACT
Cassava, a dietary source of calories for millions of people in tropical America, Africa and Asia is majorly used for food, feed and non-food purposes especially in industries. Biofortified cassava is an effective means to combat the challenges of hidden hunger and poor nutrition among rural poor farmers who are the major producer of the crop in sub Saharan Africa. This study aims to identify the effects of cropping seasons on biofortified cassava accessions. Forty-two (42) yellow cassava accessions with three white checks (TMEB 419, TMEB693 and IBA 980581) and a yellow check (IBA070593) were evaluated at different harvesting periods of 6, 9 and 12 months after planting (MAP) in a split-plot design in Ibadan- a derived guinea savanna agroecology at two seasons to determine variability among cassava accessions in terms of fresh root yield and total carotenoid content during the 2019/2020 and 2020/2021 cropping season. Data were collected on fresh root yield and total carotenoid. The result of the study showed that first seasons with the highest rainfall of 127.38mm favoured higher total carotenoids while the second seasons with lower rainfall of 8.45mm favoured higher root yield production. Variability existed in the performance of accessions in relation to these traits at different cropping seasons.
Keywords: Biofortified, carotenoids, cassava accessions, variability

INTRODUCTION
End user preference is important for farmers' adoption of developed cassava varieties and most varieties may not be adopted by rural farmers if they do not meet market needs (Aurelie *et al.,*2015) and therefore, there must be a linkage between breeding for important traits and end users preferences. Cassava is a food security and industrial crops from which flour and starch-a highly profitable food could be derived (Ayetigbo *et al.,*2018. In cassava breeding improvement, one of the major breeding goal is to increase root yield (Chen *et al.,* 2012) but root yield reduces with total carotenoid content in provitamin A cassava varieties. However, variability among studied accessions as shown in this study shows that some accessions have higher root yield as they recorded increase in their total carotenoid content. These variability enables desirable selection for possible introgression of these important traits into provitamin A cassava germplasm in improving its gene pool for higher root yield and total carotenoid content. The objectives of this study was to identify variabilities among pro-vitamin A accessions for fresh root yield (FYLD) and total carotenoids.

MATERIALS AND METHOD
The study was conducted at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria a derived savanna zone with global positioning system of 07.488249^{0}N, 003.904875^{0}E and altitude 207m from 2019 to 2020 cropping seasons. Forty two yellow cassava acessions

with white checks (TMEB419, TME693and IBA980581) and yellow check (IBA070593) were sourced from IITA, Ibadan. The treatments were the 42 accessions which was arranged in a split plot design with two replications. The accessions were planted at a spacing of 1 x 0.8m in 2 replicates in 2019 and 2020 cropping season and were evaluated at 6, 9 and 12 months after planting (MAP) for their total carotenoid and fresh root yield. Data was analyzed using the restricted maximum likelihood/best linear unbiased prediction (REML/BLUP) procedure, proposed by Piepho *et al* (2008) using R statistical analysis (R version 4.0.3) and data visualizations were carried out using R statistical software.

RESULTS AND DISCUSSION

There was more variability among the accessions for fresh root yield and carotenoids contents at different cropping seasons. Accessions vary more in the first seasons in terms of total carotenoids contents and the traits recorded higher values at the first seasons than the second season. Fresh root yield was more variable and higher at the second cropping seasons than the first season (Fig. 1). The major element of the growing seasons is the climate which affects all component of crop production. Rainfall is essental for overall growth and development, and enough moisture will aid metabolic processes especially photosynthesis. However, root yield was higher in the second season with less rainfall than in the first season. Higher rainfall will enhanced good vegetative growth in which there is good leaf area development upon which photosynthesis is dependedent. And utilization of this vegetative source can influence or regulate photosynthesis (Krieg, 1983) and hence higher photo assimilates being distributed across different part of the growing plant but for these accessions with higher root yield at a period of less rainfall shows that the accessions could be effective in assimilates partitioning even at a period of lower moisture or there are other favourable conditions in the second cropping seasons aside rainfall which had enhanced the productivity of the accessions in terms of fresh root yield. The lower root yield, 12 months after planting at first cropping seasons (2019/2020) could have been as a result of water deficit during bulking period. Water deficit especially at the period of tuberization has been found to affects root initiation and storage root yield could be affected by up to 60% (Alves, 2002) and this could also affect photosynthesis. During water stress, stomata closes to conserve water and this process also affects the use of CO_2 as it decreases photosynthetic assimilation of CO_2 which affects photosynthesis.

As reported by De Souza *et al* (2018) in their leaf-level model created for cassava. Photorespiration in cassava removes large CO_2 needed by the plants for production of assimilates from plant cells and since photosynthetic rate in cassava is very high (Angelov, 1993) with numerous pysiological challenges affecting its effective photosynthetic use of CO_2 (De Souza et al , 2018) water stress during the period of bulking might affect root yield. Environment or cropping seasons with water stress might affects water use efficiency which will only compound the challenges of cassava productivity in terms of its photosynthethic efficiency. Water use efficiency has been found to be linked with effective fixation of CO_2 during photosynthesis. In improving cassava productivity, if the ratio of water use efficiency could be improved by 16%, cassava could fix six (6) times CO_2 each day (De souza et al, 2018).

Variability exists in yield of cassava at different years (Conrad *et al*., 2019) and cassava as a crop has been regarded as being adaptable to different climatic conditions and has shown different performance in terms of yield in different years as a result of differences in the annual weather condition (Enete, 2003). Temperature and rainfall serve as a major factor of productivity in cassava and its growth is affected under no-rainfall in a rain-fed agriculture (BNRCC, 2012). However, this study shows that cassava yield higher when there was no or less rainfall (Table 1). In study conducted by Ilyasu *et al* (2019) where rainfall and data were collected over the span of twenty-two years was compared with cassava yield in Imo state, it was found out that in 2005, when rainfall was 2236.6mm, cassava yields 16.21t/ha and while in 2006 when rainfall was higher with 3209mm, cassava yields 14.18t/ha. Similar result was obtained in same study conducted by Akagha *et al* (2021) where they analysed seven years data of rainfall and cassava yield in Imo state. This is similar to result obtained in this study where cassava yield was lower in year one (2019/2020) despite recording higher rainfall of 127mm and higher in year two (2020/2021) when there was less rain (8mm). Rainfall may not be the only factor affecting root yield in cassava as also revealed in another study in Indonesia by Fauzan and Puspitoni (2001), where the effect of dry periods on different stages of cassava growth cycles was conducted. They found out that cassava varieties *Adira, Rayong 60, Rayong 90, Kasetsart* and *CMR30-50-1* had higher root yield of 43t/ha, 46t/ha, 49t/ha, 34t/h and 44t/ha respectively during harvest in May 1997 with rainfall of 2092 mm while having lower yields when rainfall was highest with 2213 mm at harvest in July, 1998. Since the performance of root yield were not affected when there was no or less rainfall, it means other elements of climate such as temperature, humidity, solar radiation, photosynthetic capacities and factors such as fertility might as well play a role in determining cassava root yield and that the accessions are effective in assimilates partitioning.

Across the months, TC was highest at 6 MAP with lowest rainfall. TC recorded 13.7μg/g when rainfall was 5mm at 6 MAP. And when the rainfall was highest at 12MAP with 107mm, TC was 13.07 (Table 1). This is an indication that even though the accessions recorded the highest TC at the months when the rainfall was low, they are not significantly affected by higher rainfall. This confirms the higher total carotenoid characteristic traits of the accessions' population. Months and seasons affect the variability of cassava accessions for TC and since selection can not be made at earlier months of 6MAP, the TC was somewhat stable across the months till 12MAP.

CONCLUSION

This shows that generally, cropping seasons had no much effects on total carotenoids (TC) of the accessions studied and period of higher rainfall favoured total carotenoid production.This study shows that across seasons, fresh root yield was higher at 12MAP and this means that selection can only be made at 12MAP and for total carotenoids, selection could be made at a period with higher rainfall and at 12MAP due to their stability.

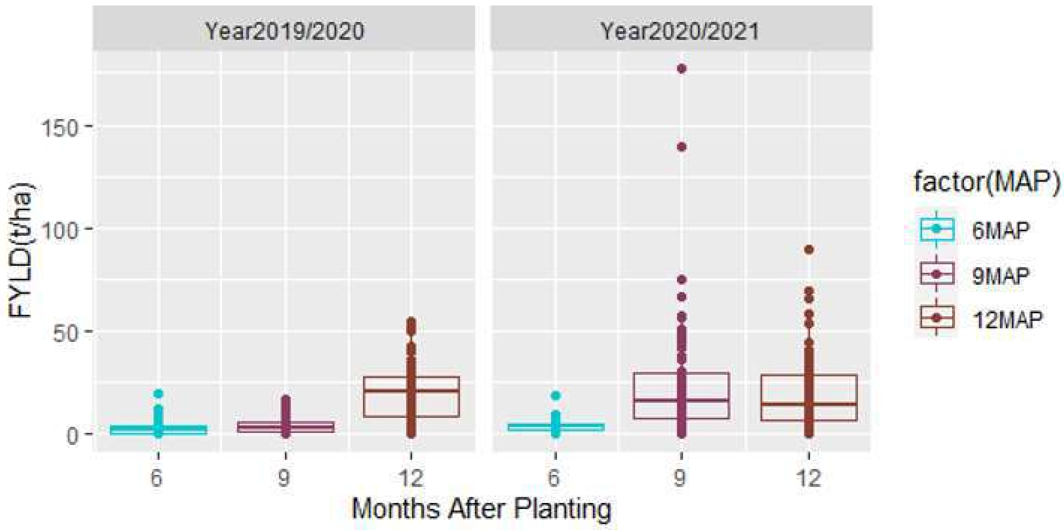

Figure 1: fresh root yield relationships with different months after planting at two seasons

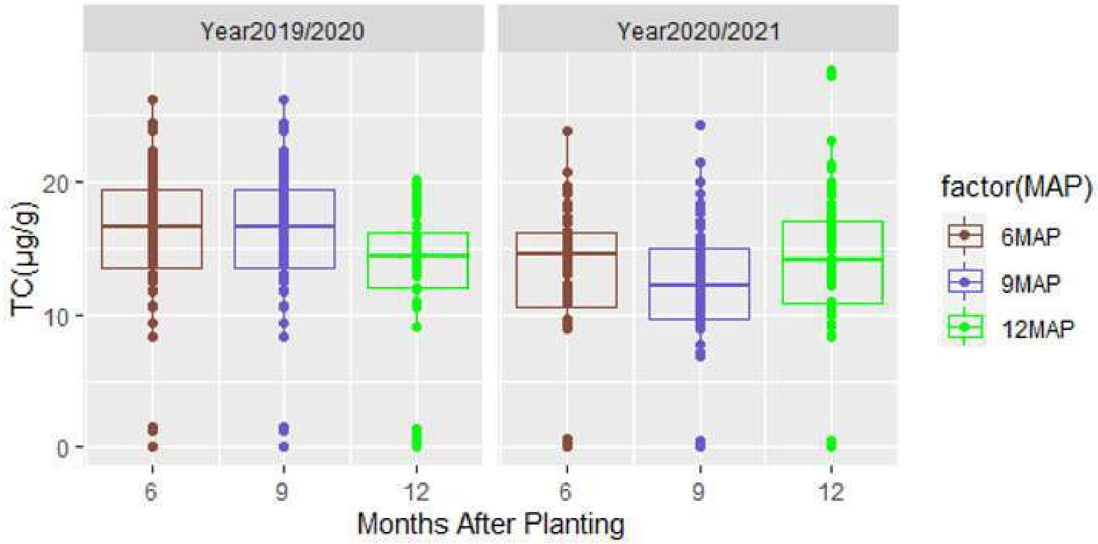

Figure 2:TC relationships with different months after planting at two seasons

Table 1: Rainfall effect on fresh root yield, dry matter and total carotenoids at different months and seasons

MAP	Rainfall(mm)	FYLD(t/ha)	DM(%)	TC(µg/g)
6MAP (December)	4.58	3.63	25.70	13.76
9MAP(March)	52.09	13.92	16.40	13.51
12(June)	107.05	19.54	18.76	13.04
Season	Rainfall(mm)	FYLD(t/ha)	DM(%)	TC(µg/g)
2019/2020	127.38	9.23	20.93	14.41
2020/2021	8.45	15.50	19.66	12.48

MAP-Months after planting, FYLD-fresh root yield, DM-Dry matter content, TC-Total carotenoids

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Divergence in Reactions to Leaf Spot Disease in Castor

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ABSTRACT

Castor production is hindered by a number of biotic and abiotic factors. Diseases, in castor farms, can be of significant economic importance. Castor diseases are predominantly caused by fungi and some of the fungal diseases commonly infect castor plant include leaf spot caused by Cercospora ricinella, wilt cause by Fusarium oxysporum f spricini, root rot cause by Macrophomina phaseolina, gray rot cause by Botrytis ricini, and leaf spot caused by Alternari ricini. In the present study, assessment of reactions to leaf spot disease caused by Cercospora ricinella was carried out on 17 promising castor genotypes at two locations in Nigeria (Ibadan and Badeggi) over two growing seasons. The genotypes were screen on replicated plots using 1 – 5 scale for disease scoring. The results obtained revealed variability in host reactions to the disease among the genotypes. Average score ranged between 1.07 and 3.19 was observed at Ibadan location and scores of 1.35 to 2.65 were recorded at Badeggi location. The dendrogram constructed from the scores showed two distinct cluster groups among the genotypes. Cluster I consists of genotypes with scores between 1.32 and 2.19 ($\approx$ 1 to 2*) and Cluster II has members with higher scores (i.e 2.33 to 2.87). The present study revealed potential sources for resistant genotypes to the disease considered; however, the genotypes require further screening under control condition to confirm the observed resistant status.*

Keywords: Castor, Disease, Fungi, Leaf spot, Cercospora

INTRODUCTION

Castor plant (*Ricinus communis* L.) is an oil plant whose oil is used in several industrial applications including production of medicine, cosmetics, paints, dyes, cold resistant plastic, hydraulic fluid, lubricants and biodiesel to mention but a few (Gana, 2015). However, castor production is hindered by many biotic and abiotic factors (Severino *et al*., 2012). Diseases cause a lot of economic damage to castor farms and in some areas it is a limiting factor to commercial castor cultivation (Salihu *et al.*, 2014). Castor diseases are predominantly caused by fungi, and if not well managed, cause severe economic loss. Several other pathogens can cause severe castor disease outbreaks depending on genotypes and climatic conditions (Severino *et al.*, 2012). Some fungal diseases commonly infect castor plant include leaf spot caused by *Cercospora ricinella,* wilt cause by *Fusarium oxysporum* f *spricini*, root rot cause by *Macrophomina phaseolina*, gray rot cause by *Botrytis ricini*, and leaf spot caused by *Alternari ricini* (Weiss, 2000). Other diseases include leaf blight, grey mould, rust, powdery mildew, bacterial leaf blight, capsule mould, capsule abortion, seedling blight, mosaic and others (Salihu *et al.*, 2014). Due to little research attention, record on sources of resistance to major diseases of castor in Nigeria is barely available (Salihu *et al.*, 2019). Therefore, this research was set to assess variation in reactions to leaf spot disease among some Nigerian castor germplasm.

MATERIALS AND METHODS

Assessment on reactions to fungal leaf spot disease caused by *Cercospora ricinella* was made on 17 promising castor genotypes at two locations in Nigeria (Ibadan and Badeggi) over two growing seasons. The genotypes were grown in a randomized complete block design with three replications. The plot size was 3 m by 4m with inter-row and intra-row spacing of 1m and 0.75m respectively. Two seeds per hole were planted and later thinned to one seedling per hole at one month after planting. Fertilizers were applied a one month after planting and weeding was done three times during the experiment. Disease scoring was carried using a 1 - 5 scale as described by Salihu *et al*. (2019). Data were taken on 10 plant samples in each plot, amounting to 30 plant samples per genotypes. The disease observations were made at first spike flowering and maturity. Score scale for the leaf spot was:

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

Analysis of Variance and Multivariate Analysis were done according to the procedure of Statistical Tool for Agricultural Research (STAR 2.0.1).

RESULTS AND DISCUSSION

The results showed significant difference among the genotypes for reactions to the leaf spot disease (Tables 1). There were effects of year variation and genotype by locations interactions among the genotypes (Table 1). Average score ranged between 1.07 and 3.19 was observed at Ibadan location and 1.35 and 2.65 was recorded at Badeggi location. The pool mean showed that only one genotype (Acc.048) has 1.32 score (≈ 1), 15 genotypes recorded approximately 2 and only one genotype (Acc.042) recorded 2.87 (≈ 3) score. At a Cophenetic Correlation Coefficient of 0.708, the dendrogram constructed from the score showed 2 cluster groups for the genotypes with cluster I and II having 13 and 4 members groups respectively (Figure 1 and Table 2). Cluster I consists of genotypes with scores between 1.32 and 2.19 ($\approx$ 1 to 2) and Cluster II has members with higher scores (i.e. 2.33 to 2.87). The results obtained revealed variability in host reaction to the disease among the genotypes. This may be an indication for presence of different gene recombinants for the leaf spot resistance among the genotypes from which resistant lines could be developed. In this sense, the genotypes with low disease severity and low damage index could serve as relevant sources for the resistance genes. The values obtained here are similar to those described by Mamza *et al*. (2008) who reported fungal leaf blight incidence and severity on castor seedling at different stages. 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 production loss of 37.83 g and 24.4 g seed yield and seed oil yield per hectare respectively.

CONCLUSION

The results obtained revealed divergence in host reactions to the leaf spot disease among the genotypes. Two cluster groups were identified among the genotypes. The cluster I consists of genotypes with scores between 1.32 and 2.19 ($\approx$ 1 to 2) and Cluster II has members with higher scores (i.e 2.33 to 2.87). The study revealed potential sources for resistant genotypes to the disease evaluated; however, stringent screening of the genotypes under control condition is recommended as a confirmatory trial of the observed resistant status.

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Table 1: Average scores for reactions of the evaluated castor genotypes to *Cercospora* leaf spots

Genotypes	Ibadan			Badeggi			
	2016	2017	Combined	2016	2017	Combined	Pool Mean
Acc.014	2.20	2.15	2.18	1.84	1.86	1.85	2.01
Acc.048	1.36	1.24	1.30	1.39	1.31	1.35	1.32
Acc.049	2.31	2.21	2.26	2.50	2.36	2.43	2.34
Acc.050	1.14	1.00	1.07	2.05	1.86	1.96	1.51
Acc001	1.62	1.65	1.64	1.84	1.85	1.85	1.74
Acc015	2.29	2.01	2.15	2.79	2.52	2.65	2.40
Acc016	1.59	1.45	1.52	2.20	2.07	2.13	1.83
Acc020	1.47	1.42	1.45	1.98	1.83	1.90	1.68
Acc024	2.34	2.23	2.29	1.62	1.59	1.60	1.95
Acc040	1.81	1.74	1.77	2.07	1.91	1.99	1.88
Acc041	2.12	1.98	2.05	1.14	1.01	1.08	1.56
Acc042	3.27	3.12	3.19	2.56	2.53	2.54	2.87
Acc043	2.66	2.60	2.63	1.75	1.76	1.75	2.19
Acc044	2.22	1.99	2.10	2.06	1.92	1.99	2.05
Acc045	1.82	1.67	1.75	1.82	1.82	1.82	1.78
Acc046	2.29	2.14	2.22	2.50	2.41	2.45	2.33
Local Check	1.71	1.64	1.68	1.96	1.88	1.92	1.80
Mean	2.01	1.9	1.95	2.00	1.91	1.96	1.96
MS Location (L)							0.11
MS Block within	3.70	1.98	5.47	0.65	1.55	1.87	3.72
MS Year (Y)			3.48**			2.18**	5.62**
MS Genotype (G)	8.32**	7.89**	16.08**	5.41**	4.76**	10.06**	17.51**
MS Y x G			0.08			0.11	0.10
MS L x Y							0.11
MS L x G							8.61**
MS L x Y x G							0.1
MS Error	0.22	0.10	0.13	0.10	0.24	0.17	0.15

Table 2: Cluster membership performances on reactions to leaf spot diseases among 17 castor genotypes

Locations	Cluster I		Cluster II	
	Min	Max	Min	Max
Ibadan	1.07	2.63	2.15	3.19
Badeggi	1.08	2.13	2.43	2.65
Pool	1.32	2.19	2.33	2.87
	13		4	
	Acc.014 Acc.048 Acc.050 Acc001 Acc016 Acc020 Acc024 Acc040 Acc041 Acc043 Acc044 Acc045 Local Check		Acc.049 Acc015 Acc042 Acc046	

Cophenetic Correlation Coefficient = 0.708

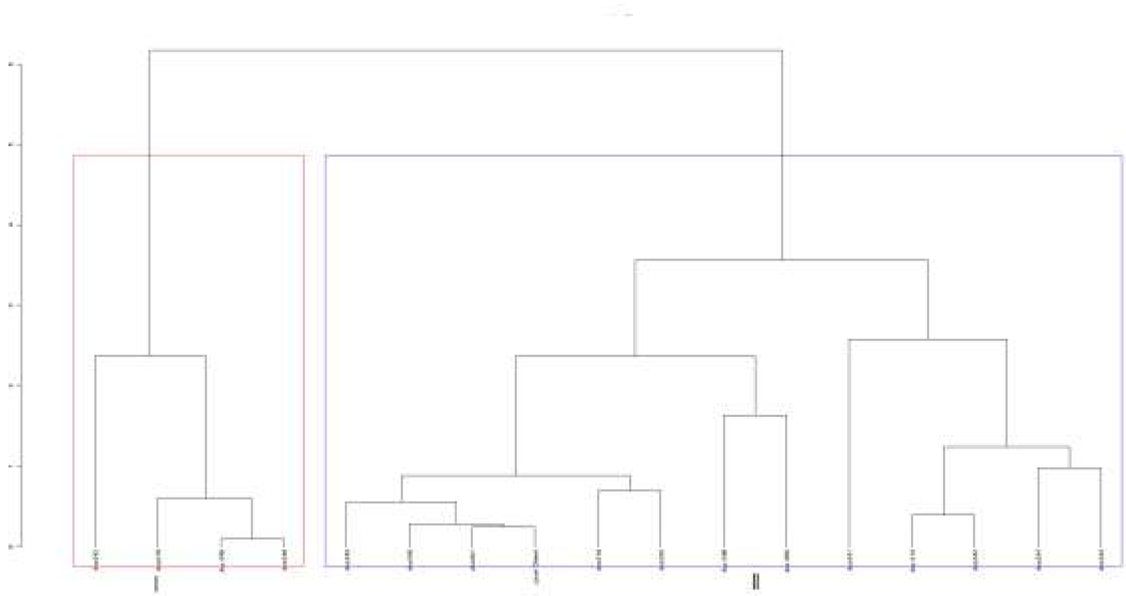

Figure 1: Dendrogram from disease scores for Cercospora leaf spot among seventeen castor genotypes

Evaluation of Some Large Seeded Castor Genotypes for Seed Yield and Quality Food Condiment (*Ogiri*)

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ABSTRACT
Food condiment (Ogiri) from castor seeds is an historical condiment, consumed by more than 20% of the Nigerian population. In the present study, some large seeded castor genotypes were evaluated for yield performance and quality Ogiri. Seventeen (17) large seeded genotypes were evaluated in 2014 and 2015 growing seasons at the research field and laboratory of the National Cereals Research Institute Badeggi Nigeria. The results revealed significant differences for all the agronomic and proximate parameters considered among the genotypes. The seed yield ranged between 399.73kg/ha and 1481.01kg/ha among the entries. Days to maturity varied from 104.00 to 124.00 days after planting. The proximate analysis revealed protein contents ranged from 12.49 to 20.61, with the highest content being recorded in Acc.001. Highest carbohydrate (CHO = 29.43) was observed in Acc048 genotype. Among the entries, Acc001 recorded the highest seed yield and comparable seed weight and oil content to that of the check. Therefore, the genotype could be considered for further evaluation towards varietal nomination.
Keywords: Ogiri, Food condiment, Large seeded castor, Proximate, Nigeria

INTRODUCTION
Castor (*Ricinus communis* L.) is one of neglected oilseed crops recently regaining popularity due to its economic values around the world (Salihu *et al.*, 2014). The castor seed contains oil which is used for many industrial applications (Salihu *et al.*, 2014). Castor has a wide-range of variability for characteristics such as seed size (Wiess, 2000). The small seeded castor is commonly chosen if the interest is on the seed oil while the large seeded ones are preferred if the interest is on the product derived from seed endosperm. In Nigeria and some other parts of West Africa, the large seeded castors are used to produce '*Ogiri'* - a local condiment (Gana, 2015). *Ogiri* is a highly proteinous fermented food condiment traditionally consume by about 20% of the Nigerian population (Okeke *et al.*, 2009). *Ogiri* from castor seeds is an historical condiment in Nigeria prepared through fermentation. During the fermentation, the water soluble toxic compounds (Ricin) in the endosperm dissolve into the water, leaving unharmed endosperm for consumption. The small seeded castor seeds are not used for the condiment due to the drudgery involved in the removal of the seed coat and low endosperm yield. The condiment has been reported to have 5.70 and 2.57 times higher protein content than pumpkin and snail respectively. The condiment, besides providing supplementary protein, has been reported to have health benefits of improving the eye vision and digestion (Okeke *et al.*, 2009). Because of the high protein content, the castor meal has been extensively considered as an alternative source of protein for animal feeds. The residual meal of castor seed, after detoxified by boiling, could be used as protein supplement in preparation of broiler finishing diets without any harmful effects (Ani and Okorie, 2009). Also, the meal (autoclaved) could be used in place of soybean in sheep rations. Organic fertilizer produced from castor meal was reported to have advantage of high nitrogen content, fast mineralization and anti-nematode effects (Severino *et*

al., 2012). Despite the huge economic benefits, castor improvement programme in Nigeria has not been receiving much attention, resulting in lack of ideal varieties for its production demand (Salihu *et al*., 2018). In this study, some large seeded castor genotypes were evaluated for agronomic performances and production of local condiment (*Ogiri*) in Nigeria.

MATERIALS AND METHODS

The genetic materials evaluated in this work were selects from castor breeding populations of the National Cereals Research Institute Badeggi Nigeria. Seventeen (17) large seeded genotypes were evaluated in 2014 and 2015 growing seasons. A widely cultivated large seeded farmer's variety (Large Ogba Okah) was considered as a check, as there were no standard checks as at the time of evaluation. The study location was the National Cereals Research Institute Badeggi Nigeria. The field trials were carried out on Randomised Complete Block Design (RCBD) with three replications. Plot size of 5m x 3m and plant spacing of 1.00m by 0.75m were used. Two seeds were sown and later thinned to one stand per hill. Fertilizer at 60:30:30 kg/ha of N:P:K respectively was applied. Weeding was carried out at 3, 6 and 9 weeks after planting. Data were collected on days to flowering (DF), days to maturity (DM), height at maturity (HM), number of spikes per plant (SPP), spike length (SL), 100 seed weight (SW), seed yield (SY). The fermentation of castor seeds into the condiment (*Ogiri*) was carried out according to Ojimelukwe *et al*. (2011). The proximate analysis of the *Ogiri* samples was carried out in triplicate using methods described by Onwuka (2005). Data generated were subjected to analysis of variance for testing of significant differences among the entries.

RESULTS AND DISCUSSION

The seed yield and other agronomic traits recorded for the large seeded castors evaluated are presented in Table 1. The seed yield ranged between 399.73kg/ha and 1481.01kg/ha among the entries. Days to maturity varied from 104.00 to 124.00 days after planting. A range of 39.23g to 57.23g was recorded for 100 seed weight. Percentage seed oil content among the genotypes varied between 29.11% and 40.11%. There were significant effects of genotypes on the variation observed in all the agronomic traits studied. Effect of year variation was recorded for seed yield, height at maturity, spikes per plant and Spike length. The result of the proximate analysis for *Ogiri* produced from the genotypes is presented in the Table 2. Protein contents ranged from 12.49 to 20.61, with the highest content being recorded in Acc.001. Highest carbohydrate (CHO = 29.43) was observed in Acc048 genotype. There was significant difference for all the proximate parameters among the genotypes. No significant effects of year variation and genotypes by year interaction. A wide-range of variability in castor has also been reported by Savy-Filho (2005). Servugaperumal *et al*. (2000), in a study on sixty castor genotypes, reported significant differences for seed yield per plant, racemes per plant and plant height. In a genetic diversity study among nine castor accessions, Costa and Pereira (2006) distinguished two clusters and said that the more prominent variability to the diversity among the accessions were contributed by days to flowering, raceme length, plant height and seed oil content.

CONCLUSION

The results revealed significant variation for all the traits considered among the genotypes evaluated. Among the entries, Acc001 recorded the highest seed yield and also produced high number of spikes than the check, a known large seeded castor (Large Ogba Okah) used for production of local condiment. Its seed weight and oil content are comparable to that of the local check. Therefore, the genotype could be considered for further evaluation towards varietal nomination.

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Table 1: Mean values for seed yield (kg/ha) and other agronomic traits of the large seeded castor genotypes evaluated during 2014 and 2015 raining seasons

Entries	SY (Kg/ha)	DM	HM (cm)	SPP	LS (cm)	100 SW (g)	SOC (%)
Acc001	1481.01	107.29	224.66	7.74	30.59	53.42	37.24
Acc014	427.05	107.50	172.00	3.11	20.57	42.98	31.56
Acc015	515.00	121.50	235.00	3.01	19.00	53.76	29.67
Acc016	457.47	109.00	187.00	2.50	26.00	53.78	30.91
Acc020	776.59	124.50	146.50	2.50	23.00	55.34	39.12
Acc024	726.96	105.00	268.50	3.50	23.00	47.80	29.11
Acc040	788.51	108.00	206.50	3.76	24.76	57.23	40.09
Acc041	554.63	118.50	206.50	3.57	23.00	55.82	34.12
Acc042	519.59	112.00	216.00	4.44	28.00	49.22	35.82
Acc043	502.46	111.00	197.50	3.56	29.51	50.57	33.01
Acc044	399.73	104.00	218.00	3.65	24.76	39.23	39.56
Acc045	919.05	115.96	169.39	5.97	30.47	50.01	39.60
Acc046	496.70	106.00	208.00	3.55	24.50	49.99	40.11
Acc048	1182.38	109.00	151.50	7.12	25.50	51.00	31.81
Acc049	420.39	113.00	206.50	3.78	20.50	42.31	39.19
Acc050	812.93	110.00	167.50	5.87	28.11	49.09	34.45
Large Ogba Okah	941.77	123.46	272.95	4.57	28.31	48.45	35.4
Grand Mean	718.95	112.69	202.59	4.25	25.27	50.88	35.28
MS Year (Y)	342900.68*	749.03	24932.66*	6.44*	122.96*	360.19	478.70
MS Block within	24684.91	421.72	2388.63	0.77	9.74	76.02	85.75
MS Genotype (G)	642310.62**	866.05**	19199.30**	15.17**	227.36**	210.51**	154.78**
MS G x Y	16863.41	208.43	1635.16	0.81*	22.37	32.87	26.93
MS Error	11323.14	249.0962	960.92	0.31	11.01	30.53	40.98

*Note: MS = Mean Square, * = significance at 0.05, ** = significance at 0.01*

Table 2: Mean values for nutritional compositions of local condiment (*Ogiri*) of the large seeded castor genotypes evaluated during the two growing seasons (2014 and 2015)

Genotypes	Moisture	Ash	Proteins	Fats	Fibres	CHO
Acc001	29.99	2.01	20.61	20.495	1.855	21.58
Acc014	25.58	3.9	17.83	21.59	1.5	18.5
Acc015	28.43	2.43	16.49	18.21	1.47	21.785
Acc016	36.01	3.2	14.66	18.76	1.335	19.1
Acc020	26.28	2.01	19.07	18.785	1.52	26.09
Acc024	26.74	1.82	19.79	22.925	1.96	24.81
Acc040	28.87	1.33	18.94	22.535	1.29	22.68
Acc041	37.63	3.86	14.99	17.555	1.395	18.055
Acc042	28.13	2.93	16.79	18.92	1.645	25.415
Acc043	31.43	3.02	14.31	24.575	1.355	15.155
Acc044	26.16	1.89	18.16	19.395	1.565	21.765
Acc045	32.26	2.59	12.49	19.075	1.54	25.49
Acc046	33.26	2.61	16.65	17.26	1.545	18.555
Acc048	21.69	3.1	17.44	19.65	1.61	29.43
Acc049	20.99	4.57	12.83	18.2	1.195	27.18
Acc050	24.79	2.61	15.27	22.805	1.885	26.06
Large Ogba Okah	30.19	2.62	15.56	21.02	1.565	24.005
Mean	28.73	2.73	16.58	20.1	1.54	22.69
MS Year (Y)	78.76	0.15	32.17	17.53	0.24	26.04
MS Block within	75.75	0.13	18.16	17.98	0.14	21.28
MS Genotypes (G)	123.06**	4.19**	33.04**	37.32**	2.26**	89.49**
MS G x Y	12.25	0.02	11.22	10.23	0.11	21.97
MS Error	43.45	0.34	10.47	12.99	0.12	22.55

*Note: MS = Mean Square, * = significance at 0.05, ** = significance at 0.01*

Survey on Seed Oil Contents in Some Castor Germplasm

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ABSTRACT
Castor (Ricinus communis L.) is an industrial oil crop with high potential yield and unique fatty acid composition that presents a unique opportunity to expand the vegetable oil production in Africa, including Nigeria. In this research, survey on the seed oil content in Nigerian germplasm was assessed. Thirty castor germplasm were grown at three locations (Federal University of Technology (FUT) Minna, NCRI Badeggi and NCRI Mokwa) during 2016 growing season. The capsule samples were taken from the three replicated plots in each location and bulked for quantification of the oil content. The seed-oil content was determined according to the procedure of Federation of Oil Seed and Fats Association. On average, the oil content ranged from 27.00% to 55.05% with population of 37.78% among the germplasm. Highest average oil content (55.05%) was observed in Acc.006 and the least (27.00%) was found in Acc.044. Phenotypic coefficient of variation (PCV) of 23.65% and genotypic coefficient of variation (GCV) 22.58% were recorded among the germplasm. The result revealed adequate variability for oil content in the germplasm and this could be exploited in breeding programme.
Keywords: Castor, Oil, Variation, Germplasm, Nigeria

INTRODUCTION
The castor seed contains oil which is used for many industrial applications. The oil is used in pharmaceutical industries, rubber/plastic industries, and lubricants/biodiesel industries (Mutlu and Meier, 2010). The high potential yield and unique fatty acid composition of castor oil presents a unique opportunity to expand industrial vegetable oil production in Africa, including Nigeria. Because of the high protein content, the castor meal has been extensively considered as an alternative source of protein for animal feeds. The residual meal of castor seed, after detoxified by boiling, could be used as protein supplement in preparation of broiler finishing diets without any harmful effects (Ani and Okorie, 2009). Also, the meal (autoclaved) could be used in place of soybean in sheep rations. Organic fertilizer produced from castor meal was reported to have advantage of high nitrogen content, fast mineralization and anti-nematode effects (Severino *et al.*, 2012). Castor is not consumed by ruminant animals, thus it is herders-farmers friendly. The economic potential of castor can be harnessed only if there is adequate research on the crop, addressing some of the factors that can enhance its production in the country. Therefore, this study was carried out to quantify the seed oil content in some Nigerian castor germplasm.

MATERIALS AND METHODS
Thirty castor germplasm used for the study was sourced from castor research programme of the National Cereals Research Institute (NCRI) Badeggi, Nigeria. The germplasm were evaluated at three locations (Federal University of Technology - FUT Minna, NCRI Badeggi and NCRI Mokwa). The germplasm were grown on replicated plot arranged in a Randomised Complete Block Design. The plot size was 3m by 3m with inter-row and intra-row spaces of

75cm by 75cm. Two seeds per hole were planted and later thinned to one seedling per hole at four weeks after planting. Planting at all the locations was done within a week (12 – 18th of June, 2016). Standard agronomic practice for castor at savanna ecology was followed. The capsule samples were taken from the three replicated plots in each location and bulked for quantification of the oil content. The seed-oil content was determined according to the procedure of Federation of Oil Seed and Fats Association (Okoh *et al.*, 2007).

RESULTS AND DISCUSSION

Seed oil contents of the thirty germplasm at three locations are presented in Table 1. A range between 25.46% and 54.12% was recorded at the Badeggi location. At FUT Minna and NCRI Mokwa, the oil contents were 26.87% - 57.36% and 27.09% - 55.37% respectively. On average, the oil content ranged from 27.00% to 55.05% with population of 37.78% among the germplasm. Highest average oil content (55.05%) was observed in Acc.006 and the least (27.00%) was found in Acc.044. Phenotypic coefficient of variation (PCV) of 23.65% and genotypic coefficient of variation (GCV) 22.58% were recorded among the germplasm. This is an indication of adequate variability in the germplasm for the oil content. Variations in castor have been reported by several authors. The finding in this study is in concurrence with the reports of Rao *et al.* (2009). Lakshmamma *et al.* (2005), in his study on the genetic variation of 68 castor lines, reported high genotypic and phenotypic coefficient of variability for capsule weight per plant, plant height, capsule number and leaf area index. Golakia *et al.* (2007) reported high estimate of PCV for seed yield, effective branches per plant and number of capsules on the main raceme. Golakia *et al.* (2015) documented adequate genetic variability for the most of characters in castor, including seed yield per plant.

CONCLUSION

On average, the oil content ranged from 27.00% to 55.05% with population of 37.78% among the germplasm. Highest average oil content (55.05%) was observed in Acc.006 and the least (27.00%) was found in Acc.044. Phenotypic coefficient of variation (PCV) of 23.65% and genotypic coefficient of variation (GCV) 22.58% were recorded among the germplasm. The result revealed adequate variability for exploitation in breeding programme.

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Table 1: Genetic Parameters for Seed Oil Content (%) of 30 Best Yielding Castor Accessions at three Locations

	NCRI Badeggi	FUT Minna	NCRI Mokwa	
Accessions	Mean ± SE. Mean	Mean ± SE. Mean	Mean ± SE. Mean	Mean
Acc.001	49.15 ± 0.59	47.17 ± 2.91	48.62 ± 1.21	48.28 bc
Acc.036M1	51.99 ± 0.37	44.08 ± 3.10	51.72 ± 1.09	51.90bc
Acc.036	30.58 ± 0.33	30.29 ± 1.14	29.54 ± 0.31	30.82 efgh
Acc.010	51.73 ± 0.27	49.36 ± 1.31	50.94 ± 1.07	51.04ab
Acc.045	44.22 ± 0.72	43.08 ± 1.59	45.35 ± 0.51	44.17 c
Acc.005	47.96 ± 0.99	47.84 ± 3.96	46.13 ± 1.59	46.98 bc
Acc.026	48.68 ± 0.48	48.25 ± 1.87	54.76 ± 0.37	50.63 ab
Acc.053	32.34 ± 2.58	31.17 ± 1.92	36.54 ± 2.58	33.90 defgh
Acc.099	26.78 ± 3.16	29.69 ± 2.95	27.57 ± 1.29	28.01gh
Acc.040	28.46 ± 1.09	26.87 ± 2.39	27.78 ± 1.44	27.10h
Acc.048	31.27 ± 4.93	31.76 ± 3.27	37.78 ± 2.57	34.77 defgh
Acc.003	48.34 ± 2.51	47.61 ± 2.99	50.63 ± 2.97	48.27 bc
Acc.046	25.61 ± 1.09	29.29 ± 2.46	27.85 ± 1.17	27.08h
Acc.009	38.80 ± 3.50	38.65 ± 0.74	37.13 ± 0.70	38.65d
Acc.022	34.42 ± 0.63	32.73 ± 0.81	32.61 ± 0.38	33.30 defgh
Acc.019	35.44 ± 0.10	34.50 ± 0.50	34.73 ± 0.31	34.16def
Acc.042	25.46 ± 1.09	33.87 ± 2.39	39.78 ± 1.44	32.69 defgh
Acc.012	47.80 ± 0.43	49.43 ± 2.89	50.31 ± 0.20	48.88 bc
Acc.002	39.55 ± 2.05	35.21 ± 2.15	29.11 ± 1.21	34.49 def
Acc.091	28.80 ± 2.63	37.22 ± 3.25	44.09 ± 4.37	36.56d
Acc.072	31.84 ± 3.23	38.03 ± 3.53	32.68 ± 2.72	34.67defg
Acc.016	31.38 ± 4.88	35.84 ± 2.72	34.62 ± 4.94	32.07 defgh
Acc.006	54.12 ± 0.54	57.36 ± 2.26	55.37 ± 0.44	55.05a
Acc.044	28.26 ± 0.14	27.92 ± 0.64	27.09 ± 0.53	27.00h
Acc.027	33.49 ± 1.50	34.15 ± 2.47	40.16 ± 1.20	35.10de
Acc.097	29.53 ± 0.18	30.16 ± 1.05	29.11 ± 0.54	29.96 efgh
Acc.103	32.38 ± 2.88	34.84 ± 1.72	34.62 ± 3.94	33.94 defgh
Acc.073	49.51 ± 0.60	39.27 ± 3.47	47.55 ± 1.24	45.56 bc
Acc.061	26.54 ± 0.79	31.38 ± 2.80	38.82 ± 2.67	32.58 defgh
Acc.062	31.66 ± 3.90	27.90 ± 0.39	28.07 ± 1.04	29.10 fgh
Mean				37.78
PCV				23.65
GCV				22.58

Effect of Poultry Manure on the Growth and Yield of Mung Bean (*Vigna radiata* (L.) R. Wilczek) in Awka Alfisols, South East, Nigeria

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ABSTRACT
This experiment was conducted at the Teaching and Research Agricultural Farm of the Department of Crop Science and Horticulture Nnamdi Azikiwe University, Awka, Anambra State Nigeria from April-August, 2019; to determine the effect of poultry manure on the yield of five Mung bean (Vigna radiata (L.) R. Wilczek) varieties. 0 and 10 tonnes/ha rates of poutry manure and 5 varieties of mungbean (Tropical Vigna radiata (Tvr 6); Tropical V. radiata (Tvr 12); Tropical V/ radiata (Tvr 14); Tropical V. radiata (Tvr 15) and Tropical V. radiata (Tvr 29) were evaluated. The study was carried out as a 2 x 5 factorial experiment with 10 treatment combinations laid out in a randomised complete block design (RCBD) experiment with 3 replications. Treatment means were separated using least significant difference (LSD=0.05). Data was taken from the following parameters; days to 50% germination, days to 50% flowering, plant height, number of leaves, number of branches, leaf area; number of pods per plant, pod length, number of seeds per pod and number of nodules per pot. The results showed that at 10 tonnes/ha of poultry manure, maximum plant height, maximum number of leaves, maximum number of pods per plant, maximum pod length and maximum number of seeds per pod were produced. Tvr15 gave the highest plant height for the experiment, while Tvr29 gave the highest number of leaves and branches. Tvr6 and Tvr15 produced the maximum leaf area. The maximum yield was obtained at PM 10tonnes/ha+Tvr12 for the experiment.
Keywords*: *Poultry manure rates, Mung bean, Growth, Yield, Alfisols

INTRODUCTION
Mungbean (*Vigna radiata* (L.) R. Wilczek) also known as green gram belongs to the family leguminosae (Sherasia *et al*., 2017). It is one of the most important pulse crops that is grown in the tropical and subtropical areas of the world for is excellent source of high quality protein (Kumari *et al*., 2012). India had been proposed as the center of origin (Lambrides and Godwin, 2006). Mung bean production is mainly (90%) situated in Asia, with India being the largest producer with more than 50% of world production but consumes almost its entire production; China also produces large amounts of mung beans, which represents 19% of its legume production (Lambrides and Godwin, 2006). Thailand is the main exporter and its production increased by 22% per year between 1980 and 2000 (Lambrides *et al*., 2006). Though produced in many African countries, mung bean is yet to become a major crop in these locations (Mogotsi, 2006). In tropical Africa, particularly Nigeria, the production of the crop has not been ranked probably because of its recent introduction. Mungbean is rich in carbohydrates, dietary fiber, energy, vitamins, minerals, iron, magnesium, thiamine, copper, phosphorus, potassium and folate; riboflavin and niacin are found in trace amount (Khalil, 2006). Mungbean is deficient in methionine in contrast with the high methionine that is observed in rice and beans (Andersen, 2007). The use of poultry manure as soil amendment to sustain adequate crop yield has been found effective on many crops in South Western Nigeria (Sanchez-Mondero *et al*., 2004). Its use for crop production might be a better substitute for chemical fertilizer

(Hochmuth *et al.,* 1993). However, mung bean being a leguminous crop does not require high doses of poultry manure or nitrogenous fertilizer, but a starter or initial dose is usually helpful in increasing its growth and yield (Anwar *et al*., 2018). The use of organic fertilizer such as poultry manure is an eco-friendly approach in the effective fertilizer management for proper growth, yield and diseases of crop by secretion of different hydrolytic enzymes (Krishnan, 2016). The present study investigated the effect of poultry manure rate on the growth and yield of mung bean grown in Awka, South-East Nigeria.

MATERIALS AND METHODS

The experiment was conducted at the Crop Science and Horticulture Agricultural Farm, Nnamdi Azikiwe University Awka, Anambra State, Nigeria, from April-August, 2019. Awka is located on latitude 6.24 and longitude 7.11 with an altitude of 30.800 metres above sea level. The experimental site has an annual rainfall of 1810.3mm per annum, a mean minimum and maximum temperature of 27ºC and 27.3ºC respectively and a relative humidity of 72.3% (Uko *et al.,* 2018). The mung bean varieties used for the experiment were sourced from the Genetic Resources Centre, International Institute of Tropical Agriculture (IITA) Ibadan.

Soil sampling

Soil samples from 0-20cm depth of the experimental site were taken by simple random sampling method in order to analyse the physicochemical properties of the soil at the start of the experiment. Ten sub-samples were randomly taken and mixed thoroughly to get a composite sample. The soil sample was then pre-treated by air drying and passing the soil through a 2mm sieve before analysed at The National Root Crop Research Institute (NRCRI) Umudike, Soil Science Laboratory. The result of the Physio-chemical characteristics of the soils of the experimental site is given in Table 2.

Experimental treatment and experimental design

The experiment was a 2x5 factorial experiment laid out in Complete Randomised Block Design (CRBD) with 3 replications, and was carried out in pots. Pots in the form of black polyethene bags were used for the experiment. About 14kg weight of sand was weighed using a weighing scale and poultry manure at 10 tonnes/ha were accurately measured using a weighing scale for the treatment combinations that needed poultry manure which was then incorporated into the soil using a hoe, then two (2) seeds were planted per hole. All agronomic practices required for healthy growth and yield of the crop were duly observed. The poultry manure was allowed to cure for 2 weeks before it was being applied to pots. Weeding was done at 4 and 8 weeks after sowing.

Treatment combinations for the Pot experiment

The treatment combinations include the following; Factor A= Poultry manure rates (0 and 10 tonnes/ha); Factor B= 5 Mungbean varieties (Table 1).

*The treatment combination for the pot include***:**

PM10 tonnes/ha+V1, PM10 tonnes/ha+V4, PM0 tonnes/ha+V4, PM10 tonnes/ha+V5, PM0 tonnes/ha+V5, PM0 tonnes/ha+V3, PM10 tonnes/ha+V3, PM0 tonnes/ha+V1, PM10 tonnes/ha+V2 and PM0 tonnes/ha+V2.

Table 1: Genotypes, varieties code and source of mungbean collection for the experiment

S/N	Genotypes	Varieties code	Sourced
1	Tropical *V. radiata* (Tvr 6)	V1	IITA
2	Tropical *V. radiata* (Tvr 12)	V2	IITA
3	Tropical *V.a radiata* (Tvr 14)	V3	IITA
4	Tropical *V. radiata* (Tvr 15)	V4	IITA
5	Tropical *V. radiata* (Tvr 29)	V5	IITA

IITA: International Institute of Tropical Agriculture (IITA) Ibadan.

Data collection
Averages of 5 plants were randomly tagged per pot for data collection. Data were collected on the following parameters:

Emergence parameters
Days to 50% germination and flowering: The number of days it took half of the mungbean seedlings to germinate and flower was recorded respectively.
Growth parameters: Growth parameters were taken from 4, 6 and 8 WAS (weeks after sowing). The growth parameters taken include:
Plant height (cm): Heights of 5 plants were randomly selected from each plot. The selected plants were marked with a white rope and were measured using a measuring tape from the base of the plants to the growing tip of the main stem. The average plant height was calculated by taking the mean of observation of the 5 plants and was expressed in cm.
Number of Trifoliate Leaf Plant^{-1}: The number of green trifoliate leaves plant^{-1} of mungbean was counted at different stages of the crop growth namely at 4, 6 and 8WAS; from the selected tagged plants per plot and the mean of observation of the randomly selected plants were computed
Number of Branches^{-1}: The number of branches plant^{-1}of mungbean was counted at different stages of the crop growth namely at 4, 6 and 8WAS; from the selected tagged plant per plot and the mean of observation of the randomly selected plants were computed.
Leaf area (cm^2): The leaf area was randomly selected twice to get an average. The length and breadth of the leaf area was measured with a measuring tape. This same procedure was repeated for the randomly tagged plant per plot and the average was computed.
Harvest parameters
Parameters assessed at harvest include:
Pod length: The pod lengths from the randomly selected plants were observed and the average number of pod length was computed.
Number of pods plant^{-1}: The total number of pods on the tagged plants was counted and average number of pods per plant was recorded.
Number of seeds per pod: The numbers of seeds per pod were randomly selected from the already tagged plants were counted and the average number of seed per pod were then calculated and recorded.
Number of nodules plant^{-1}: The numbers of nodules in each plant per pot were recorded in the pot experiment after 12 weeks of planting.
Statistical analysis:
The data collected were subjected to analysis of variance to show the significance between treatment means and to draw valid conclusions. The significant means were separated using the least significant difference at 5% level of probability (Genstat, 2011)

RESULTS AND DISCUSSION

The physical and chemical characteristics of the soil of the experimental site were taken before planting. The physio-chemical characteristics were analyzed and the result given in Table 2. The soil of the experimental site was sandy loam in texture, slightly acidic (pH 6.56) and was generally low for the cultivation of mung bean as reported by Food and Agricultural Organization (FAO, 2008). It was also low in total nitrogen (0.07%), phosphate (3.63mg/kg) and potassium (0.18Cmol/kg). The soil sample had 0.78%, organic carbon content 1.34% organic matter, 1.20Cmol/kg total exchangeable acidity, 0.70 Cmol/kg aluminium content, 0.14 Cmol/kg sodium content, 2.40 Cmol/kg calcium, 1.60 Cmol/kg magnesium, 5.52 Cmol/kg CEC and 78.2%base saturation.

Effect of poultry manure rates and variety on emergence and flowering of Mungbean
The result of the pot experiment showed that poultry manure (PM) rates and variety had effect on the emergence and flowering of Mungbean. Moreover, there were no significant difference ($P>0.05$) in the poultry manure rates at emergence and among the varieties but significant difference ($P<0.05$) in the PM in the days to 50% flowering were recorded (Table 3). The plants

flowered earlier at 10tonnes/ha because PMis known to support vegetative growth in legumes which will later take time to flower than when no PM was applied (Sitinjak and Purba, 2018). For varietal response on emergence and flowering, Tvr29 emerged earlier, while Tvr12 flowered earlier. The result of the analysis of variance showed no significant difference (P>0.05) in the interaction between PM and variety in both emergence and days to 50% flowering. However, PM 10tonnes/ha+Tvr29 emerged earlier because an initial or starter dose of the manure is usually helpful in increasing its growth and yield, while PM 0tonnes/ha+Tvr12 flowered lately (Table 3). The result was in agreement with the findings of Anwar *et al*. (2018) in mung bean.

Main effect of poultry manure rates and variety on plant height and number of leaves at 4, 6 and 8WAP

The result of the analysis of variance showed that there was significant difference (P<0.05) in the PM rates and variety at 4, 6 and 8WAP with respect to the plant height. While, for the number of leaves, there was significant difference (P<0.05) in the PM rates at 4, 6 and 8WAP, but in terms of the variety, there was significant difference (P<0.05) at 4 and 8WAP with respect to the number of leaves. The data on the main effect of PM on plant height and number of leaves showed that the maximum plant height and maximum number of leaves was obtained at PM 10 tonnes/ha, which could be as a result of increase in the PM which helped to supply it with its essential nutrients for growth for the varietal response on plant height and number of leaves, Tvr15 and Tvr29 produced the maximum plant height and number of leaves respectively (Table 4). The result was in consonance with the findings of Anwar *et al*. (2018); Sitinjak and Purba, (2018) in mung bean. Table 5 shows the interaction of PM and variety on plant height and number of leaves on Mungbean. The result of the analysis of variance showed that there was no significant difference (P> 0.05) in the interaction of PM and variety on plant height at 4, 6 and 8WAP. While, for the days to 50% flowering, there was significant difference (P< 0.05) in the interaction of PM and variety at 4 and 8WAP. For the interaction (i.e. PM and variety) effect on plant height and number of leaves, PM 10tonnes/ha+Tvr6 and PM 10tonnes/ha+Tvr29 gave the highest plant height and highest number of leaves respectively.

Main effect of poultry manure rates and variety on number of branches and leaf area at 4, 6 and 8WAP

Table 6 indicates the main effect of PM rates and variety on number of branches and leaf area at 4, 6 and 8WAP. There was significant difference (P<0.05) in the PM rates in both the number of branches and leaf area. While, in terms of the variety, there was no significant difference in both the number of branches and leaf area (P > 0.05). The results of the main effect of PM rates and variety on the number of branches and leaf area statistically showed that the maximum number of branches and leaf area was obtained at the rate of 10 tonnes/ha of PM as supported by Mainuel *et al*., 2014; Aniefiok *et al*., 2018. For the varietal influence, Tvr29 produced the maximum number of branches while Tvr6 and Tvr15 produced the maximum leaf area. Table 7 reveals the interaction of PM rates and variety on number of branches and leaf area of mungbean. The analysis of variance depicts no significant difference (P>0.05) in the interaction of PM and variety in both the number of branches and leaf area. For the interaction (i.e. PM and variety) effect on number of branches and leaf area, PM 10tonnes/ha+Tvr29 gave the maximum number of branches for the pot experiment, while PM 10tonnes/ha+Tvr6 and Pm 10tonnes/ha+Tvr15 produced the maximum leaf area for the pot experiment.

Main effect of poultry manure rates and variety on yield attributes of Mungbean

Table 8, shows the main effect of PM rates and variety on yield attributes of Mungbean. The result of the analysis of variance reveals significant difference (P<0.05) in PM rates in terms of total number of pods and number of seeds per pod while there was no significant difference (P>0.05) in the PMrates of the pod length. Thus, the varieties revealed significant difference (P<0.05) across all the yield attributes. Bhargavi, (2017) posited that maximum productivity of yield is achievable at 10tonnes/ha of PMThe result aligned with the findings of Azu, (2017) and Vilmar *et al*. (2013) which approves of the increase in the number of nodules per plant in groundnut and soybean respectively. For varietal influence, Tvr12 gave the highest number of pods, pod length and number of seeds per pod, while Tvr29 gave the highest number of nodules per plant. The result of the analysis of variance depicts significant difference ($P<0.05$) in the interaction of PMand variety on the total number of pods and nodules, while there was no significant difference (($P>0.05$)) in the interaction of PMrates and variety on the pod length and number of seeds per pod. For the interaction, PM 10 tonnes/ha+Tvr12 gave the maximum number of pods and highest number of seeds per pod. The maximum pod length was obtained at PM 10tonnes/ha+Tvr6 and PM 10tonnes/ha+Tvr15, while the maximum number of nodules was obtained at PM 10tonnes/ha+Tvr29 (Table 9).

CONCLUSION

In conclusion, PM 10tonnes/ha + Tvr12 should be used by farmers in order to obtain maximum yield while Tvr29 should be used as a cover crop and for nitrogen fixing ability because it produced maximum number of leaves and maximum number of nodules per plant.

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Table 2: Physicochemical properties of the Alfisol taken from 0-20cm depth of the experimental site.

Physiochemical properties	Values	Method of analysis
Physical properties		
Sand (%)	78.8	Hydrometer (Jackson, 1962)
Silt (%)	8.8	Hydrometer (Jackson, 1962)
Clay (%)	12.4	Hydrometer (Jackson, 1962)
Textural class	Sandy loam	
Chemical properties		
Organic Carbon (%)	0.78	(Walkley and Black, 1934)
Organic matter content (%)	1.34	
Total Nitrogen (%)	0.07	Kjeldahl method (1983)
Total exchangeable acidity (Cmol/kg)	1.2	
Aluminium (Cmol/kg)	0.7	
Hydrogen (Cmol/kg)	0.5	
Available phosphorus (mg/kg)	3.63	Flame photometer (Okalebo *et al*., 1993)
Potassium (Cmol/kg)	0.18	Flame photometer (Taffouo *et al*., 2008)
Sodium (Cmol/kg)	0.14	Flame photometer(Taffouo *et al.,* 2008)
Calcium (Cmol/kg)	2.4	Flame photometer(Taffouo *et al*., 2008)
Magnesium (Cmol/kg)	1.6	Mehlich's method(Taffouo *et al*., 2008)
Soil pH (H_2O)	6.56	pH meter
Cation Exchange Capacity (Cmol/kg)	5.52	
Base Saturation (%)	78.2	

Table 3: Main effect and Interaction of poultry manure rates and variety on emergence and flowering of Mungbean for pot experiment

Main Effects of Poultry Manure Rates			**Interactions of Poultry Manure Rates**		
PM Rates	Days to 50% Emergence	Days to 50% Flowering	PM X Variety	Days to 50% Emergence	Days to 50% Flowering
0	4.47	69.9	PM10 x V1	4.33	52.3
10	4.27	53.3	PM10 X V2	4.00	62.7
LSD0.05	NS	6.89	PM10 X V3	4.33	46.0
Variety			PM10 X V4	3.33	58.3
V1	4.50	65.2	PM10 X V5	5.33	47.0
V2	4.33	71.7	PM0 X V1	4.67	78.0
V3	4.33	48.8	PM0 X V2	4.67	80.7
V4	4.00	64.3	PM0 X V3	4.33	51.7
V5	4.67	57.8	PM0 X V4	4.67	70.3
LSD0.05	NS	10.89	PM0 X V5	4.00	68.7
			LSD0.05	NS	NS

WAP- Weeks after planting

Table 4: Main effect of poultry manure rates and variety on plant height and number of leaves at 4, 6 and 8WAP

	Plant Height (cm)			Number of Leaves		
PM rates (ton/ha)	4WAP	6WAP	8WAP	4WAP	6WAP	8WAP
0	8.30	12.02	16.0	10.9	17.3	22.7
10	15.12	27.06	46.6	30.7	70.5	147.5
$LSD_{0.05}$	1.446	3.518	6.46	6.16	10.33	28.41
Variety						
V1	13.42	23.15	39.1	22.3	42.2	84.7
V2	14.33	23.32	37.6	22.2	37.7	69.2
V3	9.00	16.40	26.8	19.3	39.0	95.0
V4	14.43	21.33	28.5	18.2	38.3	70.3
V5	7.37	13.50	24.3	22.2	62.3	106.3
$LSD_{0.05}$	2.286	5.562	10.21	NS	16.33	NS

WAP- Weeks after planting

Table 5: Interaction of poultry manure rates and variety on plant height and number of leaves of Mungbean

	Plant Height (cm)			Number of Leaves		
PM rates x Variety	4WAP	6WAP	8WAP	4WAP	6WAP	8WAP
PM10 X V1	16.57	32.37	59.7	33.0	67.7	148.3
PM10 X V2	19.03	33.17	58.8	33.3	57.7	117.3
PM10 X V3	11.23	22.30	38.8	28.0	61.0	165.3
PM10 X V4	18.67	28.13	37.5	23.7	58.0	114.0
PM10 x V5	10.10	19.33	37.9	35.7	108.0	192.7
PM0 X V1	10.27	13.93	18.4	11.7	16.7	21.0
PM0 X V2	9.63	13.47	16.4	11.0	17.7	21.0
PM0 X V3	6.77	10.50	14.8	10.7	17.0	24.7
PM0 X V4	10.20	14.53	19.5	12.7	18.7	26.7
PM0 X V5	4.63	7.67	10.7	8.7	16.7	20.0
$LSD_{0.05}$	NS	NS	NS	NS	23.09	NS

WAP- Weeks after planting

Table 6: Main effect of poultry manure rates and variety on number of branches and leaf area at 4, 6 and 8WAP

	Number of Branches			Leaf Area(cm^2)		
PM rates	4WAP	6WAP	8WAP	4WAP	6WAP	8WAP
0	3.13	5.73	7.2	9.2	21.4	27.0
10	9.53	24.33	49.7	60.7	83.5	93.3
$LSD_{0.05}$	2.025	4.156	9.25	14.99	13.61	11.0
Variety						
V1	6.83	1 4.67	28.5	42.4	61.2	71.3
V2	6.67	12.17	23.0	37.7	50.0	59.6
V3	5.83	14.33	31.7	29.8	51.1	58.9
V4	5.50	13.83	22.2	31.2	54.9	60.6
V5	6.83	20.17	36.8	33.5	45.1	50.3
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS

WAP- Weeks after planting

Table 7: Interaction of poultry manure rates and variety on number of branches and leaf area of Mungbean for pot experiment

	Number of Branches			Leaf Area(cm^2)		
PM rates x Variety	4WAP	6WAP	8WAP	4WAP	6WAP	8WAP
PM10 X V1	10.33	23.67	50.0	74.1	101.9	117.6
PM10 X V2	10.00	18.67	39.3	64.0	77.1	92.4
PM10 X V3	8.67	22.33	55.7	51.7	82.3	91.6
PM10 X V4	7.33	21.67	36.7	51.8	83.7	86.8
PM10 X V5	11.33	35.33	66.7	61.9	72.7	78.0
PM0 X V1	3.33	5.67	7.0	10.7	20.5	25.1
PM0 X V2	3.33	5.67	6.7	11.5	23.0	26.7
PM0 X V3	3.00	6.33	7.7	7.9	20.0	26.2
PM0 X V4	3.67	6.00	7.7	10.7	26.1	34.4
PM0 X V5	2.33	5.00	7.0	5.2	17.5	22.6
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS

WAP- Weeks After Planting

Table 8: Main effect of poultry manure rates and variety on yield attributes of Mungbean

PM rates	Pod/plant	Pod length	No of seeds/pod	Nodules/plt
0	28.0	5.53	9.80	11
10	118.5	6.13	11.20	399
$LSD_{0.05}$	40.89	NS	0.953	54.7
Variety				
V1	39.0	7.03	12.33	85
V2	119.5	7.27	13.83	143
V3	74.3	4.62	8.67	251
V4	35.3	6.57	10.83	121
V5	98.2	3.68	6.83	425
$LSD_{0.05}$	64.65	1.055	1.507	86.5

WAP- Weeks after planting

Table 9: Interaction of poultry manure rates and variety on yield attributes of Mungbean

PM rates x Variety	Pod/plant	Pod length	No of seeds/pod	Nodules/plt
PM10 X V1	64.7	7.67	13.7	163
PM10 X V2	233.3	7.47	13.67	285
PM10 X V3	114.7	5.33	10.00	483
PM10 X V4	39.7	6.30	11.67	233
PM10 X V5	140.3	3.90	7.00	832
PM0 X V1	13.3	6.40	11.00	6
PM0 X V2	5.7	7.07	14.00	1
PM0 X V3	34.0	33.90	7.33	19
PM0 X V4	31.0	6.83	10.00	9
PM0 X V5	56.0	3.47	6.67	18
$LSD_{0.05}$	91.43	NS	NS	122.3

WAP- Weeks after planting

Breeding for Adaptability of Cassava Germplasm in Drought – Prone Environment

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ABSTRACT
Cassava accounts for approximately one-third of the staple food production and provides over 50% of the energy for more than 300 million people in sub-Saharan Africa. It is particularly important in areas where food supply is constantly threatened by environmental constraints such as moisture/water stress. Given the expanding importance of cassava as food, feed, and industrial crop, genotypes that are drought tolerant are considered strategic. Field trial in three replications was conducted at Minjibir to evaluate Latin American (CIAT) and some African cultivars for drought tolerance. The trials consisted of the national lines that comprised eight African elite cassava varieties, while the 36 exotic lines were the CIAT germplasm. The objective of this study was to screen these genotypes for yield, productivity and identify the best line for adaptation in marginal environments. Plant characteristics measured included fresh root yield, dry root yield, harvest index, and number of leaves. Genotypes such as CR14B-218 and CR14B-67 showed a high recovery rate of leaves on resumption of rain. Result also showed that most of the genotypes had yield that was above 10t/h.
Keywords: Drought tolerance, dry savannahs, Manihot esculenta, marginal environment, root yield

INTRODUCTION
Cassava is cultivated as the most important staple food crop for over 900 million people in the world. It is the most important staple crop in Africa after maize, and the 6th most often consumed crop in the world. In Africa, the cultivation of cassava is common mostly in humid environments where there is adequate rainfall, while in the marginal environments; its production is mainly in the hands of poorly-resourced farmers who cannot afford the cost of irrigation. Therefore, there is dire need to extend the breeding activities to the marginal ecology to enhance productivity (Okogbenin *et al.,* 2013). As advancement to this approach, the National Root Crops Research Institute (NRCRI), Umudike undertook steps to test some lines from Central Agricultural Research Institute (CIAT), Columbia and Nigeria to address this initiative. This study was intended to screen cassava lines from Nigeria and Latin America for yield and productivity, identify the best lines for adaptation that can be utilised to develop new germplasm with better agronomic traits.

MATERIALS AND METHODS
The genotypes were evaluated at Minjibir, Kano (dry location).

Experimental design

The experimental design used was an alpha lattice design. The trial consisted of 8 elite national cassava genotypes including a commercial variety 419 and 36 genotypes of Latin American germplasm (CIAT lines). The plot size was 20 m^2 with 20 plants per plot.

Data collection
Data were taken randomly from the net plants of each genotype. Dry root yield and fresh root yield were measured at harvest. Fresh root yield was derived from the equation: FRY = (root weight (kg)*10)/plot size while dry root yield was derived by multiplying the fresh root yield with dry-matter content.

RESULTS AND DISCUSSION

Morphological and physiological traits
Plant physiology related to leaf drop during stress, and leaf growth when the rain resumed, are shown in Fig. 1. The leaf growth was measured as the total number of leaves per genotype between 8 months after planting (MAP) and 11 MAP. Results indicate that there was a very slow growth during the dry season. The growth rate of leaves at the peak of dry season did not change significantly from 8 MAP to 9 MAP (Fig. 1). At 9 MAP, rains resumed, and the plants began to recover from stress for the next three months when the plants were ready for harvest. Resumption of rains resulted in a rapid response of leaf growth generally (Fig. 1). Genotypes such as CR14B-218 and CR14B-67 were found to show a high recovery rate.

Yield at harvest
Over 30 good promising and potential genotypes such as AR9-45, CR15B-7, AR9-5, CW451-80, CW595-9, CR14-4, CW420-75, CR14B-218, TMS419, CW482-3 were found with fresh root yield above 10 t/ha (Fig. 2).

Cassava is an essential crop for increasing food security in sub-Saharan Africa and other food-insecure regions. Despite being a drought-tolerant crop, low water availability is still among the most significant limitations to cassava production in low rain-fed areas. One of the modern breeding strategies for drought tolerance is the characterisation of germplasm in response to extended water shortages (Okogbenin *et al.,* 2013). Genotypic differences in leaf drop were used to identify genotypes that were severely affected by drought. Some genotypes showed heavy leaf loss, which is a mechanism by the plant to reduce physiological stress due to low moisture. Such genotypes are thus highly sensitive to stress. However, a good number of genotypes (over 80%) were able to maintain good foliage with different degrees during the peak of drought, indicating tolerance to drought stress. Cassava reduces water loss through closing its stomata (Setter and Fregene, 2007) and decreasing its leaf area through leaf shedding (Alves and Setter, 2000). Hence, leaf shedding is an effective adaptation mechanism as an effect of moisture stress (Okogbenin *et al.,* 2013). The high recovery rate of shaded leaves tells that cassava is quick to resume growth when conditions are favourable. Such rapid recovery in leaf growth has been reported by El-Sharkawy (2002). Potential genotypes exhibited fresh root yield of above 10 t/ha. The average annual cassava yield worldwide is 10 t/ha, ranging from 6 t/ha in Mozambique to 26 t/ha in India (Okogbenin *et al.,* 2013). Based on the result obtained in this study, genotype by environment (G X E) studies will be done to test the yield stability of the genotypes in other drought prone environments.

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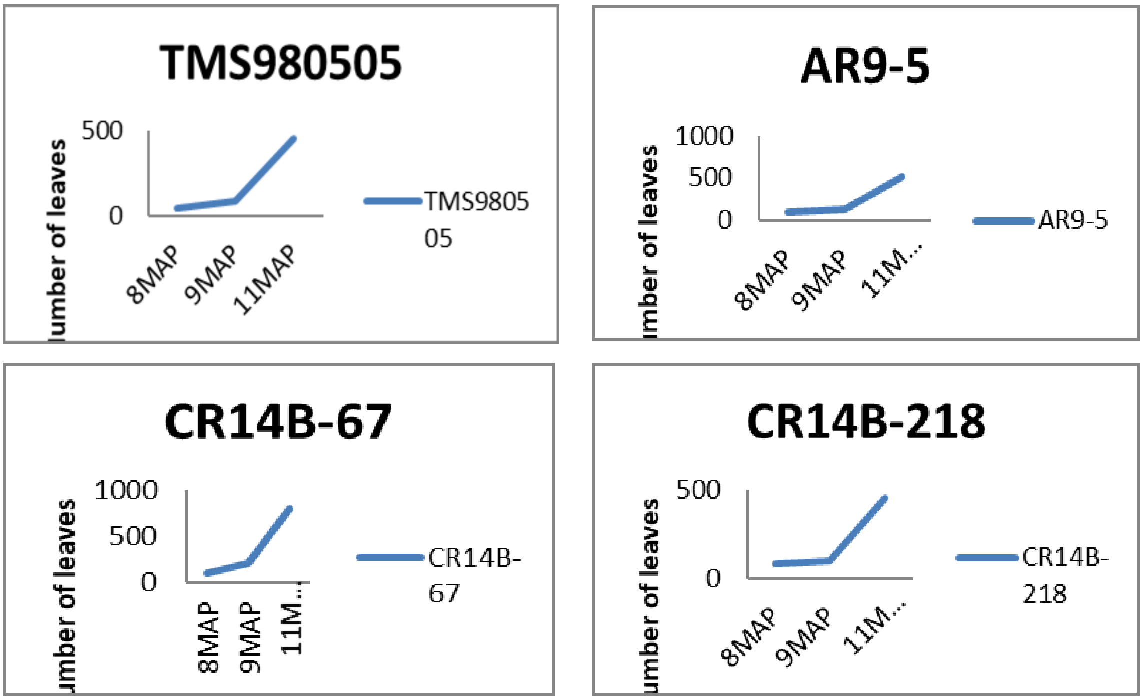

Fig. 1: Growth curve of number of leaves of some genotypes during moisture stress (8-9 MAP) and recovery rate on resumption of rains

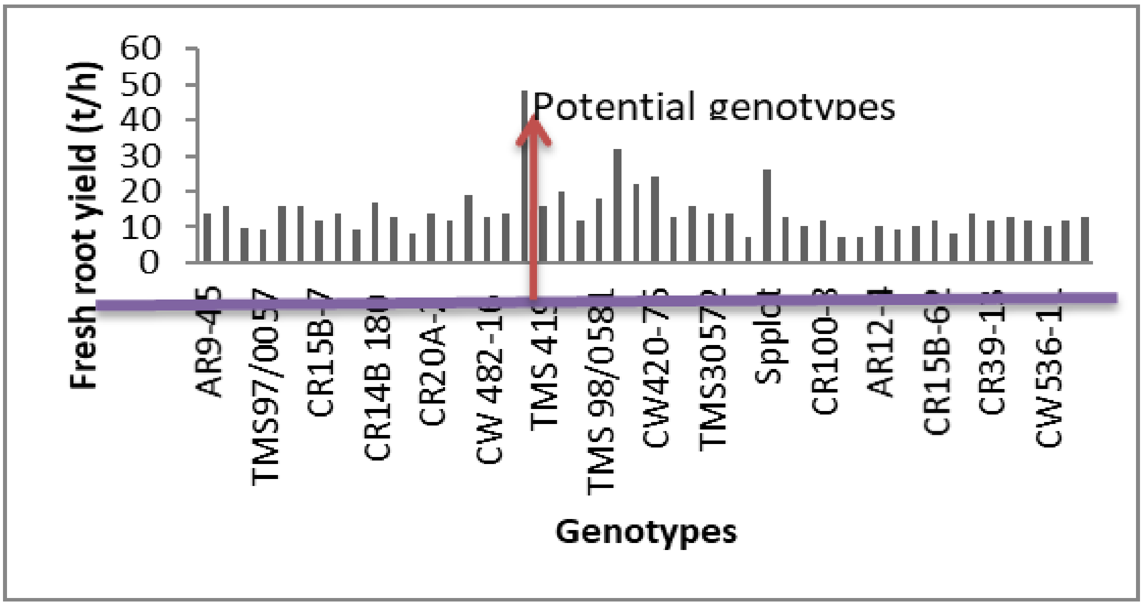

Fig. 2: Fresh root yield of cassava genotypes

Disease Evaluation in Second Backcross (BC_2) Population of Cassava (*Manihot walkare*)

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ABSTRACT

Cassava cultivars are deficient in many economically important characters such as resistance to diseases and pest as a result of the mode of evolution of the species and modifications of the allogamy system of the plant. The use of crop wild relatives (CWR), the progenators as well as other species more or less related to them have beeen of great importance in agriculture, providing plant breeders with a broad pool of potentially useful genetic resources and have been employed effectively in a variety of breeding programmes. Second backcross population from Manihot walkarea were evaluated for resistance to cassava mosaic disease (CMD), cassava green mite (CGM) and cassava bacterial blight (CBB) in National Root Crops Research Institute, Umudike, Nigeria. Frequency distribution of the genotypes revealed that some of the genotypes were resistant to CMD, CBB and CGM.

Keywords: Cassava wild relatives, cassava mosaic disease, cassava green mite, cassava bacterial blight, diseases

INTRODUCTION

Cassava *(Manihot esculenta* Crantz*)* is the third largest source of carbohydrates in the world and the major source of carbohydrates in sub-Saharan Africa (Okogbenin *et al,* 2007). It is the most important staple food in Africa and the principal source of calories for more than 500 million people from mainly poor populations of the tropical regions. Plant breeders are increasingly interested in the genes of wild crop relatives because they offer many opportunities for transfering alien genes (Nassar, 2003). They are a potential source for increasing genetic diversity in cultivated crops. Biotic constraints contribute to the potential yield losses in cassava. Cassava mosaic disease is devastating, causes chlorosis in cassava leaves which reduces photosynthetic activity and ultimately leads to reduced plant growth and low yield. Cassava bacterial blight causes root yield reduction and shortages in availability of healthy planting materials while cassava green mite (CGM) causes reduction in leaf weight and yield loss. We report here the evaluation of second backcross populations (BC_2) of cassava *Manihot walkerae* for disease resistance .

MATERIALS AND METHODS

The materials used for this study were second backcross (BC_2) populations from wild relative, *Manihot walkerae*. The experiment was carried out in National Root Crops Research Institute (NRCRI), Umudike. The experimental design was randomised complete block design (RCBD) replicated three times. The genotypes were planted in single rows with five plant stands per plot.

Data collection

Cassava mosaic disease (CMD), cassava bacterial blight and cassava green mite severity of scoring scale 1-5 was collected at 3 months after planting (MAP), 6 MAP, 9 MAP and at harvest.

Data Analysis
Data collected was subjected to simple statistics using the excel package.

RESULTS AND DISCUSSION
Disease evaluation
Frequency distribution of diseases in BC2 population
In the second year, 62 genotypes were selected and evaluated for pest and diseases. Over 60% of the genotypes evaluated showed no symptom of cassava mosaic disease. High moderate resistance was also observed while none were highly susceptible (Fig. 1). None of the genotypes were found to be highly resistant to cassava bacterial blight (Fig. 2) while greater percentage of the genotypes evaluated were moderately resistant. None were also found to be highly susceptible to cassava bacterial blight. Screening the genotypes for resistant to cassava green mite (CGM) showed that none of the genotypes were highly resistant i.e. with no symptom of CGM (Fig.3). Majority of the genotypes were moderately resistant (66%) while the rest of the genotypes were susceptible to CGM. The use of wild relatives for gene improvement is beneficial for modern agriculture, providing breeders with a broad pool of potentially useful gene resources (Hajjar and Hodgkin, 2007). The discovery and use of resistance genes from wild relatives have steadily increased in different crops (Akinbo *et al*., 2012). The CMD status of the BC_2 populations indicated resistance in some of the genotypes meaning that the introgression was equally successful. Resistance observed in other biotic stresses (CBB, and CGM) shows that *M/ walkerae* can be a source of resistance to those biotic stresses. *Manihot walkarea* is a wild relative of cassava known to possess resistant gene for post-harvest physiological deterioration (PPD). Result from this study shows that crossing of elite cultivars to the wild relatives not only introduced desirable genes for PPD but did introduce genes for resistance to CBB and CGM. This study therefore recommend the use of wild relatives as a source of gene introgression and hybridisation because it offers so many oppurtunities of introducing useful traits to the breeding programme.

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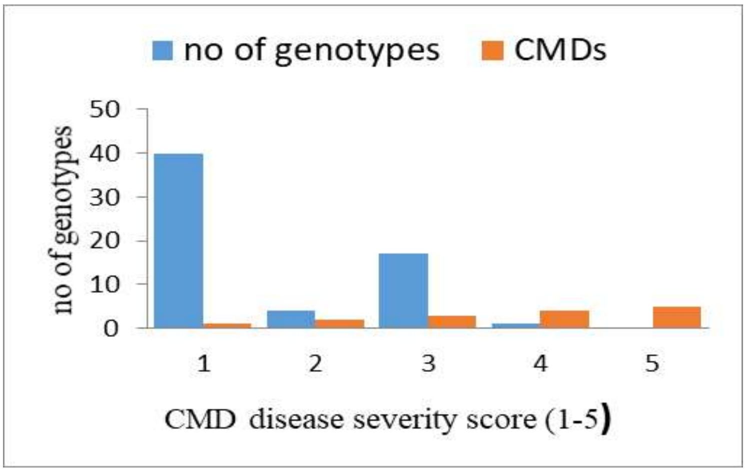

Fig 1: Cassava mosaic disease severity score of BC2 population
1= highly resistant. 2= resistant. 3= moderately resistant. 4= susceptible. 5= highly susceptible

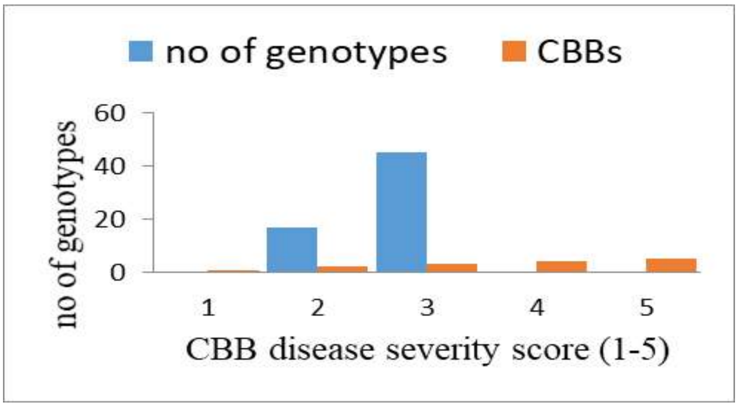

Fig 2: Cassava bacterial blight disease severity score of BC_2 population
1= highly resistant. 2= resistant. 3= moderately resistant. 4= susceptible. 5= highly susceptible.

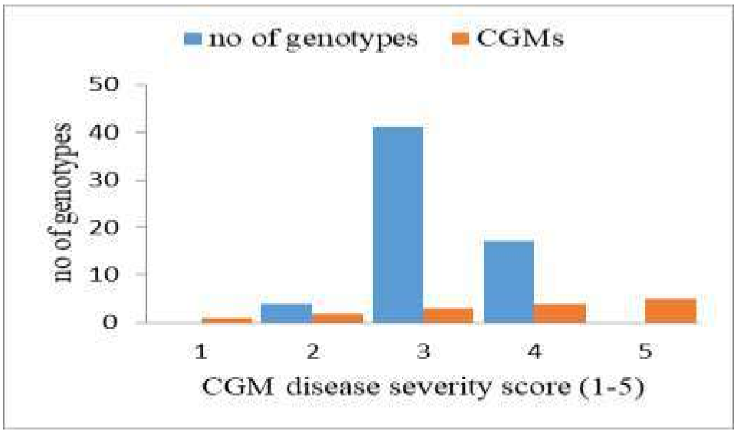

Fig 3: Cassava green mite disease severity score of BC2 population (year2)
1= highly resistant. 2= resistant. 3= moderately resistant. 4= susceptible. 5= highly susceptible.

Effect of Leguminous Crops, Poultry Manure and NPK Fertilizer on Soil Properties and Yield of Ginger in Abuja, Nigeria

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ABSTRACT
A field trial was carried out during the 2018 farming season in the Teaching and Research Farm of University of Abuja (GPS coordinates of 9° 4' 20.1504" N and 7° 29' 28.6872" E, 360m above sea level) with the aim of studying the effect of leguminous crops, poultry manure and NPK fertilizer on soil properties and yield of Ginger in Abuja, Nigeria. The trial had seven treatments comprising of erect brown cowpea (Vigna unguiculata), erect white cowpea, Groundnut (Arachis hypogea), Soybean (Glycine max), NPK 0.2t/ha, Poultry Manure 5t/ha and Control (sole ginger). The trial was laid out in a Randomized Complete Block Design (RCBD) with three replications. Results obtained showed that plots treated with poultry manure had taller plants (45.87cm), more leaves (21.97) and higher yield (3t/ha) while ginger intercropped with erect brown cowpea had the highest number of tillers (3.83). Soil analysis results showed that poultry manure had the most influence on total nitrogen (1.50 g/kg), Available Phosphorous (7.60 mg/kg), Calcium (2.92 C mol/kg), Magnesium (3.52 C mol/kg) and Organic Carbon (0.76 g/kg) while NPK had lower pH (5.35) and most influence on Potassium (0.75 C mol/kg) and control plots had higher amount of Sodium (0.90 C mol/kg).
Keywords: Ginger, Intercropped Leguminous crops, Soil properties

INTRODUCTION
Ginger (*Zingiber officinale* Roscoe) is a monocotyledonous, herbaceous, tropical plant belonging to the family *Zingiberaceae*. It is a perennial plant, but is usually grown as an annual crop for harvesting as a spice. (Abeykera *et al.*,2005). Traditionally, *Z. officinale* is used in Ayurveda, Siddha, Chinese, Arabian, Africans, Caribbean and many other medicinal systems to cure a variety of diseases viz, nausea, vomiting, asthma, cough, palpation, inflammation, dyspepsia, loss of appetite, constipation, indigestion and pain (Grzanna *et al.*, 2005). Low soil fertility, which is due to interplay of many factors, is a major constraint to increased food production in the Savanna and is a large contributor to poverty and food insecurity in the whole of the Sub-Saharan Africa (Gruhn *et al.*, 2000). Inorganic fertilizers appears to be the most popular soil amendment among smallholder ginger farmers but is expensive and has detrimental effects on the soil and environment (Moses *et al*., 2003). Organic manures and legumes are being studied as better sources of soil nutrients as they are better suited to both the soil and the environment hence the need for this study to determine the most appropriate leguminous crop, rate of poultry manure and NPK fertilizer for optimum growth and yield of ginger

MATERIALS AND METHOD
The research was conducted at the Teaching and Research farm, University of Abuja, (GPS coordinates of 9° 4' 20.1504" N and 7° 29' 28.6872" E, 360m above sea level) during the 2018 cropping season. Abuja is located in the southern guinea savannah ecological zone of Nigeria. The experiment was laid out in a Randomized Complete Block Design(RCBD) with three replications. The plot size for each replicate was 2x2($4m^2$) with 7 plots in each replication with

an inter-rep distance of 1m and inter-plot distance of 0.5m. The experiment comprised of seven treatments made up of Poultry Manure (5t/ha), NPK 15:15:15 fertilizer (0.2t/ha), erect brown cowpea, erect white cowpea, Soybean, Groundnut and control. The experimental soil was analyzed for physical and chemical properties following standard laboratory procedures. Data collected were plant height, number of leaves, number of tillers and rhizome yield and all the data collected were subjected to Analysis of Variance (ANOVA) using the Genstat statistical package and the treatment means were separated using Least Significant Difference (LSD).

RESULTS AND DISCUSSION

Table 1 showed the Pre-planting soil analysis. It showed that the textural class of the experimental site is silt loam with a particle distribution of sand (35.0%), silt (40.0%) and clay (25.0%), the soil is slightly acidic (p^H 5.45), Total N (0.52g/kg), Available P 6.50 (mg/kg), K (0.41 C mol/kg), organic carbon (0.60 g/kg), Mg (2.20 C mol/kg), Na (0.12 C mol/kg), Ca (2.30 C mol/kg). Teferra *et al* (2015) opined that ginger prefers sandy loam soils because they are loose, well drained and offer minimum resistance to rhizome development. Table 2 showed height per plant of ginger as influenced by legume crops, NPK and poultry manure. There was no significant difference at 2 and 4 months after planting (MAP) but at 6 MAP there was significant difference ($P<0.05$). Plots treated with poultry manure recorded the highest plant height value (45.87cm) while ginger stands intercropped with groundnut had the lowest value of plant height (33.80cm).. This agrees with the findings of Aliyu (2000) that poultry manure is rich in nitrogen which is known to enhance physiological activities in crops thereby improving the synthesis of photo-assimilates.

The result of number of leaves per plant is presented in Table 3. There was no significant difference at 2 and 4 MAP respectively but there was significant difference ($P<0.05$) at 6 months after planting with plots treated with poultry manure recording the highest value (21.97) while ginger stands grown in mixture with groundnut had the lowest value of number of leaves per plant (13.10). This agrees with the findings of Jahn *et al* (2004) who asserted that poultry manure promoted root and vegetative growth and so influenced plant height, number of leaves and leaf area of plants. The result of number of tillers per stand of ginger as affected by legume crops, NPK and poultry manure is presented in Table 4. Tillering as affected by the treatments was significant at both 2 and 6 MAP only. Ginger stands intercropped with brown cowpea had the highest number of tillers per stand (3.83) at 6 MAP while those in control plots had the lowest number of tillers (1.60), ($P<0.05$). This agrees with the observations of Nwaogu and Muogbo (2015) where they observed that ginger-legume intercrop gave higher responses in terms of tiller formation. Dantata (2014) also opined that legume intercrop resulted in higher tiller formations.

The result of rhizome yield is presented in Table 5. There was significant difference with plots treated with poultry manure recording the highest yield (3t/ha) while plots treated with cowpea recorded the lowest value (0.6t/ha), ($P<0.05$). This agrees with the findings of Eghuchua and Enujeke (2013) observed that plots treated with poultry manure resulted in the highest ginger yield. The result for post-harvest soil analysis is presented in Table 6. It showed that there was a reduction in soil p^H in the legume intercrops and control plots with plots having ginger-white cowpea intercrop recording the lowest p^H (5.39) while plots treated with poultry manure had an increase in p^H (5.50), there was on the other hand an increase in total soil N with plots treated with poultry manure recording the highest total N (1.50 g/kg). There was an increase in soil P with plots treated with poultry manure recording the highest (7.60 m/kg). There was also an increase in soil K with plots treated with poultry manure recording the highest (0.75 C mol/kg), control plots recording the highest Na (0.90 C mol/kg), while poultry manure recorded the highest increase in soil Ca highest (2.92 C mol/kg), Mg i (3.52 C mol/kg) and soil organic carbon (0.76 g/kg). This agrees with the findings of Egerszegi (1990) who reported that application of poultry manure resulted in higher effects on soil properties. In a related development, Mohamed *et al.,* 2010 opined that poultry manure has high proportion of organic carbon content and improves organic matter content of the soil and retains substantial amounts of soil water and this subsequently increases the water content of soil upon application of the manure.

CONCLUSION

From the study, it is recommended that 5t/ha poultry manure should be adopted for the cultivation of ginger in the study area.

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Table 1: Pre-planting Soil Analysis

Soil Properties	Values
pH	5.45
Total Nitrogen (g/kg)	0.52
Available Phosphorous (mg/kg)	6.50
Potassium (C mol/kg)	0.41
Organic Carbon (g/kg)	0.60
Magnesium (C mol/kg)	2.20
Na (C mol/kg)	0.12
alcium (C mol/kg)	2.30
Texture (Sandy loam)%	35.0
Silt	40.0
Clay	25.0

Table 2: Effect of Legume Crops, Poultry Manure and NPK Fertilizer of Ginger Plant Height per Plant (cm) at Abuja in 2018 rainy season

Treatment	2 MAP	4 MAP	6 MAP
White Cowpea	21.57	30.10	38.40
Brown Cowpea	23.73	32.03	39.43
Groundnut	23.50	28.27	33.80
Soybean	24.63	32.03	39.47
NPK (0.2t/ha)	25.10	31.70	38.40
Poultry Manure (5t/ha)	23.97	35.60	45.87
Control	23.17	34.27	44.17
LSD	**5.96**	**7.96**	**10.26**

LSD = Least Significant Difference, MAP = Months after Planting

Table 3: Effect of Legume Crops, Poultry Manure and NPK Fertilizer of Ginger on Number of Leaves at Abuja in 2018 rainy season

Treatment	2 MAP	4 MAP	6 MAP	Mean
White Cowpea	8.00	11.87	15.70	11.86
Brown Cowpea	8.37	11.10	15.53	11.67
Groundnut	7.80	10.27	13.10	10.39
Soybean	7.77	13.43	18.20	13.13
NPK (0.2t/ha)	8.53	12.37	16.77	12.56
Poultry Manure (5t/ha)	7.60	15.33	21.97	14.96
Control	9.10	14.03	19.37	14.17
LSD	**2.44**	**3.23**	**5.750**	**7.58**

LSD = Least Significant Difference, MAP = Months after Planting

Table 4: Effect of Legume Crops, Poultry Manure and NPK Fertilizer on Tiller Production of Ginger

Treatment	2 MAP	4 MAP	6 MAP
White Cowpea	1.33	2.03	2.67
Brown Cowpea	2.33	3.20	3.83
Groundnut	1.33	2.23	2.67
Soybean	2.00	2.17	2.17
NPK (0.2t/ha)	1.00	1.97	2.10
Poultry Manure (5t/ha)	1.57	3.20	2.60
Control	1.67	1.60	1.60
LSD	**1.09**	**1.90**	**1.72**

LSD = Least Significant Difference, MAP = Months after Planting

Table 5: Effect of Legume Crops and Poultry Manure on Rhizome Yield

Treatment	Rhizome Yield t/ha
White Cowpea	0.60
Brown Cowpea	0.60
Groundnut	1
Soybean	1.7
NPK	2
Poultry Manure	3
Control	1.3
LSD	**1.2**

Table 6: Post-harvest Soil Analysis

Treatment	pH (H_20 1:1)	Total Nitrogen (g/kg)	Avail. Phosphorus (mg/kg)	Potassium (Cmol/kg)	Na/Calcium (C mol/kg)	Magnesium (C mol/kg)	O.C (g/kg)	Zinc (mg/kg)
White Cowpea	5.39	0.54	6.52	0.45	0.18/2.34	2.26	0.65	0.277c
Brown Cowpea	5.40	0.53	6.53	0.46	0.18/2.33	2.27	0.66	0.363b
Groundnut	5.41	0.47	6.59	0.45	0.16/2.35	2.28	0.68	0.463a
Soybean	5.40	0.60	6.60	0.48	0.20/2.36	2.29	0.67	0.317bc
NPK	5.35	1.30	7.40	0.90	0.28/2.40	3.50	0.62	0.283c
Poultry Manure	5.50	1.50	7.60	0.75	0.25/2.92	3.52	0.76	0.280c
Control	5.43	0.48	6.42	0.37	0.90/2.20	1.80	0.43	0.253c

Fungal Rot of Water Yam (*Dioscorea alata* lin.) Sold around Local Markets in Ikwuano L.G.A, Abia State, Nigeria

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ABSTRACT

Fungal decay of water yam (Discorea alata) bought from local markets around Ikwuano L.G.A of Abia state, Nigeria was investigated for the fungi responsible for post-harvest rot of the tubers in storage. The tubers were used to isolate and identify fungal species that causes rot of tubers. A total of five fungal isolates were found, they are Botryodoplodia theobromae, Aspergillus niger, Fusarium oxysporum, Penicillium chrysogenum and Rhizopus stolonifer. Pathogenicity test was done and proved for all isolates with Bothryodiplodia theobromae and Penicillium chrysogenum as the most pathogenic. Percentage occurrence of isolated fungi had R. stolonifer 10% as the lowest followed by A. niger 15%, then B. theobromae 20%, F. oxysporum 30% had the highest percentage occurrence followed by P. chrysogenum 25%. Inoculated tubers were examined and the nature of the rot varied with the pathogens.

Keywords: fungi, pathogenicity, isolates, post-harvest, yam tubers

INTRODUCTION

Yam belongs to the genus *Discorea* and family *Discoreaceae* which is an important economic crop grown purposely for its tubers. It is a major staple crop in Africa where it was first cultivated 11,000 years ago and has a great cultural importance especially in the tropical countries of the world such as Nigeria, Ghana, South America and Asia (Okigbo and Ikediugwu, 2000). Several methods have been developed for the storage of yams (FAO, 2013), however, the traditional yam barn, in spite of its challenges still remains the most popular among farmers. In 2007, Africa produced about 96% of world yams production with Nigeria accounting for 70 – 76%. Yam production is gradually declining due to the decline in soil fertility, increase in pest attack and high cost of labor, therefore, farmers needs access to new findings to reduce labor and increase productivity (Cornelius and Oduro,1999). The major pest of yams includes leaf and tuber beetle, mealy bugs and scales, fungi such as anthracnose, leaf spot, leaf blight, tuber rot and viruses such as yam mosaic virus (YMV). Yam production is compelled to several factors including those caused by the genus *Collectrotrichum* causing about 90% losses in yield. The genus affects the leaves, stems, petioles, tubers and the veins of yams (Cannon *et al*., 2012). Fungi are the causative agents of storage rots, which contribute to post harvest storage losses of yam (Amusa and Baiyewu, 1999). The objectives of this work are to contribute to knowledge on storage rots with respect to water yam sold in a local market to determine under conditions of experimental storage, the influence of fungal rot on post-harvest storage.

MATERIALS AND METHODS

Water yam tubers sold around the local markets in Ikwuano L.G.A of Abia state, Nigeria were bought, examined and selected for the investigation. Poor rotted yam tubers were identified by visual examination and by exerting slight pressure with the fingers. Unhealthy tubers which were signs of decay were isolated, taken to the laboratory for fungal isolation and identification. Affected portions were sliced and the advanced areas of decay were removed with a sterilized scapel. The removed portions were aseptically cultured in Potato Dextrose Agar (PDA) medium and growth was observed after five days.

Isolation of fungi from spoilt yam

A sterile scapel was used to cut the rotten part of the yam, which was washed by a running tap water and surface sterilized in 5% sodium hypochloride (NaOCl) (Ritchie,1991) so that no contaminant was seen with the tubers, then it was rinsed in a sterile water (Okigbo, 2005). Five segments of the already sterilized rotten yam piece were placed on Potato Dextrose Agar medium and incubated for 6 days at 28°C and subcultures were made to obtain a pure culture. The pure cultures were obtained with the help of a microscope and an identification guide (Barnett and Hunter, 1999).

Identification of Fungi Associated with Spoilage of water yam tuber

Five fungal isolates (*Botryodiplodia theobromae*, *Aspergillus niger, Penicillium chrysogenum, Rhizopus stolonifer* and *Fusarium oxysporum*) were isolated from the spoilt yam tuber. The characteristics of these isolates such as the branched septate hyphae, presence of spores, mycelial growths were observed and they were studied by using a compound microscope (Barnett and Hunter, 1987). The fungal isolate was identified microscopically by taking a portion of the fungal growth using a sterile needle and placing it on a sterile slide. A few drops of lactophenol blue was added, the fungal growth was teased, then covered with the cover slides and viewed under the microscope using X10 and X40.

Pathogenicity Test with Fungal Isolates

This test was done by washing healthy tuber, surface sterilized and blotted dry (Okigbo and Ikediugwu, 2000). Holes were made by using a sterile cork borer and about 5mm of the mycelia plugs taken from the edge of the fungal growth of each isolate were placed in the holes of the healthy tubers (Sameza *et al*., 2016). A disk was used to cover the surface inoculated with a wet cotton wool and incubated for 14 days at 25°C. Observations were made at regular intervals to check for infection (Agrios, 2005).

Percentage Occurrence of Fungi Isolated (%)

The occurrence of the fungi isolated were taken note of, isolation and characterization were carried out, therefore the number of times each fungi pathogen was expressed in the percentage of the total number of all the organisms isolated over the period of the experiment (Okigbo and Ikeugwu, 2000).

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) using SAS 2002 and significant means were separated with the Duncan's multiple range tests (DMRT) ($P < 0.005$).

RESULTS AND DISCUSSION

The fungi isolated from the decayed portion of the tubers were identified using their growth pattern, mycelia colors and morphological features as parameters for identification. Fungal growth is the main cause of rot in yam tubers in storage in many parts of Nigeria known for massive production of water yams. The effect of this fungal rot can lead to low productivity and as such reduced yield which will result to demand for yam tubers to exceed the supply (Amusa and Baiyewu, 1999). The fungi isolated and identified in this study have been associated with post harvest rot of yams in various locations in Nigeria (Ogunleye and Ayansola, 2014), (Ogaraku and Usman, 2008). The result of the isolated organisms on healthy tubers clearly showed that fungi have the ability to cause rot. This was probably the ability of these organisms to utilize the nutrient composition of yam (Amadioha, 2001). It has been found that most of these pathogenic organisms infect tubers while in the field thereby reducing their capacity to germinate, affect their survival in the field and eventually manifest in storage barns (Amusa *et al*., 2003).

CONCLUSION

In conclusion pathogenicity proved for all the fungal pathogens associated with postharvest decay of water yam in storage and a host of factors pre disposes them to such. This can cause large scale economic losses to farmers and households and thus a major threat to food availability and security in Nigeria and the world at large. It is therefore recommended that healthy practices associated with postharvest storage such as proper handling of tubers during harvesting and transportation should be avoided. Storage barns should be well ventilated and high temperature in barns should be avoided to prevent tuber rot.

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Table 1: Fungi isolated from spoilt water yam

Number of Isolates	Fungi isolated
1	*Botryodiplodia theobromae*
2	*Aspergillus niger*
3	*Penicillium chrysogenum*
4	*Rhizopus stolonifer*
5	*Fusarium oxysporum*

Table 2: Percentage occurrence of fungi isolated

Number of Isolates	Fungi isolated	Percentage occurrence (%)
1	*Botryodiplodia theobromae*	20
2	*Aspergillus niger*	15
3	*Penicillium chrysogenum*	25
4	*Rhizopus stolonifer*	10
5	*Fusarium oxysporum*	30

Table 3: Microscopic description of fungal isolates

Macroscopic view	Microscopic view	Fungi
Black, fluffy	Oval spores with branched mycelia growth	*Botryodiplodia theobromae*
Black colony growth	Spores and vesicles	*Aspergillus niger*
Colorless and slender	Branched septate hyphae	*Penicillium chrysogenum*
Brown color, cottony	Ovoid shape, root like hypae	*Rhizopus species*
Whitish to yellow	Microconidia, chlamyspores	*Fusarium oxysporum*

Effects of Organic and Inorganic Manure on the Growth, Yield, and Vegetative Traits of Fluted Pumpkin *(Telfairia occidentalis)* in Nasarawa, Nasarawa State, Nigeria

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ABSTRACT
This study is to determine the effects of NPK 15:15:15, Cow dung, poultry droppings and fish waste on the yield, and vegetative traits of fluted pumpkin (Telfairia occidenatalis). The study was subjected to Complete Randomized Block Design (RCBD) with three replications. The data collected include; the number of leaves, number of branches, vine length, leaf length, leaf width, leaf area and vine girth of the plant. The results of the analysis show that, at two weeks after transplanting (WAT), 120g of poultry droppings produced the highest number of leaves (29.33), 60g NPK 15:15:15 produced the highest number of branches (1.33), leaf area and girth length of 18.80cm^2 and 2.72cm respectively. At 6 WAT, a significant difference ($p<0.05$) effect was observed on number of leaves, vine (length) and leaf length. Eighty calories (80 cal.) of fish waste produced the longest vine (32.92cm). At 4 WAT, 60g NPK 15:15:15 produced the highest number of leaves (66.67) and branches (2.00) respectively; 100g of cow dung produced the longest vine (48.92cm) and highest leaf area (18.58cm^2). At 6 WAT, 100g of cow dung produced the highest number of leaves (110.00), number of branches (1.33), longest vine (64.58cm) and leaf area (23.17cm^2) while 60g NPK 15:15:15 produced the highest girth length (3.71cm). The correlation results showed that there was no statistically significant ($p<0.05$) difference in number of branches, vine length, leaf width, leaf area and vine girth at 2 WAT. The findings of this study shows that the use of 60g NPK 15:15:15 and 120g poultry droppings exerts much effects on the growth of T. occidentalis at early stage of growth, while 100g of cow dung exerts much effects of the growth and yield of the plant at maturity stage.

Keywords: Manure, growth, yield, Telfairia occidentalis, Nasarawa, Nasarawa State

INTRODUCTION
Telfaria occidentalis is a dioecious, creeping, perennial vegetable shrub that spreads low across the ground and climbs by means of befit and often coiled tendrils (Horsfall and spiff, 2005). According to Ossom *et al.* (1997), *T. occidentalis* thrives well within the temperature range of 30 - 50°C, while Udoh *et al.* (2005) reported that the tropical vine crop thrives under a warm environment with plenty of sunshine and prolonged rainy season. Rainfall appears to be the major factor in its productivity with a requirement of 1000 - 2500mm per annum (Akoroda, *et al.*, 1990). In Nigeria, the edible vegetable is commonly known as *Ugu* (Igbo), *Ubong, Nkong ubong* (Efik/Ibibio), and *Ireke* (Yoruba). It's succulent young shoots and tender leaves are used in preparing soups (Schippers, 2000) and sauce for *garri* and *foofoo* meals and it is equally cooked lightly with okra and fish or meat (Udoh *et al.*, 2005). The nutritional value of pumpkin seeds is different from that of the leaves. The protein contents of seeds and leaves are 20.5g and 29g respectively (FAO, 1998; Schipper, 2000). Fluted pumpkin leaves have high iron and protein contents about 86% moisture, 11% crude protein, 25% carbohydrates, 3% oil, 11% ash

as much of 700ppm of iron (Oyolu, 1978). According to FAO, (1998) and Udoh *et al*., (2005), fluted pumpkin leaves have nutritional values of about 86ml water, 9g protein, 1.8g fat, 7.0g carbohydrates and 1.7g fibre. Its seed contains about 13% oil which is used for cooking manufacturing and cookies formulation (Okoli and Nyanayo, 1998; Horsfall and spiff, 2005). Despite the nutritive values obtainable from fluted pumpkin, it is a common observation that the demands far exceed the supply resulting in scarcity which increases cost. There is therefore, the need to increase the productivity, growth and the yield of fluted pumpkin by improving the soil condition upon which it is grown. Production of fluted pumpkin is predominating done by poor resources-based farmers. Although integrate soil fertility management advocates the combined use of organic and inorganic sources of fertilizer thereby exploiting the potential of positive interaction between both input but efficient use of this fertilizer by plants are often low, accompanied by the problem of unstable producer prices which eventually limits farmers interest in fertilizer usage.

MATERIALS AND METHOD

Experimental Site

The experiment was conducted in the year 2021 cropping season at the Department of Agricultural Technology, Federal Polytechnic, Nasarawa, Nasarawa State, Nigeria. The nursery site was sited under a shade (tree) and the permanent site some meters away from the nursery site. The study area falls within the guinea savannah zone of North Central Nigeria latitude 08.33N and longitude 08.32E with an average monthly rainfall range from 40mm - 350mm and temperature ranges from 20.0°C - 38.5°C in a well-drained sandy loam soil.

Field Preparation and treatments

Conventional tillage operations which include land clearing and seedbed preparation were carried out to conserve the soil and its nutrients. The land was cleared and beds were prepared. The nursery bed was 3.00m by 2.00m. The permanent sites bed was 6.00m by 4.00m with about 2.00m gap between the beds to ease movement during cultural operations. A plot contained 12 plant stands. The spacing between the plants were 1.0, 1.5, 2.0, and 2.5. Sticks were used for staking. *Telfiaria* pods were gotten from 'Orange Market', Mararaba, Karu Local Government Area, Nasarawa State. The nursery bed after being prepared and constructed, was irrigated, making use of saw dust to retain its water holding capacity as well as improving soil moisture content, seed germination and seedling emergence. Two pods of *Telfairia* with an estimate of 80 seeds per pod, were planted randomly in the nursery bed. Two weeks after planting, seedlings were transplanted to the permanent beds where they were 12 seedlings were planted per plot. A week after transplanting, NPK 15:15:15, poultry droppings, fish waste and cow dung were used.

Data Collection

Data were collected 2, 4, and 6 weeks after transplanting (WAT). These included: number of leaves, number of branches, vine length, leaf length, leaf width, leaf area and vine girth length of the plant.

Data Analysis

Data collected were all subjected to analysis of variance using General Linear Model Procedure of Statistical Analysis System (SAS) Package (SAS, 2002). The significant difference between treatment means were compared using the Least Significant Difference (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

The non-significant response of fluted pumpkin to NPK 15:15:15, poultry droppings, cow dung and fish waste in terms of number of branches, vine, leaf width, leaf area and vine girth at 2 WAT (Table 1) may be attributed to the fact that cow dung and fish waste releases nutrients slowly. But at 6 WAT, the effect of additional nutrients was clearly seen in all the treatments (Table 3). This result is in tandem with the findings of Aderi *et al.* (2011) who reported that chicken manure and inorganic fertilizer formulations exerts tremendous influence on some quantitative parameters of fluted pumpkin. Also, the non-significant effect of all treatments at 2, 4 and 6 WAT (Table 1, 2 and 3) may be attributed to the morphological characteristics of the plant. This result agreed with the work of Dauda *et al.* (2008). The study revealed that, there is always a proportional increase in the growth parameters, namely: number of leaves, number of branches, vine length, leaf area and vine girth when additional nutrients are applied. This may be as a result of the higher availability of nitrogen in both the organic and inorganic manure which encouraged higher vegetative growth. This finding agreed with the work of Ndor *et al.* (2010).

CONCLUSION

This study showed that poultry droppings and NPK 15:15:15 are the best manure for good growth and herbage yield of fluted pumpkin (*Telfairia occidentalis)* at early stage of growth and cow dung was the best during maturity stage within the Guinea Savannah of North Central Nigeria and should be applied at uniform rate of 120g poultry droppings per plant, 60g NPK 15:15:15 per plant and 100g Cow dung per plant. Although, cow dung and poultry droppings gave the best performance in terms of yield and nutritional compositions respectively, there was no significant difference ($p<0.05$) between the values obtained from these treatments and that recorded from NPK 15:15:15.

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Table 1: Effects of manure on fluted pumpkin after two weeks of transplanting

Treatments	NL	NB	LLV	LL	LW	LA	GL
Cow Dung	28.67	1.00	31.00	7.33	4.50	16.50	2.51
Fish Waste	27.33	1.00	32.92	7.33	4.17	15.38	2.52
NPK 15:15:15	29.00	1.33	27.83	8.00	4.70	18.80	2.72
Poultry Dropping	29.33	1.00	29.25	7.60	4.10	15.72	2.23
LSD	4.06	0.58	6.41	1.57	0.82	4.50	0.27
Mean	28.58	1.08	30.25	7.57	4.37	16.60	2.49

NL=number of leaves, NB=number of branches, LLV=length of longest vine (cm), LW=leaf width, LL=leaf length (cm), LA=leaf area (cm) and GL=girth length (cm)

Table 2: Effects of manure on fluted pumpkin after four weeks of transplanting

Treatments	NL	NB	LLV	LL	LW	LA	GL
Cow Dung	54.33	1.00	48.92	7.67	4.83	18.58	2.43
Fish Waste	55.00	1.33	40.00	6.67	4.00	13.33	2.74
NPK 15:15:15	66.67	2.00	43.33	7.50	4.67	17.54	2.60
Poultry Dropping	53.33	1.00	42.83	7.67	4.67	18.00	2.32
LSD	21.53	0.58	7.95	0.64	0.55	3.08	0.37
Mean	57.33	1.33	43.77	7.38	4.54	16.87	2.52

NL=number of leaves, NB=number of branches, LLV=length of longest vine (cm), LW=leaf width, LL=leaf length (cm), LA=leaf area (cm), and GL=girth length (cm)

Table 3: Effects of manure on fluted pumpkin after six weeks of transplanting

Treatments	NL	NB	LLV	LL	LW	LA	GL
Cow Dung	110.00	1.33	64.58	8.67	5.33	23.17	3.52
Fish Waste	68.67	1.00	60.33	7.65	4.67	17.93	3.11
NPK 15:15:15	91.33	1.33	59.83	7.33	5.33	19.50	3.71
Poultry Dropping	72.33	1.00	54.50	8.33	4.83	20.13	2.75
LSD	28.20	0.67	15.97	0.94	0.64	3.99	0.46
Mean	85.58	1.17	59.81	8.00	5.04	20.18	3.27

NL=number of leaves, NB=number of branches, LLV=length of longest vine (cm), LW=leaf width, LL=leaf length (cm), LA=leaf area (cm), and GL=girth length (cm)

Table 4: Correlation studied of traits at two weeks after transplanting

	NL	NB	LLV	LL	LW	LA	GL
Number of Leaves		0.4299	0.6112**	0.4928	0.154	0.4049	0.1727
Number of Branches			0.015	0.1477	0.0921	0.141	0.6201
Length of Longest Vine				0.5347	0.2431	0.4743	0.1992
Leaf Length					0.4008	0.8663**	0.3076
Leaf Width						0.8038	0.4519
Leaf Area							0.4323
Girth Length							

NL=number of leaves, NB=number of branches, LLV=length of longest vine (cm), LW=leaf width, LL=leaf length (cm), LA=leaf area (cm), and GL=girth length (cm)

Table 5: Correlation studied of traits at four weeks after transplanting

	NL	NB	LLV	LL	LW	LA	GL
Number of Leaves		0.54	0.46	0.35	0.08	0.21	0.51
Number of Branches			-0.14	0.00	-0.07	-0.05	0.19
Length of Longest Vine				0.83**	0.61**	0.75**	0.09
Leaf Length					0.84**	0.95**	-0.30
Leaf Width						0.96**	-0.37
Leaf Area							-0.35
Girth Length							

NL=number of leaves, NB=number of branches, LLV=length of longest vine (cm), LW=leaf width, LL=leaf length (cm), LA=leaf area (cm), and GL=girth length (cm)

Table 6: Correlation studied of traits at six weeks after transplanting

	NL	NB	LLV	LL	LW	LA	GL
Number of Leaves		0.42	0.75**	0.60*	0.57*	0.79**	0.52
Number of Branches			0.30	0.31	-0.04	0.16	0.38
Length of Longest Vine				0.56	0.43	0.67**	0.17
Leaf Length					0.13	0.73**	-0.25
Leaf Width						0.77	0.33
Leaf Area							0.07
Girth Length							

NL=number of leaves, NB=number of branches, LLV=length of longest vine (cm), LW=leaf width, LL=leaf length (cm), LA=leaf area (cm), and GL=girth length (cm)

Effect of Single Super Phosphate (SSP) Fertilizers Rates on the Performance of Selected Varieties of Soya Bean (*Glycine max* L.) at Jalingo, North-East, Nigeria

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ABSTRACT
Phosphorus deficiency in soils could result in poor root establishment and grain yield. Varieties of Soyabean introduced to meet food demand will respond differently to P levels. Therefore, a preliminary pot experiment was carried out in 2018 season, at the Teaching and Research Farm, Taraba State University, Jalingo to investigate the influence of various dosage of Single Super Phosphate (SSP) fertilizer on the performance of soya bean varieties. Three varieties of Soyabean, Fledder John (FJ), Samsoy 1(SS1) and Samsoy 2 (SS2) were evaluated under five SSP fertilizer regimes, 0 kg/ha, 20kg/ha 30kg/ha 40kg/ha 60kg/ha (SSP0, SSP1, SSP2, SSP3 and SSP4) respectively, replicated four times in a completely randomized design (CRD). Data were collected on growth and yield parameters and subjected to Analysis of Variance, with mean separated using Duncan Multiple Range Test (DMRT) at 5% probability level. Results showed that variety did not significantly influenced all measured parameters except grain yield, while fertilizer significantly influenced all growth parameters but not yield and yield related attributes; the untreated performed better than most treatments. Interaction between varieties and fertilizer significantly affected all measured parameters except number of pods and number of seed per pod. Grain yield was only influenced by variety in this study. A confounding effect of application of SSP on a land with P level adequate to grow soyabean was confirmed. The best soybean cultivar, irrespective of fertilizer was Samsoy 2 (Mokwa 21) with grain yield of 1048kg/ha. Field trials on soil with P deficiency should be conducted to validate response to Phosphorus.
Keywords: Soyabean, Variety, Phosphorus, Soil fertility, Mokwa

INTRODUCTION
Soyabean, (*Glycine max*, L.) is a leguminous vegetable, which grows in tropical, subtropical, and temperate climates (Dugje *et al*., 2009) and remain one of the most important legume crops for human nutrition. Ir has been traditionally cultivated in arid and semi-arid regions because of its high protein (25%-29%) content (Hamel *et al.,* 2014) and vitamins (Venter, 2014). The crop is good for diabetics (Agwu *et al*., 2009), dieting (Fabiyi, 2006) and protects against some types of cancer and liver carcinoma (Venter, 2014). According to Dugje *et al*. (2009), soyabean performs well where rainfall is more than 700 mm, although short-duration varieties can thrive in the much drier Sudan savanna when sown early and with an even distribution of rainfall throughout the growing period. Planting Soyabean depends upon temperature and day length. Low yield in soybean production are attributed to biotic .and abiotic factors such as drought and low soil fertility status (Singh *et al*., 2003). Most soils in humid regions, especially those in subtropical areas where a greater proportion of the population live are nutrients deficient (Emede. and Alika, 2012). The essential plant nutrients; nitrogen and phosphorus are often in short supply in many soils of tropical Africa (Ngugi, 2012). The amount of available phosphorus in tropical soils is largely insufficient to meet the demand of legumes and thus

phosphorus deficiency is widespread in pulse crops (Rao *et al*. 2014). Phosphorus is essential in the formation of useful energy needed for sugar formation and translocation. The use of P fertilizer to meet plants P requirement is limited by its high cost, as organic inputs generally do not provide sufficient P for optimum crop growth due to their low P concentration (Aulakh *et al*., 2003). Therefore, the optimal use of phosphorus fertilizers with its resultant effect of increased P use efficiency should be encouraged. New varieties of soyabean are continually being developed and introduced to meet food demand and other uses, it is important to evaluate these varieties, in terms of best yielding cultivar(s) and their most appropriate fertilizer rates for optimum performance. This study evaluated the effect of five (5) levels of P fertilizer on the growth and yield of three (3) soyabean varieties.

MATERIALS AND METHODS

The experiment was conducted at the Teaching and Research Farm, Taraba State University, Jalingo, Taraba State in 2018 rainy season. The pot experiment consists of three varieties of soyabean and five levels of SSP fertilizer, giving fifteen treatments combinations, replicated four (4) times in a Completely Randomized Design (CRD). A total of sixty (60) pots were used. Each pot was filled with about 20kg soil up to 3/4 of the pot capacity. The three varieties of Soyabean (Fledder John, Samsoy 1 (Mokwa 79) and Samsoy 2 (Mokwa 21) sourced from International Institute of Tropical Agriculture (IITA), Kano were plated two seeds per pot and thinned to one per pot. SSP fertilizer was applied at five levels (0, 20. 30. 40 and 60kg/ha),. The pots were watered regularly, while pest including insects and weeds were managed appropriately. Data collected on plant height (cm), number of leaves, branches, pods, seeds per pod, 100 seed weight and grain yield were subjected to Analysis of variance (ANOVA) with mean separated with DMRT at 5% probability.

RESULTS AND DISCUSSION

***Growth*:** Table 1 shows the effect of SSP fertilizer rates and varieties on plant height, number of leaves and number of branches. There was significant difference in plant height at all sampling times, except at 6 WAP due to different SSP fertilizer rates (Table 1). Generally, the untreated, (SSP0) recorded the tallest plants when compared with SSP1. At 3 WAP plant height in SSP2 was greater than SSP1. Treatment SSP2 significantly increased number of leaves than other treatments except SSP0 at 4-6 WAP. Similar trend was observed for number of branches. Similar findings of significant differences in plant height in response to various levels of phosphorus fertilizer have been reported by Malik *et al.,* (2006). The interaction between SSP fertilizer and variety significantly influenced plant height, except at 6 WAP, number of leaves and branches (Table 2). Plot FJSSP0 recorded soyabean plants that are significantly taller than FJSSP1 and SS1SSP1 (3WAP) and SS1SSP1 (4WAP), while SS2SSP0 was taller than SS1SSP1 (5WAP). The soil might not be highly deficient in P. This disagrees with the report of Mabapa *et al.,* (2010) who reported significant difference in plant height with various levels of fertilizer. FJSSP3 plots recorded significant more leaves than FJSSP4 (3WAP) and FJSSP1, SS1SSP1, SS2SSP3 and SS2SSP4 (6WAP), whereas SS1SSP2 plots recorded more leaves than FJSSP0, FJSSP1, SS1SSP1, SS2SSP3 and SS2SSP4 (4WAP) and FJSSP1, SS2SSP3 and SS2SSP4 (5WAP). The result is in agreement with Bishnoi *et al*., (2007) and Mabapa *et al.,* (2010) that observed significant difference in number of leaves due to the interactive effect of soyabean varieties and Phosphorus fertilizer and fertilizer alone. Number of branches in SS1SSP2 plots was more than in FJSSP0, FJSSP1, SS1SSP1, SS2SSP3 and SS2SSP4 (4WAP). FJSSP3 plots recorded significant more branches than SS1SSP1, SS2SSP3 and SS2SSP1, SS2SSP3 and SS2SSP4 (5WAP). However, at 6WAP, plants in SS2SSP0 recorded more branches than FJSSP1and SS2SSP4. Fledder John variety seems to require and respond better at higher P dosage when compared with Samsoy (SS1 or SS2) varieties.

***Yield*:** Variety significantly influenced soyabean grain yield (Table 3) The similarity in yield at various fertilizer rates and interaction could be attributed to likely adequate P level in the soil, which make the untreated to be as productive as the treated plots. In a highly fertile soil growth and yield of crops receiving additional nutrient have been reported to be comparable with or even less than those without fertilizer. This is contrary to several reports, Iqbal *et al*., (2010); Mandal and Sikder (2012); Ali *et al*., (2004); Jin *et al.,* (2004) and Desclaux and Rournet (I996) who reported that number of pod per plant, seed yield and harvest index were increased due to increasing level of P, varietal differences and the combined effect of varieties and P fertilizer in a P deficient soil.

CONCLUSION

A confounding effect of application of SSP on a land with P level adequate to grow soyabean was confirmed. The best soybean cultivar, irrespective of fertilizer was Samsoy 2 (Mokwa 21) with grain yield of 1048kg/ha. Field trials on soil with P deficiency should be conducted to validate response to Phosphorus.

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Table 1: Effect of SSP fertilizer rates and varieties on plant height, number of leaves and number of branches

	Weeks after planting (WAP)			
	3	**4**	**5**	**6**
Fertilizer		**Planting height**		
SSP0	11.2a	14.1a	18.2a	24.1a
SSP1	8.5b	12.3b	14.6b	19.5a
SSP2	10.4a	12.9ab	16.7ab	22.6a
SSP3	9.7ab	12.8ab	16.3ab	22.0a
SSP4	9.7ab	13.1ab	17.1ab	22.9a
		Number of leaves		
SSP0	5.2a	6.8b	17.4ab	27.0ab
SSP1	4.8a	6.1b	13.6b	17.6c
SSP2	5.0a	8.6a	21.4a	32.2a
SSP3	5.0a	6.8b	16.2ab	23.7bc
SSP4	4.8a	6.3b	15.4b	21.4bc
		Number of Branches		
SSP0	-	1.8ab	4.0ab	6.0a
SSP1	-	0.8b	2.4c	4.2a
SSP2	-	3.2a	4.3a	5.5a
SSP3	-	0.9b	3.2abc	5.0a
SSP4	-	1.8ab	2.7bc	4.2a

Means with same letters are not significantly different from each other according to DMRT at $p \le 0.05$

FJ=Fledder John, SS1=Samsoy 1, SS2=Samsoy 2, SSP0= 0kg/ha, SSP1=20kg/ha, SSP2=30kg/ha, SSP3=40kg/ha, SSP4=60kg/ha

Table 3: Effect of SSP fertilizer on grain yield

Treatment	**Grain yield (kg/ha)**
Varieties	
FJ	854c
SS1	988b
SS2	1048a

Means with same letters are not significantly different from each other according to DMRT at $p \le 0.05$

FJ=Fledder John, SS1=Samsoy 1, SS2=Samsoy 2, SSP0= 0kg/ha, SSP1=20kg/ha, SSP2=30kg/ha, SSP3=40kg/ha, SSP4=60kg/ha.

Table 2 Effect of SSP fertilizer rates and varieties interaction on plant height, number of leaves and number of branches

Fertilizer x Varieties	Plant height			Number of leaves			Number of branches		
	FJ	SS1	SS2	FJ	SS1	SS2	FJ	SS1	SS2
Fertilizer		**3 WAP**			**3 WAP**			**3 WAP**	
SSP0	11.9a	10.4abc	11.1ab	5.0ab	5.3ab	5.3ab	-	-	-
SSP1	8.0bc	7.4c	9.9abc	4.8ab	4.8ab	5.0ab	-	-	-
SSP2	10.2abc	11.6a	9.3abc	5.3ab	5.0ab	4.8ab	-	-	-
SSP3	10.6abc	10.4abc	8.1bc	5.5a	4.8ab	4.8ab	-	-	-
SSP4	9.0abc	10.7abc	9.4abc	4.5b	5.3ab	4.8ab	-	-	-
		4 WAP			**4 WAP**			**4 WAP**	
SSP0	14.9a	13.2ab	14.3ab	5.5bc	8.0abc	7.0abc	5.5 bc	8.0 abc	7.0 abc
SSP1	11.4ab	10.1b	12.3ab	6.0bc	5.8bc	6.5abc	6.0 bc	5.8 bc	6.5 abc
SSP2	13.1ab	14.4ab	11.4ab	8.0abc	9.3a	8.5ab	8.0abc	9.3a	8.5ab
SSP3	14.1ab	12.7ab	11.7ab	8.3abc	6.5abc	5.5bc	8.3 ab	6.5abc	5.5bc
SSP4	13.1ab	13.9ab	12.3ab	6.3abc	7.5abc	5.0c	6.3abc	7.5abc	5.0c
		5 WAP			**5 WAP**			**5 WAP**	
SSP0	18.5ab	16.0ab	20.0a	17.8abcd	12.8abcd	21.8abc	3.3abcde	3.8abcde	5.0ab
SSP1	14.3ab	13.4b	15.9ab	11.5bcd	13.3abcd	16.0abcd	3.0abcde	2.3cde	2.0de
SSP2	17.2ab	19.9ab	14.0ab	21.0abcd	23.5a	19.8abcd	3.8abcde	4.5abcd	4.8abc
SSP3	18.3ab	16.2ab	14.5ab	22.8ab	14.5abcd	11.3cd	5.5a	2.5bcde	1.5e
SSP4	16.8ab	19.1ab	15.5ab	13.8abcd	22.3abc	10.3d	1.5e	4.5abcd	2.0de
		6 WAP			**6 WAP**			**6 WAP**	
SSP0	23.8a	21.4a	27.1a	29.5abcd	19.3abcd	32.3abcd	5.3abc	5.3abc	7.5a
SSP1	21.2a	16.8a	20.6a	17.3bcde	16.3cde	19.3abcde	4.8abc	3.8abc	4.0abc
SSP2	23.7a	26.0a	18.3a	29.5abcd	32.5abc	34.5a	5.5abc	5.5abc	5.5abc
SSP3	25.7a	21.0a	19.3a	33.8a	21.3abcde	16.0de	7.0ab	4.3abc	3.8abc
SSP4	23.3a	25.7a	19.9a	19.3abcde	33.5ab	11.8e	3.0bc	7.0ab	2.5c

Means with same letters are not significantly different from each other according to DMRT at p≤0.05. FJ=Fledder John, SS1=Samsoy 1, SS2=Samsoy 2, SSP0= 0kg/ha, SSP1=20kg/ha, SSP2=30kg/ha, SSP3=40kg/ha, SSP4=60kg/ha.

Effect of Plant Spacing on Growth and Yield of Four Cultivars of Groundnut (*Arachis hypogaea* L.) at Jalingo, North-East Nigeria

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ABSTRACT
A field experiment was conducted at the Teaching and Research Farm, Taraba State University, Jalingo in 2016 growing season to study the effect of planting spacing on the growth and yield of groundnut. Four cultivars of groundnut, Dama (V1), Kampala (V2), Yarkasa (V3), and ICGV (V4) were evaluated at three planting spacing, 50cm X 25cm (S1), 75cm X 25cm (S2), and 90cm X 25cm (S3), giving a total of 12-treatment combinations replicated three times laid out in a Randomized Complete Block Design (RCBD). Growth and yield data collected from four sampled plants per plot were subjected to analysis of variance (ANOVA) and means separated by Least Significant Difference (LSD) at 5% level of probability. Results show that spacing did not significantly influenced all growth and yield parameters. However, variety and interactions between spacing and variety significantly influenced growth and yield. Plant height was generally in the order V4>V1/V3>V2. Treatment V4S1 (ICGV planted at 50cm x 25cm) recorded significantly more number of leaves, number of branches and plant height when compared with many other treatments. The pod weight and shoot biomass were in the order V4>V1>V3 and V4/V2>V1 respectively. It was concluded that varieties, V4 (ICGV) and V1(Dama) were superior in respect to number of pod (14.9, 14.7), weight of pod (21.5g, 15.4g), days of flowering (44.9, 37.2) and 100 seed weight (48.2g, 36.7g) and thus recommended.
Keywords: Groundnut, variety, spacing, seed weight

INTRODUCTION
Groundnut is one of the must economic legumes crops of the world. Nigeria is the largest groundnut producing country in Africa and the fourth largest producer in the world with 1.55 million metric tons, accounting for 51%, 39% and 10% of West African, Africa and global production respectively. Between 1956 and 1967, groundnut was the country's most valuable single export crop, exemplified by the famous Kano groundnut pyramids. Groundnut is the major source of edible oil and effective in treatment for children with protein related malnutrition (Arya *et al*., 2016), as well as livelihoods for small-scale farmers in Nigeria. Being a labor-intensive crop, its generate employment for the rural poor. It is planted on about 34% of total cultivated area and contribute to 23% of household cash revenue. (Ajeigbe *et al*., 2015) with over 85% produced in northern Nigeria, especially Kano, Kaduna, Taraba. Its ability to grow vigorously in adverse environment especially in N-deficient soils makes it prominent in subsistence agriculture (Rahman, 2003) and can provide an equivalent of 60kg N ha-1 to subsequent non-legume crop through biological nitrogen fixation (Ghosh *et al*., 2007 Rwamugira and Massawe, 1990). The production of groundnut has been increasing at an estimated growth rate of 8%, resulting both from area expansion (6%) and increase in productivity of 2% (Ajeigbe *et al*, 2015). In tropical African average yield of groundnut range from 300-1000kg/ha can be achieved. However, groundnut production has continued to decline with famers realizing less than one-ton/ha in Nigeria (Farnham, 2001; FAO 2008), far less than 5 tones/ha obtainable with good management practice and proper disease control. The low

yield is attributed to genetic and environmental constraints, weed, insect and nematode, and disease epidemic at various growth stages (ICRISAT 1992, Boote and Ketring 1990). Spacing is one of the most important management practices determining yield. The crop architecture, growth rate, canopy are influenced by land area occupied per plant (Ahmad and Mohammad, 1997; Mozingo and Steele, 1989). As the number of plants increased in a given area the competition among the plants for nutrients uptake and sunlight interception also increased leading to low yield/ha (Sangakkara *et al.,* 2004). The quest for optimum spacing for individual groundnut cultivar is the essence of the present study. The objective of the study was to investigate the response of four cultivars of groundnut Dama, Kampala, Yarkasa, and ICGV to three planting spacing, 50cm X 25cm, 75cm X 25cm, and 90cm X 25cm.

MATERIALS AND METHODS

The field experiment was conducted at the Teaching and Research Farm, Taraba State University Jalingo. The experimental site lies between latitude 11°52- 11°57' N and longitude 11^0 19^1- 11^0 26^1E. It has a mean annual rainfall of about 1200mm/annum and temperature of 29^0 C, humidity in the region ranges between 60-70% in the raining season and 30-35% in the dry season.

Four cultivars of groundnut, Dama, Kampala and Yarkasa obtained from Jalingo market and ICGV from Farming Skill Acquisition Centre (FSAC) were evaluated at three planting spacing, 50cm X 25cm, 75cm X 25cm, and 90cm X 25cm, giving a total of 12-treatment combinations replicated three times laid out in a Randomized Complete Block Design (RCBD). The plot size was 14.8m x 29m including foot paths which was 2m between blocks and 1m between plots. Each plot was 3.6m x 1.5m. The land was prepared manually with the use of hoe. Planting was at spacing of 50x25cm, 75x25cm, and 90x25cm appropriately. Weeding along with earthing up was done at 3, 6 and 9 weeks after planting (WAP). Growth and yield data collected from four sampled plants per plot. were subjected to analysis of variance (ANOVA) and means separated by Least Significant Difference (LSD) at 5% level of probability with SAS version 2002.

RESULTS AND DISCUSSION

Tables 1 and 2 show the effect of spacing and variety on number of leaves, number of branches and plant height (cm) of groundnut at 4, 6 and 8 WAP. Spacing did not significantly influenced number of leaves, branches and plant height of groundnut at all the sampling times. This could be attributed to growth habit of groundnut variety. This observation disagrees with the report by Muoneke and Asiegbu (2008) who found that the number of leaves and branches of groundnut increased with increased in row spacing. However, Ahmed *et al*., (2010) and Lazim and Nadi, (1974) found that intra-row spacing had no significant differences on number of leaves, branches and plant height. But variety significantly affected all growth parameters (Table 1). At 4 and 6 WAP, number of leaves of V4 (ICGV) was more than in V2 (Kampala). However, at 8 WAP, V4 and V3 recorded more number of leaves than in V1(Dama). Similar trend was observed for number of branches. Plant height was generally in the order V4>V1/V3>V2. The superiority of V4 could be attributed to genetic variation, being an improved variety with higher growth rate and survivability. The interaction between spacing and variety significantly influenced all growth parameters (Table 2). Treatment V4S1 (ICGV planted at 50cm x 25cm) recorded significantly more number of leaves at all the sampling periods when compared with V2S3 (4WAP), V2S1, V2S3, V3S1, V3S3 (6WAP) and all V1 plots (8WAP). The same trend was observed for number of branches. The number of branches in V4S1 was more than the values recorded in V2S3 (4WAP), V1S2, V1S3, all V2 plots, V3S1, V3S3 (6WAP), all V1 plots and V2S1 (8WAP). Similarly, groundnut plants in V4S1 were significantly taller than in V1S2, all V2 and V3 plots (4WAP), V1S2, V1S3, all V2 and V3, V4S2 (6WAP) and V1S2, V1S3, all V3, V4S2 (8WAP). The observed trend suggests that V4 growth was optimum at S1 while others did better at S2.

Yield and Yield Components

Spacing did not significantly influence all yield and yield components as well as days to 50% flowering (Table 3). However, the highest number of pod and weight were recorded in S2 plot (14.5) while S3 recorded highest above-ground biomass per plant. Variety significantly influenced all yield and yield components of groundnut. The number of pods in V4 and V1 were more than the value recorded in V3. The pod weight and shoot biomass were in the order V4>V1>V3 and V4/V2>V1. The days to 50% flowering in V3 and V2 were the longest (53.8-56.6 days) and significantly longer than the values in V4 (44.9 days) and V1 which was the least (37.2 days). The 100 seed weight followed the trend observed for weight of pod in the order V4>V1>V2/V3. These were lower than that reported by other studies (Abdullah *et al.,* 2007) probably due to zero fertilizer input. The variations in the number of pods observed were probably largely attributable to the genotypes of the groundnut varieties (Ahmad and Mohammad, 1997; Ogundele, 1988).

CONCLUSION

It was concluded that varieties, V4S1 was superior in growth parameters while V4 (ICGV) and V1(Dama) were superior in respect to number of pod (14.9, 14.7), weight of pod (21.5, 15.4), days of flowering (44.9, 37.2) and 100 seed weight (48.2, 36.7). The observed trend suggests that V4 growth was optimum at S1 while others did better at S2. ICGV and Dama with best yield performance are recommended for seed production, but Kampalla and ICGV should be considered by livestock farmers that desire higher biomass. ICGV is dual purpose as the overall best.

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Table 1: Effect of spacing and variety on number of leaves, number of Branches, Leaf length (cm), and Plant height (cm) of groundnut at 4, 6 and 8 WAP evaluated in TSU farm in 2016 rainy season

Treatment	**Number of leaves**			**Number of Branches**			**Plant height (cm)**		
	4 WAP	**6 WAP**	**8 WAP**	**4 WAP**	**6 WAP**	**8 WAP**	**4 WAP**	**6 WAP**	**8 WAP**
Spacing									
S1	108.3 a	155.1 a	280.1 a	27.1 a	38.8 a	70.1 a	7.4 a	11.2 a	18.7 a
S2	109.8 a	148.4 a	287.1 a	27.5 a	38.1 a	71.7 a	7.1 a	10.5 a	18.8 a
S3	95.0 a	132.9 a	270.5 a	23.8 a	33.3 a	67.7 a	6.6 a	9.6 a	16.9 a
Variety									
V1	107.9 ab	142.8 ab	207.1 ab	27.0 ab	35.7 ab	51.5 b	7.9 ab	11.3 b	18.5 b
V2	88.1 b	123.0 b	277.1 ab	22.0 b	32.0 b	69.3 ab	4.4 c	7.0 c	15.4 c
V3	107.1 ab	146.1 ab	305.0 a	26.8 ab	36.6 ab	76.2 a	6.9 b	10.1 b	17.1 bc
V4	114.4 a	170.0	328.9 a	28.6 a	42.5 a	82.3 a	9.1 a	13.2 a	21.5 a

Means with the same letter are not significantly different at 5% using LSD. S1 -50x25cm, S2 - 75x250m, S3 - 90x250m, V1 - Dama, V2 - Kampalla, V3 - Yarkasa, V4 – ICGV

Table 2: Effect of spacing and variety interaction on number of leaves, number of Branches, Leaf length (cm), and Plant height (cm) of groundnut

Spacing x	Number of leaves				Number of Branches				Plant height (cm)			
Variety	**V1**	**V2**	**V3**	**V4**	**V1**	**V2**	**V3**	**V4**	**V1**	**V2**	**V3**	**V4**
4 WAP												
S1	116.3 ab	78.3 b	108.7 ab	130.0 a	29.1 ab	19.6 b	27.2 ab	32.5 a	8.6 ab	4.1 de	6.8 bc	10.2 a
S2	110.0 ab	111.7 ab	115.0 ab	102.7 ab	27.5 ab	27.9 ab	28.8 ab	25.7 ab	6.9 bc	5.3 cde	7.6 bc	8.5 ab
S3	97.3 ab	74.3 b	97.7 ab	110.7 ab	24.4 ab	18.6 b	24.4 ab	27.7 ab	8.1 ab	3.7 e	6.2 bcd	8.4 ab
6 WAP												
S1	153.0 abc	124.7 bc	140.7 bc	202.0 a	38.3 abc	31.2 bc	35.2 bc	50.5 a	13.0 ab	6.2 d	10.0 bc	15.6 a
S2	139.7 bc	130.3 ab	169.3 abc	154.3 abc	34.9 bc	36.4 bc	42.4 ab	38.6 abc	10.1 bc	8.7 cd	11.5 bc	11.9 bc
S3	135.7 bc	114.0 c	128.3 bc	153.3 abc	33.9 bc	28.5 c	32.1 bc	38.4 abc	10.7 bc	6.3 d	8.8 cd	12.7 ab
8 WAP												
S1	222.0 cd	234.3 cde	289.7 abcd	374.3 a	55.5 bc	58.6 bc	72.6 abc	93.5 a	20.6 ab	11.3 e	18.1 bcd	24.5 a
S2	195.7 d	330.7 abc	346.3 abcd	275.7 abcd	48.9 c	82.7 ab	86.2 ab	68.9 abc	17.1 bcd	21.0 ab	18.1 bcd	19.1 bc
S3	200.0 d	266.3 abcd	279.0 abcd	336.7 abc	50.0 c	66.6 abc	69.8 abc	84.4 ab	17.8 bcd	13.3 ab	15.3 cde	21.0 ab

Means with the same letter are not significantly different at 5% using LSD. S1 -50x25cm, S2 - 75x250m, S3 - 90x250m, V1 - Dama, V2 - Kampalla, V3 - Yarkasa, V4 - ICGV

Table 3: Effect of spacing and variety on yield and yield components per plant

	No of pod	**Weight of Pod (g)**	**shoot biomass (g)**	**Days to 50% Flowering**	**100 seed Weight (g)**
Spacing					
S1	13.4a	15.1a	54.7a	48.3a	37.2a
S2	14.5a	16.8a	58.6a	46.6a	39.4a
S3	11.9a	13.1a	60.8a	49.5a	39.4a
Variety					
V1	14.7a	15.4b	36.8b	37.2c	36.7b
V2	12.7ab	13.3bc	64.5a	53.8a	34.0c
V3	10.5b	9.9c	58.1ab	56.6a	33.8c
V4	14.9a	21.5a	72.6a	44.9b	48.2a

Means with the same letter are not significantly different at 5% using LSD. S1 -50x25cm, S2 - 75x250m, S3 - 90x250m, V1 - Dama, V2 - Kampalla, V3 - Yarkasa, V4 - ICGV

Response of Local and Improved Maize Variety to Organic and Inorganic Fertilizers

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ABSTRACT

High cost of inorganic fertilizer in Nigeria resulted to inadequate fertilizer application by resource poor farmers leading to unpredictable low yield. A field experiment therefore was conducted at Teaching and Research farm, Taraba State University, Jalingo to investigate the effect of organic manure (M) and inorganic (NPK 20-10-10) fertilizer (F) on the performance of a local (L) and improved (I) maize varieties. The experimental design was a Randomized Complete Block Design (RCBD) with fourteen treatments replicated three (3) times. Fertilizer was applied at the rate of 100, 75, 50, 25 and 0% of 300 kg per ha NPK 20-10-10 or 10 tons per ha poultry manure (IM 100, IM 25, 1M 50, IF 75, IF 25, IF 50, I0, LM 100, LM 75, LM 50, LM 25, LF 100, LF 50 and L0). Data on growth and yield parameters were collected at 3, 6 and 9 weeks after planting (WAP) and subjected to analysis of variance using statistical analysis system (SAS) and treatment means separated by Duncan Multiple Range Test (DMRT) at 5% level of significance. The cob in LM100 (428.2 g) and LF100 (419.3 g) were significantly more than the value in IM25, LM50, L0 and I0. The 100% poultry dropping or inorganic fertilizer and 75% NPK 20-10-10 fertilizer which significantly enhanced growth, cob yield of local and improved maize varieties respectively are thus recommended.

Keywords: Cob yield, inorganic fertilizer, organic manure

INTRODUCTION

Maize is cultivated throughout the world, with over 139 million hectares and around 600 million tons produced globally (Langner *et al*, 2019). Maize occupies the top three position, along with rice and wheat in area and production (Guzzon *et al*, 2021). USA, China, Brazil, Mexico, India, Romania and Indonesia are some of the important countries cultivating maize crop. Maize, with its large number of cultivars and different maturity periods has wider range of tolerance to different environmental condition (Sah *et al*, 2020). The crop has a wide range of use: as staple human food, feed for livestock and many industrial uses, such as starch, textile wrap, and laundry finishing (Undie *et al*, 2012; Sah *et al*, 2020). Maize is a very high nutrient –demanding crop, requiring adequate nutrient for maximum performance (Rashid and Ryan, 2004). In most parts of Africa including Nigeria, traditional method of maintaining soil fertility has been bush fallow system, where arable land is allowed to revert to fallow after 3 – 4 years of continuous cultivation (Bationo *et al*, 2018). However, due to the growing population and other socio-economic pressures, the fallow period has been reduced from 7 – 10 years to almost no fallow in order to accommodate the increasing high demand for food (Asadu and Unagwu, 2012). The use of both organic and/or inorganic fertilizers by farmers has been reported to increase yield and sustain soil productivity (Michael and Tijani-Eniola, 2010). Many research works have shown that the use of several organic materials especially cow dung, poultry droppings and farm yard manure as soil amendments is suitable for increasing maize production particularly among subsistence farmers in West Africa (Asadu and Unagwu, 2012). The use of fertilizers is highly needed to replenish nutrients taken out from the soil by harvested crops and to supplement more nutrients to boost yield (Olatunji and Ayuba, 2012). Organic fertilizer can be used to improve soil characteristics and obtain high crop yields in addition to inorganic fertilizers (Usman *et al*, 2015; Baghdadi *et al*, 2018). The addition of organic amendment to manage the current trend of soil physical, chemical and biological degradation has been recommended by Michael and Tijani-Eniola, (2010) and Chukwu *et al*, (2012). Use of inorganic fertilizer, could guarantee production of crops free from heavy metal contamination (Asadu and Unagwu, 2012). Organic and inorganic fertilizers have their merit and demerits. For instance, organic fertilizers are slow in releasing nutrient resources. 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 (Adekiya *et al*, 2012). On the other hand, inorganic fertilizers ensure quick availability of nutrient to crops, they have limited residual effect of the applied nutrients (Okigbo, 2000) and their reckless use can create nutrient imbalance that limits uptake of other essential nutrients and cause soil acidity leading to low maize yields (Rashid and Ryan, 2004; Chukwu *et al*, 2012). The challenge of large quantity of manure and high cost of inorganic fertilizers calls for the determination of application rates that will not significantly reduce yield of maize. The objective of this study was to evaluate the response of local and improved maize cultivars to varying rates of poultry manure and NPK 20-10-10.

MATERIALS AND METHODS

***Experimental site*:** The experiment was conducted at the Teaching and Research farm, Taraba State University, Jalingo during the cropping season of 2015. Jalingo lies between latitude 8^0 11' to 8^0 50' N and longitudes $11^0$05'E to $11^0$25'E.

***Experimental design*:** The experimental design was a Randomized Completely Block Design with fourteen (14) treatments, replicated three (3) times. A Local cultivar purchased from open market and improved maize variety (Premier seed) from a seed store were used in this experiment. Each plot measured 3m X 4m. Total plot size was 16 m X 55 m (880 m^2). Each plot and block was separated by 1 m and 2 m, respectively.

***Trial establishment and management*:** Maize was planted at 25 cm x 75 cm spacing. Each plot has four rows with 16 plants per row to give a total plant population of 64 plants per plot. NPK 20-10-10 fertilizer was applied at the rate of 100%, 75%, 50%, and 25% of 300 kg per ha NP and 10 tons per ha poultry manure in appropriate plots. Control plots were left untreated and hand-weeding regimes were carried out at 3, 6 and 9 WAP in all the plots.

***Data Collection and Analysis*:** The parameters that were measured and recorded during the experiment include; plant height, stem girth, number of leaves, number of cob, cob weight. Data were collected from the two central rows exempting the border plants at 3, 6 and 9 WAP. Data were collected from three plants and data collected were subjected to the analysis of variance (ANOVA) using statistical analysis system (SAS) and the treatment means separated by Duncan Multiple Range Test (DMRT) at 5% level of significance.

RESULTS AND DISCUSSION

Table 1 shows the effect of organic and inorganic fertilizers on stem girth, plant height and number of leaves per plant 3-9 WAP.

***Stem girth*:** Fertilizer did not significantly influence stem girth at 6 and 9 WAP (Table 1) but at 3 WAP. The stem girth recorded shown that IM25 (5.7 cm) and LF50 (4.5 cm) were significantly bigger than the value in all other plots. The result shows that local maize responded better than improved maize at 25% organic manure. This result confirms the findings of Motavalli *et al*, (1994) who reported general improvement in maize crop yield and quality obtained when adequate rates of organic soil amendment are incorporated into the soil. The result also confirms that poultry manure contains many essential nutrients required for crop production, and its value as an organic fertilizer and source of plant nutrients has been recognized for centuries (Ritz, 2016).

***Plant height*:** Fertilizer treatments did not significantly influence plant height at 3, 6 and 9 WAP (Table 1). However, among the treatments, there was statistically taller plants in LM75

(118.8 cm) than the value in IF25 (49.4 cm) treated plot of improved maize cultivar. The result from the research shows that local maize treated with poultry manure grows taller than inorganic fertilizer treated plot. This result confirms the findings of Osemwata *et al* (2012) who reported that organic fertilizer enhanced maize plant height, leaf area, stem girth and number of leaves significantly.

***Number of leaves per plant*:** Organic and inorganic fertilizers did not significantly influence the number of leaves at 9 WAP (Table 1). However, at 3 and 6 WAP, both organic and inorganic fertilizers affected (<0.05) the number of leaves produced by the maize plant. At 3 WAP, the number of leaves in IF50 (8.6) was significantly more than the value in IM50, IF75 and L0 (4.6 b) treated plot of local maize, but at 6 WAP, the number of leaves in IF50 (11.2) was significantly more than the value in IF75 (5.9) treated plot. These results obtained at 3 and 6 WAP confirms the findings of Osemwata *et al* (2012) who reported that maize plant height, leaf area, stem girth and number of leaves were significantly affected by abbatoir effluence and sawdust. Also result at 9 WAP confirms the findings of Materechera and Salagae, (2002) and Gonzalez and Matheus (2001) who reported non-significant difference on the use of partial decomposed cattle and chicken manure amended with wood ash.

Yield parameters

Table 2 shows the effect of organic and inorganic fertilizers on Cob weight, Number of Cob, 100 Seeds Weight.

***Number of cobs*:** Fertilizers did not significantly influence the number of cobs (Table 2). All fertilizer rates were equally effective. The uniformity value on the number of maize cobs was a result of inadequate or shortage of rainfall tasseling and cob formation stage in September 2017 raining season. The result obtained disagrees with the findings of Adebayo (2010) who reported that the raining season normally begins around April and ends in October.

***Cob yield*:** Organic and inorganic fertilizers significantly affected Cob yield (Table 2). The cob in LM100 (428.2 g) and LF100 (419.3 g) were significantly more than the value in IM25, LM50, L0 and I0. Result show that local maize at maximum fertilizer rate (100%) could be as productive as improved maize variety. This was a result of gradual release of nutrient by manure to maize plant thereby enhancing constant supply of nutrient for plant growth and yield on local maize. The result confirms the findings of Ojeniyi (2002) who reported that, nearly all attempts to maintain continuous crop production with chemical fertilizers alone in the tropics have failed. The result also confirms the findings of Bahrani *et al*, (2007) who reported that the use of organic fertilizer had higher positive effects on microbial biomass and hence soil health.

***100 seeds weight*:** Fertilizers significantly (<0.05) affected 100 seeds weight (Table 2). The seeds weight in LM100 (26.0 g) and LF100 were heavier than 25 – 100% IM, 25-50% LM, LF50 and the untreated plots. The result shows that organic manure release nutrients to maize gradually to enhance its effective growth and yield. However, the result on LM100 (26.0 g) does not confirm the findings of Ojeniyi (2002) who reported that, there are abundant evidence that inorganic fertilizer can improve yield of maize crop significantly. Many authors have suggested that in order to overcome the problem of food scarcity in Nigeria, key attention should be given to organic fertilizer use to boost crop yield and keep soil in a much better condition than when inorganic fertilizer is used (Usman and Kundiri, 2016; Dahunsi *et al*, 2021)

CONCLUSION

Poultry droppings and inorganic fertilizer significantly enhanced growth, cob weight and yield of maize. LM 100 and LF100 gave the highest cob yield (428.2 g) and 100 SW (26.0 g) are comparable to other treated plots except IM low-dose manure in improved maize and the controls.Improved maize cultivar could be satisfactorily grown with NPK 20-10-10 fertilizer at

75% rate (225 kg/ha), but local maize requires manure (poultry dropping 10 t/ha) or NPK 20-10-10 (300 kg/ha) fertilizer at 100% rate for optimum growth and yield of maize in the study area.

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Table 1: Effect of organic and inorganic fertilizers rates on stem girth, plant height and number of leaves per plant 3-9 WAP

	Stem girth (cm)			**Plant height (cm)**			**Number of leaves per plant**		
Treatments	3WAP	6WAP	9WAP	3WAP	6WAP	9WAP	3WAP	6WAP	9WAP
IM100	3.5 b	6.2 a	8.6 a	10.6 a	70.0 a	78.1 a	6.4 ab	9.2 ab	11.4 a
IM50	4.1 b	5.6 a	7.4 a	9.3 a	57.8 a	75.1 a	5.7 b	8.1 ab	19.1 a
IM25	5.7 a	6.0 a	8.1 a	10.7 a	80.8 a	100.3 a	6.1 a	8.8 ab	12.6 a
IF 75	2.8 b	6.4 a	8.4 a	9.5 a	49.3 a	65.6 a	5.6 b	5.9 b	11.8 a
IF50	4.0 b	7.1 a	9.5 a	11.5 a	89.8 a	112.0 a	8.6 a	11.2 a	12.9 a
IF25	2.9 b	5.3 a	6.6 a	6.1 a	34.2 a	49.4 a	5.3 b	8.1 ab	10.6 a
I0	3.5 b	6.6 a	7.9 a	13.9 a	94.5 a	110.9 a	5.9 ab	9.2 ab	11.7 a
LM100	3.6 b	6.4 a	8.6 a	11.8 a	68.9 a	81.2 a	5.7 b	9.1 ab	10.5 a
LM75	3.7 b	6.9 a	9.1 a	11.8 a	71.8 a	118.8 a	6.3 ab	9.3 ab	11.7 a
LM50	3.9 b	7.1 a	9.2 a	13.4 a	57.2 a	77.8 a	6.8 ab	9.4 ab	11.6 a
LM25	2.5 b	5.5 a	12.3 a	7.4 a	38.6 a	57.8 a	5.4 b	8.1 ab	9.8 a
LF100	3.0 b	5.6 a	7.1 a	11.8 a	63.2 a	73.6 a	5.6 b	7.8 ab	10.2 a
LF50	4.5 a	5.0 a	6.3 a	8.2 a	39.7 a	53.1 a	6.4 ab	8.0 ab	10.0 a
L0	2.9 b	5.5 a	7.8 a	8.8 a	34.5 a	53.3 a	4.6 b	8.8 ab	11.0 a

Means with same letter are not significantly different. Where I = improved maize, I0= Improved maize control, L = Local maize, L0= local maize control, M= manure and F = synthetic fertilizer that was used

Table 2: Effect of organic and inorganic fertilizers rates on Number of Cobs, Cob yield and 100 Seeds Weight

Treatments	No. of Cobs	CY (g)	100 SW (g)
IM100	4.0 a	280.5 abcd	16.8 bed
IM50	4.0 a	288.9 abcd	17.9 bcd
IM25	4.0 a	204.8 cde	13.9 cde
IF 75	3.7 a	408.3 ab	20.6 abc
IF50	4.0 a	290.3 abcd	22.6 ab
IF25	3.7 a	407.7 ab	20.0 abcd
I0	4.0 a	126.2 e	6.9 f
LM100	4.0 a	428.2 a	26.0 a
LM75	4.0 a	380.4 ab	21.1 abc
LM50	4.0 a	254.7 bcde	13.1 def
LM25	4.0 a	341.4 abc	17.9 bcd
LF100	3.7 a	419.3 a	25.6 a
LF50	4.0 a	313.0 abcd	16.0 bcde
L0	3.7 a	156.0 de	9.5 ef

Means with same letter are not significantly different. I = improved maize, I0= Improved maize control, L = Local maize, L0= local maize control, M= manure and F = synthetic fertilizer that was used, CY = Cob yield, 100 SW = 100 seed weight

Assessment of Variability in Yield and Proximate Composition of Nine Mungbean (*Vigna radiata*) Genotypes in Awka, South-Eastern Nigeria

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ABSTRACT

The growth, yield and proximate composition of nine mungbean genotypes (Umudike V1a, Umudike V2a, Tvr 194, Tvr 294, Iran mungbean, Umudike V1b, Tvr 20, Umudike V2b, Tvr 111) were evaluated at the Teaching and Research Farms of Crop Science and Horticulture, Nnamdi Azikiwe University, Awka. The experiment was laid out in Randomized Complete Block Design (RCBD) and replicated three (3) times. The result of this study showed that appreciable level of variation exists among the mungbean genotypes, Umudike V1a was a quick maturing genotype. At 4 weeks after sowing (WAS), it had the highest number of branches (8.67), height (18cm) and number of leaves (24.67). It also had the highest 100 and 1000 seeds weights (6.67g) and Umudike V1b with 67.3g). Its seed is relatively low in protein (25.66%) and high in carbohydrate (53.96%). The pods are long (8.34cm) and seeds large of Umudike V2a shared related attributes with Umudike V1a, and so should be selected alongside for traits like quick maturity, erect stature, long pods, large seeds that are rich in carbohydrate and relatively low in protein. Iran mung bean had the highest number of branches (23.11) at 8 WAS which enabled it to bear the largest number of leaves (69.3) and pods (24.8). Its 100 and 1000 seed weights of (5.67g) and (54g) is relatively high. The seed is relatively high in protein (29.73%) and low in carbohydrate (50.3%). Tvr 194 genotype shared similar attributes and should be selected alongside. Generally, in the tested genotypes of mungbean, seed yield is independent of plant height, number of branches and number of leaves.
Keywords: Genotypes, mungbean, proximate composition, Umudike, seed yield

INTRODUCTION

Legumes belongs to the family Fabaceae, or the fruit or seed of such a plant (also called a pulse, especially in the mature, dry condition). Legumes are grown primarily for human consumption, for livestock forage and silage, and as soil-enhancing green manure (Elbert, 2014). Mungbean (*Vigna radiata* L. Wilczek) is an important annual leguminous crop mainly cultivated in the tropical, subtropical and temperate zones of Asia including Bangladesh, India, Parkistian, Mayanmar, Indonesia, Philippine, Sri lanka, Nepal, China, Korea and Japan (Rahim *et al*., 2010). It is a short duration legume, hence grown solely as well as in inter and multiple cropping system under rain fed and irrigated conditions. It is an excellent source of easily digestible high quality protein for the predominant vegetarian population of India (Tomooka *et al.,* 2003). It contains 3.5-4.5% fiber, 22-28% total protein, 21-25% total amino acid and 1.53-2.63% lipids, 1.0-1.5% fat, ash content ranges from 4-5% and 59-65% carbohydrate on dry weight basis and provide 334-344 kcal energy (Agugo, 2010). Mungbean is known to be high source of manganese, potassium, magnesium, copper, zinc, and phosphorus. It is also rich in various B vitamins and also serves as a food filter high in protein, resistant starch and dietary fibre (DOA, 2013). Mungbean is widely used as human food, green manure and forage for livestock.it also serves for medicinal purpose (Hujjie *et al*., 2003). Due to good taste easy digestibility, better palatability and acceptable market price may be the first choice of farmers (Aguogu, 2017). It increases farmer's income and improves soil fertility through symbiotic nitrogen fixation (Malik *et al.*, 2000). It is a vital crop in developing countries where it is consumed as dry seeds, fresh green pods or leaves due to its high protein, vitamin and mineral content. It is also consumed as green pods and seeds as vegetables (Tang *et al.,* 2014). Primarily, the purpose of growing this crop is for its protein rich edible seeds and fresh sprout. The seed of mungbean mainly used for making soups, bread and biscuits (Sehrawat *et al.,* 2013). Other than food it is important for assistance in normal use of land water resources and enriching the soil. India is the largest producer of mungbean, contributing 65% by area and 54% by production towards global mungbean production. It is cultivated in about 2.7million hectares with the production of 1.19million tons. However, the national productivity remains low 46g kg ha-1 (Tomooka *et al.,* 2003). The objectives of this study were to: evaluate the growth and yield parameters of mungbean varieties and determine their proximate composition in order to select the best performing genotypes using Rank Summation Index by Mulumba and Mock (1978).

MATERIAL AND METHODS

The experiment was conducted at the Research Farm of Crop Science and Horticulture, Nnamdi Azikiwe University Awka, Anambra State, Nigeria during the rainy season (June-September) 2019. Awka is at an altitude of 91m from sea level with latitude and longitude 6°15' N and 7°07' E. respectively with an average annual rainfall of 1650-2000 mm per annum, a mean minimum and maximum temperature of 27°C and 30°C respectively and a relative humidity of 75-80%.

Mungbean varieties used were:

Variety1= Umudike V1a, Large seed
Variety2= Umudike V2a Small seed
Variety3= Tvr 194 – Tropical *V, radiata*
Variety4= Tvr 249 - Tropical *V. radiata*
Variety5= IRAN mungbean
Variety6= Umudike V1b
Variety7= Tvr 20 - Tropical *V. radiata*
Variety8= Umudike V2b
Variety9=Tvr 111-Tropical *V. radiata*

Mungbean seeds were sourced from Michael Okpara University of Agriculture Umudike, Abia State, Nigeria, Agricultural Development Program, Awka, Anambra State, Nigeria both in Nigeria and International Institute of Tropical Agriculture (IITA) Ibadan, Oyo State, Nigeria. Proximate composition analysis was carried out at Food Profiling and Biotechnology Laboratory, Michael Okpara University of Agriculture Umudike.

The experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications.

Cultural Practices

The mungbean seeds were planted at the distance of 50cm × 50cm and the seeds were sown 2 seeds/hole. Weeding of individual plots was done at intervals as the need arose. Application of poultry manure was done before planting at the rate of 1.44kg per plot. The following growth parameters: plant height (cm), number of branches, number of leaves and leaf area (cm^2) were taken at fourth, sixth and eighth weeks after planting (WAP) respectively. Yield parameters evaluated include: number of pods per plant, pod length and weight of seeds (100 and 1000 seed) respectively.

Selection of Best Performing Mung Bean Genotypes

A rank summation index (RSI) method of Mulumba and Mock (1978) was used to rank the genotypes for their overall performance. To obtain the ROD, genotypes were first ranked for each parameter (that is, 1=best and 9 poorest) and parameter ranks summed to generate overall performance of each genotype. Hence, the lower the RSI of any genotype, the greater is its performance.

Proximate analysis

Proximate analysis of the mungbean were determined according to the standard methods of Association of Official Analytical Chemists (AOAC, 2010). Parameters determined are: moisture content, crude protein, fat content, crude fibre, ash and carbohydrates content. The data analysis was done using GENSTAT 2011 edition. The differences of the treatment means were tested using Least Significant Difference at 5% level of probability.

RESULTS AND DISCUSSION

The result of this study showed that appreciable level of variation exists among the mungbean genotypes. Paven *et al.,* (2019) reported a variation in growth and yield parameters of mungbean plant. Variety V1 is a quick maturing genotype, this is in accordance with Sofie *et al*., (2011). At 4 WAS; it had the highest number of branches (8.67), height (18cm) and number of leaves (24.67) as shown in Table 2. It had the highest 100 and 1000 seeds weights of (6.67g) and (67.3g) with V6 (Table3). This high yield is in line with the findings of Rasul *et al*. (2009). Its seed is relatively low in protein (25.66%) and high in carbohydrate (53.96%). The pods are long (8.34cm) and seeds large. V2 genotype shared related yield attributes with V1, it had the longest pods (8.48cm) and seeds are high in carbohydrate (56.58%) and relatively low in protein (24.32%). It also had the highest (14.33) seeds per pod (Table 3). From Table 5, Genotypes V1 and V2 should be selected for agronomic qualities like; quick maturity, short and erect stature and yield qualities like: long pods, large seeds that are rich in carbohydrate relatively low in protein. V5 had the highest number of branches (23.11) at 8 WAS which enabled it to bear the largest number of leaves (69.3) and pods (24.8) although not significant. Its 100 and 1000 seed weights of (5.67g) and (54g) is relatively high (3rd highest). The seed is relatively high in protein (29.73%) and low in carbohydrate (50.3%). V3 genotype shared similar agronomic and yield attributes and should be selected alongside. Generally, in the tested genotypes of mungbean seed yield is independent of plant height, number of branches and number of leaves. Traits that are linked positively include number of branches and leaves, number of flowers and seeds, large pod size and seed weight. This is in line the findings of Mehmet *et al,*(2014). Proximate analysis showed that high carbohydrate seeds are relatively low in protein and vice versa. The overall performance of the nine *V. radiata* genotypes was determined using their rank summation index as shown in Table 5. For overall performance in Table 5. V1 (Umudike V1a) and V4 (TVR 249) ranked first, with a rank summation index (48).

CONCLUSION

This research work revealed that V1 (Umudike V1a) is the best and should be considered for breeding purposes for seed yield, for forage or vegetative growth while variety V3 (Tvr 194) should be considered for high protein content, fat, energy and ash content. In selecting the best variety for growth and yield Tvr 249 should be selected due to its lowest rank summation of 17 and 14 respectively. The best for overall performance based on the rank summation index with the lowest rank is Umudike V1a and thus should be selected for best performance.

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Table 1: Variation in Number of Flowers and Days to 50% Germination of Nine (9) mungbean Genotypes

Genotypes	Days to 50% germination	No. of flowers
UMU V1a	6.00	25.8
UMU V2a	5.33	17.3
TVR 194	4.33	14.8
TVR 249	5.00	18.0
IRAN	5.33	16.7
UMU V1b	3.67	12.7
TVR 20	4.67	18.3
UMU V2b	4.67	18.8
TVR 111	5.33	21.7
$LSD_{0.05}$	1.72	13.74

Table 3: Variation in Number of Pod per Plant and Number of Seeds per Pod, 1000 Seed Weight, Pod Length of Nine Mungbean Genotypes

Genotypes	No. of pod per plant	No. of seeds per pod	Pod length(cm)	1000 seed weight(g)
UMU V1a	15.0	11.22	8.34	67.3
UMU V2a	13.9	14.33	8.48	32.0
TVR 194	8.1	12.55	6.59	30.7
TVR 249	12.7	11.67	7.03	38.7
IRAN	24.8	11.89	8.33	54.0
UMU V1b	24.4	11.22	8.34	67.3
TVR 20	17.9	11.89	6.64	40.0
UMU V2b	16.1	12.45	6.53	42.0
TVR 111	22.2	11.45	6.37	32.0
$LSD_{0.05}$	19.06	2.59	1.73	16.12

Table 4: Variation in proximate composition of Nine (9) Mungbean Genotypes

Genotypes	% Ash	% CHO	% CP	% CF	% FAT	% MC	KcalEv
UMU V1a	2.800	53.965	25.660	3.305	1.620	12.650	333.080
UMU V2a	2.510	56.585	24.320	3.120	1.415	12.050	336.355
TVR 194	3.225	50.770	31.485	2.985	1.815	9.720	345.355
TVR 249	2.985	52.870	29.415	3.545	1.350	9.835	341.290
IRAN	3.055	50.300	29.730	3.665	1.780	11.740	335.060
UMU V1b	2.775	53.935	25.605	3.325	1.605	12.665	333.100
TVR 20	2.920	53.680	28.854	3.680	1.540	9.640	342.135
UMU V2b	2.485	56.565	24.330	3.165	1.400	12.100	336.320
TVR 111	3.005	52.220	29.635	3.635	1.480	10.025	340.740
$LSD_{0.05}$	0.04587	0.02211	0.03408	0.03082	0.01748	0.03291	0.7984

% CHO= % Carbohydrate, % CP= % Crude Protein, % MC=% Moisture Content, % CF= % Crude Fibre

Table 2: Variation in Plant Height, Number of Branches, Number of Leaves, Measured Leave Area at 4, 6 and 8 Weeks after sowing (WAS) of Nine (9) mungbean Genotypes

Genotypes	Plant Height (cm)			No of Branches			No of Leaves			Measured Leave Area (cm^2)		
	4WAS	6WAS	8WAS	4WAS	6WAS	8WAS	4WAS	6WAS	8WAS	4WAS	6WAS	8WAS
UMU V1a	18.00	25.6	29.5	8.67	10.44	13.00	24.67	32.33	40.1	65.1	131.1	100.8
UMU V2a	14.67	19.83	29.6	5.78	10.11	16.22	19.33	32.33	49.3	50.8	89.8	98.5
TVR 194	13.56	19.17	26.6	4.89	11.00	15.11	16.67	35.00	47.2	52.0	90.0	96.0
TVR 249	16.00	25.00	31.4	5.66	11.33	18.22	17.90	37.57	54.9	56.1	115.2	131.2
IRAN	15.89	17.78	18.2	6.44	10.67	23.11	21.33	34.20	69.3	57.9	108.9	118.2
UMU V1b	10.22	16.33	19.2	5.89	9.89	19.89	19.67	31.67	60.3	45.9	78.5	103.8
TVR 20	12.39	18.45	20.6	5.45	11.22	14.39	19.33	27.00	38.2	42.3	73.5	85.6
UMU V2b	12.67	18.45	27.1	5.11	9.22	15.89	17.33	29.77	51.2	62.0	91.4	126.3
TVR 111	13.78	21.11	60.0	5.44	10.89	15.55	21.00	34.10	45.0	55.3	99.0	112.5
$LSD_{0.05}$	5.40	6.63	15.82	1.52	3.09	8.36	4.69	7.24	11.21	NS	NS	NS

Table 5: Rank summation index of quantitative trait in Vigna radiata of Nine (9) mungbean Genotypes

Genotypes	Days to 50% Germ	No of Flowers	Pod Lt (cm)	No of pods / plant	No of seeds /Pod	1000 Seed Wt (g)	Leaf Area (cm^2)	No of Leaves	No of Branches	PH at 4Wks (cm)	PH at 6Wks (cm)	RSI
UMU V1a	6.00(9)	25.8(2)	8.34(2)	15.0(6)	11.22(8)	67.3(1)	100.8(6)	32.33(5)	10.44(6)	18.0(1)	25.6(1)	48
UMU V2a	5.33(6)	17.3(6)	8.48(1)	13.9(7)	14.33(1)	32.0(7)	98.5(7)	32.33(5)	10.11(7)	14.67(4)	19.8(4)	62
TVR 194	4.33(2)	14.8(8)	6.59(5)	8.1(9)	12.55(2)	30.7(9)	96.0(8)	35.00(2)	11.00(3)	13.56(6)	19.17(5)	69
TVR 249	5.00(5)	18.0(5)	7.03(5)	12.7(8)	11.67(6)	38.7(6)	131.2(1)	37.57(1)	11.33(1)	16.00(2)	25.00(2)	48
IRAN	5.33(6)	16.7(7)	8.33(4)	24.8(1)	11.89(4)	54.0(3)	118.2(3)	34.20(3)	10.67(5)	15.89(3)	17.78(8)	50
UMU V1b	3.67(1)	12.7(9)	8.34(2)	24.4(2)	11.22(8)	67.3(1)	103.8(5)	31.67(7)	9.89(8)	10.22(9)	16.33(9)	62
TVR 20	4.67(3)	18.3(4)	6.64(7)	17.9(4)	11.89(4)	40.0(5)	85.6(9)	27.00(9)	11.22(2)	12.39(8)	18.45(6)	65
UMU V2b	4.67(3)	18.8(3)	6.53(8)	16.1(5)	12.45(3)	42.0(4)	126.3(2)	29.77(8)	9.22(9)	12.67(7)	18.45(6)	63
TVR 111	5.33(6)	21.7(1)	6.37(9)	22.2(3)	11.45(7)	32.0(7)	112.5(4)	34.10(4)	10.89(4)	13.78(5)	21.11(3)	60

PH = Plant height, RSI = Rank summation index, the values in bracket are the ranking for individual variables

Effect of Organic and Inorganic Fertilizer on Yield of Rice at NOUN Irrigation Scheme

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ABSTRACT

A field experiment was conducted with objective to find out the effect of combination of organic sources and inorganic fertilizer on crop productivity of rice cropping system at NOUN Fadama Irrigation site. Data showed that treatment T_6 produced significantly higher grain yield (5562, kg/ha) of rice yield than the other treatments. It may be concluded that organo-inorganic combination as integrated nutrient supply system is superior to use of inorganic fertilizers alone. Organic sources even in their moderate doses are capable of improving physical, chemical as well as biological properties of soil up to a considerable extent. Substitution of 50% N either through FYM or wheat straw or green manuring+50% RFR through inorganic fertilizers in rice is the best mechanism for raising crop productivity.

Keywords: organic fertilizer, inorganic fertilizer, crop productivity, irrigated rice

INTRODUCTION

Rice (*Oryza sativa* L.) plays a significant role in food security (Toungos, 2018). Rice is one of the major staple foods in Nigeria, consumed across all geopolitical zones and socioeconomic classes. Rice consumption is increasing rapidly in Nigeria because of the shift in consumer preference towards rice, increasing population growth, increased income levels, and rapid urbanization. It is commonly boiled and eaten with stew or vegetable soup. It is also used in the preparation of several local dishes that are eaten in every home, especially during festivals and ceremonies (Imolehin and Wada, 2004). However, for sustainable production of crops, it is inevitable that there is a need to balance the method of fertilizer application to our crops and soils (Toungos, 2018). Application of imbalanced chemical fertilizers has led to decline of nutrient use efficiency making fertilizer consumption uneconomical and producing adverse effects on environment. Prolonged use of chemical fertilizer hampers the sustainability of crop production and soil fertility. Imbalance use of chemical fertilizer alone tends to decline yield over a period of years with given input. All these factors led to search for alternative sources of plant nutrients. In this circumstance, nutrient recycling in the soil-plant ecosystem through judicious and efficient use of fertilizers and organic manures may play a vital role towards sustainable productive agricultural enterprise. Use of chemical fertilizers and organic manures has been found promising in arresting the declining trend in soil-health and crop productivity through the correction of marginal deficiencies of some secondary and micro-nutrients, micro-flora and fauna and their beneficial influence on physical and biological properties of soil. Integrated nutrient management system can bring about equilibrium between degenerative and restorative activities in the soil eco-system. Thus, keeping in view the above consideration the study was designed to study the effect of combination of organic sources and inorganic fertilizer on growth indices and crop productivity under rice cropping system in NOUN Irrigation Scheme.

MATERIALS AND METHODS

A field experiment was conducted to study the effect of organic and inorganic sources of fertilizer on the performance of rice. The trial was conducted during the dry seasons of two consecutive years, 2016/17 and 2017/18 at the Fadama Irrigation Research Site of the Faculty of Agricultural sciences, NOUN (11°39'N, 0827'; 500m above sea level) in the Sudan Savanna agro-ecological zone. The temperature during the period of trials ranged between 19.9 – 36.1°C while relative humidity was 29.9 – 39.3. The physio-chemical analysis for the three seasons indicated the soils to be sandy-loam, contained 1.2 – 2.1g kg^{-1} total N, 0.02 – 0.90 meq kg^{-1} available P and 0.04 – 0.37 exchangeable K. The experimental plot was provided with assured irrigation facility having uniform topography and proper drainage. The experiment was laid under RBD in four replications. Net plot size was 7.5 m x 4.35 m for rice and 7.5 m x 4.15 m for wheat. The spacing was 15 cm x 15 cm. 40 kg/ha in rice seed was used. Recommended dose of fertilizer (N, P and K) was 80:40:20 (kg/ha) in rice. Rice variety 'Faro 44' was used in the study. Well decomposed FYM (0.5% N) and wheat straw after threshing by a thresher used in the experiment. For green manuring (*Sesbania rostrata*) as green manure for lowland rice was used from which required quantity of twigs were chopped and incorporated during puddling as green manure. FYM and wheat straw were incorporated in soil 15 days ahead of transplanting time.

Full dose of phosphorus as DAP (18%N + 46% P_2O_5) and potash as muriate of potash (60% K_2O) was applied at the time of last ploughing. Nitrogen was applied through urea (46% N) in 3 splits as per the recommended practice, in which half was applied at transplanting of rice. Remaining half of N was top dressed in two splits as one fourth at active tillering and one fourth at panicle initiation stages in rice. About 25 days old seedlings were used in rice transplanting. Two seedlings per hill were transplanted keeping both inter and intra row spacing at 15 cm and 15 cm, respectively on 9th July during 1st and 2nd year of study.

Treatments

The experiment was conducted in randomized block design with four replications. Treatments comprised T_1 : Control *i.e.* no application of any manure/fertilizer to rice; T_2 : 50% RFR; T_4 : 75% RFR to rice; T_5 : 100% RFR to rice; T_6 : 50%N through FYM+50% RFR to rice; T_7 :25%N through FYM+75% RFR to rice; T_8 : 50% N through wheat straw+50% RFR to rice; T_9 : 25% N through wheat straw+75% RFR to rice followed by 75% RFR; T_{10}: 50%N through green manure (*Sesbania rostrata*) + 50% RFR to rice; T_{11} : 25% N through green manure (*Sesbania rostrata*) + 75% RFR to rice; and T_{12}: Farmers' practice ($N_{70}P_{30}K_{10}$) to rice.
The recommended dose of fertilizer for rice was 80 kg N+40 kg P_2O_5+20 kg K_20 ha^{-1}. Rice variety 'Faro 44' was transplanted at spacing of 15 cm × 15 cm using seed rate of 40 kg/ha. The soil of the experimental plot at the inception of the experiment during was well drained, sandy loam in texture, neutral in reaction, low in organic carbon and nitrogen and medium in phosphorus and potassium.

RESULTS AND DISCUSSION

Grain yield (kg ha^{-1})

Pooled data on grain yield (kg ha^{-1}) presented in Table 1 revealed that Integrated Nutrient Management (INM) practices (inorganic fertilizer and in combination with organic sources) significantly influenced the grain yield of rice.The highest grain yield (5562 kg ha^{-1}) was obtained in T_6 (50% N through FYM + 50% RFR) which was significantly superior to all the treatments except T_8 and T_{10}. The increase in grain yield was 41.38% over farmers' practice. The lowest grain yield (920 kg ha^{-1}) was recorded in control T_1 ($N_0P_0K_0$). The treatment T_{12} (farmers' practice) recorded grain yield of 3260 kg ha^{-1}. Use of 100% RFR (inorganic) recorded 4893 kg ha^{-1} grain yield, which was 33.37% more than farmers' practice. Data revealed that integrated use of FYM coupled with chemical fertilizers as in T_6 produced 12% higher grain yield in comparison to T_5 (100% RFR). Treatment T_5 and T_7 were at par with each other. Other organic sources for INM, T_7 and T_{10} were at par to each other. Therefore, among these three organic sources, substitution up to 50% N through FYM was found to be effective in INM practices. Higher availability of nutrients due to effect of organic sources leads to improve physiological and metabolic functions in the plant body. This might have been responsible for better expression of growth parameters. Better growth of plant, in turn, might have been responsible for bearing yield attributes in rice, the sum total of which was reflected in increased yield in both the crops (Ojobor, 2008). Organic sources especially in their moderate doses play the key role in enhancing efficient utilization of the native as well as added nutrients and in maintaining a balance between growth and yield attributes (Adeoye *et al.,* 2005). Amongst different organic sources, FYM has advantage over wheat straw in being fully decomposed before application. Similarly, in comparison with green manuring with *Sesbania rostrata*, FYM has higher quantum of organic matter capable of improving the physical and biological properties of soil. These advantages of FYM over wheat straw and green manuring with *Sesbania aculeate* might have been the prime factors responsible for higher yield under FYM substitution. FYM, as compared to wheat straw and green manuring with *Sesbania rostrata* has dominance of highly humified state (fulvic acid) of organic matter as well as relatively higher availability of macro and micro nutrients for improving the physical and chemical properties of soil. Wider C:N ratio of wheat straw than that of FYM or *Sesbania rostrata* also resulted in initial immobilization of soluble soil N and delayed decomposition, creating a shortage of plant available N and thus, resulting inferior yield. Similar result has been reported by Ram *et al.,* (2016).

CONCLUSION

It can be drawn that organo-inorganic combination as integrated nutrient supply system is superior to use of inorganic fertilizers alone. Organic sources *viz.,* FYM, wheat straw and green manuring of *Sesbania rostrata* can be used as a viable alternative through partial substitution of inorganic fertilizers. Organic sources even in their moderate doses substituting only 25% of recommended N in the base crop of the cropping system, are capable of improving physical, chemical as well as biological properties of soil up to a considerable extent. Substitution of 50% N either through FYM or wheat straw or green manuring+50% RFR through inorganic fertilizers in rice is the best mechanism for raising crop productivity. If FYM is not available, green manuring with *Sesbania rostrata* or wheat straw can be viable alternatives for substitution of inorganic fertilizers.

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Table 1: Effect of Integrated Nutrient Management practices on yield of the system (Pooled mean)

	Rice	Yield (kg ha^{-1})
T1	N0P0K0	920
T_2	50% RFR	2730
T3	50% RFR	2762
T_4	75% RFR	3571
T5	100% RFR	4893
T6	50% RFR+50% N through FYM	5562
T_7	75% RFR+25% N through FYM	5128
T8	50% RFR+50% N through (WS)	5361
T_9	75% RFR+25% N through (WS)	4946
T10	50% RFR+50% N through (GM)	5492
T11	75% RFR+25% N through (GM)	5106
T12	FP($N_{70}P_{30}K_{10}$)	
	SEm(±)	131.75
	CD at 5%	373.32

RFR: Recommended dose of fertilizer, WS: Wheat straw GM: Green manure, FP: Farmers' practice

Determination of Appropriate Plant Population for Optimum Performance of Castor (*Ricinus communis* L.)

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ABSTRACT
Appropriate plant population per hectare is a simple agronomic practice that can significantly increase crop seed yield per hectare. In castor, this is highly influenced by the varieties, environmental conditions and farming system. Therefore, this research was carried out to determine appropriate plant stand per hectare for optimum yield of a newly released castor variety (NCRICAS2) in Nigeria. The variety was evaluated on a replicated plots arranged in randomized complete block design. Plant stand per hectare considered were: 40000 (at plant spacing - 0.5m×0.5m), 33333 (0.6m×0.5m), 27777 (0.6m×0.6m), 26667 (0.75m×0.5m), 22222 (0.75m×0.6m), 17778 (0.75m×0.75m), 13333 (1m×75m), 10000 (1m×1m), 6666 (1.5m×1m) and 4444 (1.5m×1.5m) per hectare. Standard agronomy practices for castor were followed. Data were taken on days to flowering, days to first raceme maturity, height at maturity, number of racemes per plant and seed yield. From the results, the castor variety (NCRICAS2) yielded above 1000kg at plant population less than 33333 plant stands per hectare and recorded highest yield of 1485.83kg/ha at the plant population of 10000 per hectare. Days to flowering and days to maturity showed no significant difference among the treatments. Tallest plants were observed at the highest plant stands (40000) per hectare. The trend of the results revealed potential increase in castor yield at appropriate plant stands per hectare.
Keywords: Castor, Spacing, Population, Optimum yield

INTRODUCTION
Seed yield of castor can be increased through the adoption of improved agronomic practices (Gana 2015). In most castor growing regions, the main technologies employed are planting of appropriate varieties, excellent quality seeds, appropriate planting time, adequate irrigation systems, good soil fertilization, efficient weed and pest/disease management, optimum plant stand per hectare, and good harvest management (Severino *et al.* 2012). In India average seed yield range between 371kg/ha and 1,864kg/ha under different agronomic conditions was reported by Basappa (2007). Silva *et al.* (2007) reported average yield of 667kg/ha and 1,600kg/ha in the state of Parana in Brazil. Appropriate plant stand per hectare is a cheap agronomic practice that can significantly increase castor seed yield per hectare. However, number of plants per hectare is highly influenced in castor by type of varieties, environmental conditions and farming system. Thus, researchers tend to emphasize on the determination of appropriate number of plant stands per hectare that is best for a particular region across years and also those that are best for diverse environments. Therefore, this research was carried out to determine appropriate plant stand per hectare for optimum yield of a newly released castor variety (NCRICAS2) in Nigeria.

MATERIALS AND METHODS

The newly released castor variety was evaluated on a randomized complete block design considering 10 plant population densities at different plant spacing. Plant stand per hectare considered were: 40000 (at plant spacing - 0.5m×0.5m), 33333 (0.6m×0.5m), 27777 (0.6m×0.6m), 26667 (0.75m×0.5m), 22222 (0.75m×0.6m), 17778 (0.75m×0.75m), 13333 (1m×75m), 10000 (1m×1m), 6666 (1.5m×1m) and 4444 (1.5m×1.5m) per hectare. Plot size of 3m by 3m was used. Fertilizer at the rate of 60:60:30 NPK was applied. Weeding was carried out two times (4WAP & 8WAP) before the harvest. Adequate pest/disease control was ensured. Data were taken on days to flowering, days to first raceme maturity, height at maturity, number of racemes per plant and seed yield. The data were analyzed using analysis of variance and the means were separated using Least Significant Difference (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

Table 1 presents the results of performances of castor variety NCRICAS2 at different plant populations per hectare. The was no statistical differences in days to flowering and days to maturity among the treatments; however, the least days (76.33 days) to the first raceme maturity was observed at plant stands of 17777 per hectare. There were significant differences among the treatments for height at maturity, number of spikes per plant and seed yield. The seed yield ranged from 944.72 (kg/ha) and 1485.83 (kg/ha) among the treatments. The highest yield was observed at 10000 plant stands per hectare; however, this was not significantly different from the yield (1461.94 kg/ha) obtained at 17777 plant population. The trend of the results revealed potential increase in castor yield at appropriate plant stands per hectare. This result showed similar trend of reports in castor at different plant populations. Severino *et al.* (2006a), Severino *et al.* (2006b) and Carvalho *et al.* (2010) reported optimum plant populations of 5000 plant ha^{-1}, 4200 plant ha^{-1} and 12,500 plant ha^{-1}, respectively for castor cultivar BRS Nordestina in different locations. For cultivar Guarani, Bizinoto *et al.* (2010) reported population range between 10,000 and 22, 000 plants ha^{-1}. Soratto *et al.* (2011), in a study on castor, observed optimum population range of 55,000 to 70,000 plants ha^{-1}.

CONCLUSION

The results showed that the castor variety (NCRICAS2) yielded above 1000kg at plant population less than 33333 plant stands per hectare and recorded highest yield of 1485.83kg/ha at the plant population of 10000 per hectare. However, a confirmatory trial needs to be conducted to validate the results reported.

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Table 1: Agronomic performance of castor at different plant populations per hectare

Population	Plant Spacing	DF	DM	HM (cm)	RPP	SY (kg/ha)
40000	0.5m×0.5m	50.33	78.67	224.00	6.40	945.00
33333	0.6m×0.5m	47.33	77.00	178.80	5.13	944.72
27777	0.6m×0.6m	50.00	78.00	206.93	7.20	1288.33
26666	0.75m×0.5m	48.33	79.67	232.27	6.73	1247.22
22222	0.75m×0.6m	56.00	81.33	201.27	6.27	1237.78
17777	0.75m×0.75m	49.67	76.33	222.33	7.27	1461.94
6666	1.5m×1m	49.00	78.67	199.40	6.80	1332.78
4444	1.5m×1.5m	50.64	81.14	203.22	8.61	1275.43
13333	1m×0.75m	48.00	79.67	189.20	7.13	1073.33
10000	1m×1m	56.67	81.00	196.80	7.87	1485.83
Mean		**50.89**	**78.58**	**208.13**	**7.33**	**1321.73**
CV (%)		**9.29**	**5.30**	**14.47**	**12.27**	**20.87**
LSD		**NS**	**NS**	**18.00**	**1.01**	**114.34**

DF - Days to 50% flowering, DM - Days to first raceme maturity, HM - Height at maturing. RPP - Raceme per plant, SY – Seed Yield

Evaluation of Fungicides Treatment on the Control of Ginger Leaf Spot

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ABSTRACT

Ginger (Gingiber officinales) is an important spice crop grown in tropical and sub-tropical regions of the world. It is one of the most important spice crops traded internationally and domestically. One of the major constraints to ginger production in Nigeria is the leaf spot disease caused by Phyllosticta zingiberi *which has resulted to significant reduction in yield. This study was conducted during the wet seasons of 2012 and 2013 to evaluate the control of ginger leaf spot by fungicide application and the yield benefit. The UG1 and UG2 varieties were used and the field plots were laid out in a randomized complete block design (RCBD) in three replications. Three treatments comprising of two fungicides (Z-force and Benlate) compared for their efficacy in leaf spot control and their yield benefit over no fungicides treatment (control) were used. Leaf spot severity was assessed by percentage plant area infected, and yield data (rhizome yield) was collected at harvest. Data collected were subjected to statistical analysis using SAS application. The result indicated that the fungicide treatments differ significantly in their effect on leaf spot severity compared to non-fungicide treatment with Z-force performing better than Benlate. There was a negative relationship between rhizome yield and leaf spot severity in the two years of assessment. This is an indication of the potential of ginger leaf spot severity to cause reduction in the rhizome yield, hence the need for implementing control measure. Fungicide treatment resulted in some significant reduction in leaf spot severity indicating that fungicidal treatment could be used in managing this disease.*

Keywords: Ginger, Z-force, Benlate, treatments

INTRODUCTION

Ginger *(Zingiber officinale)* is grown in tropical and sub-tropical regions of the world, because of the spice and medicinal values of the rhizome. It is one of the most important spice crops traded internationally and domestically. India is a leading producer of ginger in the world (Medhi *et al.,* 2012). Ginger cultivation is affected by many diseases like: soft rot, bacterial wilt, leaf spot and one of the major constraints to ginger production in Nigeria is the leaf spot disease. Ginger leaf spot is caused by *Phyllosticta zingiberi* and the disease is noticed on the leaves from July to October. During the recent years the disease has become significantly important due to its severe leaf spotting which destroys the chlorophyllous tissues which in turn, leads to significant yield reduction and for this reason; it is considered as a destructive foliar disease of ginger (Singh *et al*., 2000). The disease is widespread in all the ginger-growing area, and it is characterized by numerous circular or elongated yellow spots on the leaves. The disease starts as water soaked spot and later turns as a white spot surrounded by dark brown margins and yellow halo. At a later stage, the spots enlarge and turn brown with white papery centers. Some portions of the white areas may drop off, producing a shot-hole effect. Infected leaves may be torn into shreds, causing withering and premature death of plants. The pathogen survives through pycnidia even up to 14 months (Brahma and Nambiar, 1982; Brahma and Nambiar, 1984). Factors like air, temperature, relative humidity and rainfall influence the incidence of this disease to an extent of 85.5% (Sood and Dohroo 2005). Continuous cultivation of ginger on the same field helps in build-up of higher concentration of inoculums (Singh, 2015). Senapati *et al*. (2012) observed that incidence of leaf spot disease was less for the plants grown under partial shade or as intercrop with coconut. Early infection of the plant leads to drastic reduction in rhizome yield (Singh, 2015). This study was conducted to evaluate the control of ginger leaf spot by fungicide application and the yield benefit.

MATERIALS AND METHODS

This work was conducted during the wet seasons of 2012 and 2013 at the Research farm of National Root Crops Research Institute Umudike. Field plots were laid out in a randomized complete block design (RCBD) in three replications. The varieties of ginger rhizomes used were UG1 and UG2 and the rhizomes were sown by hand with a spacing of 50cm by 50cm at one rhizome per hole. All other agronomic practices were observed. A total of three treatments comprising of two fungicides (Z-force and Benlate) compared for their efficacy in leaf spot control and their yield benefit over no fungicides treatment (control). Application of treatments commenced immediately the first symptom of leaf spot was noticed and spraying was done with a knapsack sprayer fitted with a T-jet nozzle at weekly interval for 3 weeks. Leaf spot severity was assessed by percentage plant area infected, and yield data (rhizome yield) was collected at harvest. Data collected were subjected to statistical analysis using SAS software package.

RESULTS AND DISCUSSION

***Effect of treatments on Leaf Spot Severity*: ** The leaf spot variance analysis showed that the fungicide treatments differ significantly in their effect on leaf spot severity (Table 1). Generally, the Z-force treatment was more effective in reducing the severity of leaf spot compared to the Benlate treatment. Both treatment significantly reduced leaf spot treatment when compared to non-fungicide treatment.

***Relationship between Rhizome Yield (Kg/ha) and Ginger Leaf Spot Severity*:** There was generally a negative relationship between rhizome yield and leaf spot severity in the two years of assessment. This is an indication of the potential of ginger leaf spot severity to cause reduction in the rhizome yield. The observed negative relationship was however only significant in the second year (Table 2).

CONCLUSION

Increasing leaf spot severity was observed to have negative impact in the rhizome yield, hence the need for implementing control measure. Fungicide treatment resulted in some significant reduction in leaf spot severity indicating that fungicidal treatment could be used in managing this disease. Z- force fungicide performed better than Benlate in reducing ginger leaf spot.

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Table 1: Effect of fungicide treatments on the variability of ginger leaf spot severity

Source	DF	MS	Value	Pr > F
YEAR (Y)	1	15.32	0.14	0.7106
GENOTYPE (G)	1	183.24	1.66	0.2016
Y*G	1	13.36	0.12	0.7290
FUNGICIDE (F)	2	1610.43	14.56	0.0001
Y*F	2	229.99	2.08	0.1314
G*F	2	64.18	0.58	0.5620
Y*G*F	2	16.31	0.15	0.8631

Table 2: Relationship between rhizome yield (Kg/ha) and leaf spot severity in 2012 and 2013

	2012	2013
Mean Leaf Spot severity (%)	44.17	46.15
Rhizome yield (Kg/ha)	6.17	4.96
Coefficient Correlation	-0.1269 ns	-0.5224 ***

Storage Root Yield Trial and Response of Exotic Orange Fleshed Sweetpotato Genotypes to Biotic Stresses in Two Different Environments of Umudike, Southeast Nigeria

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ABSTRACT
The experiment was conducted in Umudike southeastern Nigeria with the objectives to increase the genetic base of sweetpotato varieties in Nigeria through crop introduction and to select varieties for adaptability and high storage root yield. The experimental design was a randomized complete block with three replications. The experimental plots had three rows with 10 plants per row arranged in planting spacing of 1.0 m between rows and 0.30 m between plants in two environments in the same experimental site. Field experiments included one check variety and 13 exotic orange fleshed sweetpotato genotypes. Data collected were on: fresh weight of total storage root, fresh weight of large roots, and fresh weight of small storage root. All yields measured in tons per hectare. Data collected were subjected to analysis of variance (ANOVA) using SAS (2003) computer package. Standard Error of Difference Means were used for means separation. Results indicated that the 3 exotic orange fleshed sweetpotato genotypes nominated for producing storage root superiority than the check variety UMUSPO/3 (1.20t/ha) were: Namanga (1.45 t/ha), Erica (1.35t.ha) and NASPOT8 (1.85), These varieties also had very low response to sweetpotao biotic stresses in the field. This was a good trait that could be incorporated into the local germplasm during gene recombination and thereby increase the genetic base of the local germplasm.
Keywords: Root yield, exotic sweetpotato, disease resistant and SPVD

INTRODUCTION
Introduction of exotic varieties is one of the methods of crop improvements. Genetic diversity found in exotic varieties are utilized to develop, improved and enhance local varieties for desirable traits required by farmers, consumers and industrialists. Exotic varieties are being evaluated to identify varieties which will ensure crops that perform under local conditions. This will contribute to the country's food security as it is a cost-effective for increasing nutritional value of the people. As population continued to increase, specially introduced high yielding disease resistance/tolerant varieties need to increase food production for the teeming population. These introduced new crop varieties not only that they perform well in their native lands, they need to be able to yield and mature in several environments outside their native land allowing for global access of their excellent performance. The major economic importance of exotic sweetpotato genotypes is their storage roots. Storage root yield is the primary trait for selection in breeding programmes that aimed at both increasing yield potential and adaptation to biotic stress environments such as weevil prone environments (Gasura *et al*, 2008). Gruneberg et al (2005) reported that Multi-site field environments are conducted in order to study the adaptation of lines to the target environments. The combination of yield data with data regarding secondary traits in environments ranging from less biotic stressed environments to high biotic stressed environments allows one to ascertain the adaptability of

genotypes to a wide range of conditions. At this level, selection is mostly based on important commercial traits. Data on secondary traits are used to explain the genotype by environment interactions especially when the heritability of the secondary traits is higher than that of the yield data and the genetic correlation of these traits with yield in the target environment is high (Gurmu *et al,* 2013). Therefore, the objectives of this study were: to increase the genetic base of sweetpotato varieties in Nigeria through crop introduction and to select varieties for adaptability and high storage root yield.

MATERIALS AND METHODS

The planting material was taken from virus-free mother plants grown in field nursery. The experimental material consisted of exoticsweetpotato clones of diverse origins received from CIP platform in Kenya and Uganda. The experimental design was a randomized complete block with three replications. The experimental plots had three rows with 10 plants per row arranged in planting spacing of 1.0 m between rows and 0.30 m between plants. Total number of environments comprised the two years in the same experimental site. Field experiments included one check as reference variety and13 exotic orange fleshed genotypes. Data collected were on: fresh weight of total storage root, fresh weight of large roots, fresh weight of small storage root. All yields measured in tons per hectare. Data collected were subjected to analysis of variance (ANOVA) using SAS (2003) computer package. Standard Error of Difference Means were used for means separation.

RESULTS AND DISCUSSION

The result of the stand count and number of storage roots produced by the exotic sweetpotato genotypes evaluated are presented in Table 1.

***Stand count at harvest*:** The stand count of the exotic sweetpotato genotypes at harvest varied significantly ($P<0.01$) in the two years. In 2019, stand count at harvest varied from 5.0 to 17.0 stands with mean of 12.1 while in 2020, stand count varied from 2.0 to 14.0 with mean of 8.4 which indicated that more sweetpotato plants survived up to harvest in 2019 than in 2020 as to contribute to number and weight of storage root yield. This also showed that 2019 environmental factors were conducive for the sweetpotato plant survival than in 2020. The combined mean stand count for the two years indicated that stand count significantly ($P<0.01$) varied from 5.0 to 14.0 stand count at harvest with grand mean of 10.3. However, NASPOT 11 had the highest stand count at harvest with the rank of 1st followed by Malinda, Delvia and Lourdes with rank of 2nd while Tio-Joe was ranked 14th which was last. Stand count at harvest contributed to the yield of the crop and an indication that the crop can adapt to the environment. Nwankwo 2012). in his work on genotype by environment interaction reported that a genotype can be said to be adapted when it responds very well to a location, geographical areas, farming practices or other factors that can be controlled by selection such as environment. He further observed that when a variety performs well in a target environment in terms of high yield and vegetative growth, it can be said that it had adapted.

***Weight of Fresh storage root*:** The fresh storage root weight of different categories of the sweetpotato roots excluding the feeder roots are presented in Table 2. This included the total fresh storage root weight, fresh storage large root weight and fresh storage small root weight.

***Fresh weight of total storage root*:** The total storage fresh root weight of the exotic sweetpotato varieties varied from 1.2t/ha produced by NASPOT 11 to 5.1t/ha as was produced by Tio-Joe with grand mean of 3.2t/ha. The rank as at 2019 showed that Tio-Joe was ranked 1st, followed by Namanga 2nd while NASPOT11 was last ranked 14th. In 2020, the total storage fresh root weight significantly ($P<0.01$) varied form 0.0t/ha for most varieties to as high as 7.8t/ha (UMUSPO/3) with grand mean of 1.1t/ha. The ranking showed that UMUSPO/3 ranked 1st followed by Erica which was ranked 2nd while six of the exotic sweetpotato varieties were last with the rank of 14th. However, the combined mean analyses indicated that high significant ($P<0.01$) total fresh weight of storage roots varied significantly from 0.61t/ha (NASPOT11) to as high as 4.8t/ha (UMUSPO/3) with grand mean of 2.2t/ha. The ranking showed that UMUSPO/3 was 1st followed by Erica 2nd while NASPOT 11 was last with the rank of 14th. For the two environment, 2019 with grand mean of 3.2t/ha performed better than the total weight of fresh storage roots obtained in 2020 which had grand mean of total fresh storage root weight of 1.1t/ha.

***Fresh weight of large storage roots*:** Fresh weight of large storage roots had high significant (P<0.01) variation of 0.2t/ha (NASPOT11) to 6.2t/ha (Tio-Joe) with grand mean of 1.8t/ha as was observed in 2019. The fresh weight of large storage roots in 2020 significantly (P<0.01) differed among the varieties with weights ranging from 0.0t/ha to 6.2t/ha with grand mean of 0.66t/ha. However, the combined analyses for the two year for fresh weight of large storage roots significantly (P<0.01) varied from 0.1t/ha (NASPOT 11) to 3.65t/ha with grand mean of 1.23t/ha. The major aim of breeding programmer is to breed and select varieties with commercial traits. Commercial trait in this context was to breed for large storage root yield with weights that generate income for the farmers. Varieties with large fresh storage weight root yield less than the check varieties should not be selected. The result also indicated that the fresh weight of large roots in 2019 which had mean weight of 1.8t/ha did better than that in 2020 cropping season which had mean fresh weight of storage root of 0.66t/ha. This may be attributed to good climatic factors that prevailed in 2019.

Fresh weight of small storage roots: The result in Table 2 showed high significant (P<0.01) variation in the weight of small storage roots for the two years. The weight of small storage roots varied from 0.7t/ha (UMUSPO/3) to 3.1t/ha (NASPOT8) with mean of 1.3t/ha in 2019. In 2020, the fresh weight of small storage roots significantly ranged from 0.0t/ha for many of the varieties to 1.6t/ha (Erica) with mean of 0.39t/ha. Varieties with very heavy weight of small storage roots higher than the grand mean of 0.39t/ha should not be selected. Heavy weight of small roots is not a good index for selection. Heavy weight or high number of small storage roots is an indication of poor soil due to very low soil nutrient, poor genetic expression of the crop which may result due to poor agronomic management such as lack of weed control and climatic factors due to little or limited rainfall. However, the combined analyses for the small storage root weight for the two years indicated that high significant (P<0.01) differences in the fresh weight of small roots which ranged between 0.4t/ha for Irene and NASPOT 12 to 1.85t/ha for NASPOT 8. The result further indicated that the fresh weight of small storage roots in 2019 with mean of 1.3t/ha was higher than that produced in 2020 which had mean weight of 0.39t/ha. The heavy weight of small storage roots in 2019 with presumed favourable climatic conditions and agronomic management indicated that these exotic sweetpotato varieties were not adaptable in terms of storage root yield to the soil in the target environment and therefore should not be selected.

Biotic responses of the exotic sweetpotato genotypes

The results in Table 2 on the biotic response of the exotic OFSP varieties evaluated indicated that all the varieties responded negatively to SPVD with mean score of 1.2. Sweetpotato virus disease is a deadly disease that reduces the yield of orange fleshed sweetpotato by 90% except the Check variety UMUSPO/3 which had disease score rate of 3.4. This quality could be used to improve the performance of UMUSPO/3 which has more deep orange colour than most of the exotic varieties. All the varieties also responded negatively to Leaf Spot disease (Score 1.1) a fungal disease that reduces the photosynthetic area of the leaves thereby causing yield loss in sweetpotato (Jill, 1990). Nematodes and root rot diseases were not observed to be a problem (with mean score of 1.1 respectively) at the time of harvest despite the high rainfall. However, there were mild attack of sweetpotato root weevil (mean score of 1.3) at the time of harvest. This may be as a result of late harvest of the varieties which fall at the time of dry period. This mild attack indicated that the varieties should be harvested early immediately the crop matures. Very late harvesting of these varieties would lead to yield loss.

CONCLUSION

Based on selection differential on number of large storage roots and fresh weight of large roots, 3 exotic orange fleshed sweetpotato genotypes were nominated for producing storage root superiority than the check variety UMUSPO/3 (1.20t/ha). The varieties were: Namanga (1.45 t/ha), Erica (1.35t/ha) andNASPOT8 (1.85), These varieties also had very low response to sweetpotao biotic stresses in the field. This was a good trait that could be incorporated into the local germplasm during gene recombination and thereby increase the genetic base of the local germplasm. These exotic materials can now be conserved at the Genetic Resource Unit of the institute for their other good qualities such as resistant to sweetpotato virus disease, leafspot, resistant to nematodes and large above ground biomass which is of breeding value.

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Table 2: Combined mean analysis for two years of biotic response of the exotic OFSP varieties evaluated 2019 and 2020

	Foliar diseases		Root pests		Disease
Genotype name	**SPVD**	**Leaf spot**	**Nematodes**	**Root weevil**	**Root rot**
Malinda	1.1	1.1	1.1	1.3	1.1
Namanga	1.2	1.1	1.1	1.2	1.1
Sumaia	1.1	1.1	1.1	1.3	1.1
Lourdes	1.0	1.1	1.1	1.2	1.1
Erica	1.1	1.1	1.1	1.3	1.1
Amelia	1.2	1.1	1.1	1.2	1.1
NASPOT8	1.2	1.1	1.1	1.3	1.1
Delvia	1.1	1.1	1.1	1.2	1.1
Irene	1.1	1.1	1.1	1.3	1.1
NASPOT12	1.2	1.1	1.1	1.4	1.1
Tio-Joe	1.1	1.1	1.1	1.3	1.1
NASPOT11	1.1	1.1	1.1	1.2	1.1
Gloria	1.1	1.1	1.1	1.3	1.1
UMUSPO/3	3.4	1.1	1.1	1.4	1.1
Mean	**1.2**	**1.1**	**1.1**	**1.3**	**1.1**

Table 1: Fresh storage root weight of the exotic sweetpotato varieties and their Ranking in different environments

Varietal name	Total fresh weight of total storage roots (t/ha) 2019	Total fresh weight of storage roots (t/ha) 2020	Mean fresh weight of total storage root for two years	Fresh weight of large storage roots (t/ha) 2019	Fresh weight of large storage roots (t/ha) 2020	Mean fresh weight of large storage root for two years	Fresh weight of small storage roots (t/ha) 2019	Fresh weight of small storage roots (t/ha) 2020	Mean fresh weight of small storage root for two years
Malinda	3.1	0.62	1.86	2.0	0.4	1.20	1.1	0.02	0.56
Namanga	5.1	0.0	2.55	2.2	0.0	1.10	2.9	0.0	1.45
Sumaia	3.1	1.9	2.50	1.6	0.9	1.25	1.5	1.0	1.25
Lourdes	2.5	1.6	2.05	1.1	0.6	0.85	1.4	1.0	1.20
Erica	3.2	2.4	2.80	2.1	0.8	1.45	1.1	1.6	1.35
Amelia	2.7	0.0	1.35	0.9	0.0	0.45	1.8	0.0	0.9
NASPOT8	4.2	1.0	2.60	1.1	0.4	0.75	3.1	0.6	1.85
Delvia	3.6	0.01	1.81	3.1	0.0	1.55	1.5	0.01	0.76
Irene	1.8	0.0	0.9	1.0	0.0	0.50	0.8	0.0	0.40
NASPOT12	2.8	0.0	1.40	2.0	0.0	1.00	0.8	0.0	0.40
Tio-Joe	7.2	0.0	3.60	6.2	0.0	3.10	1.0	0.0	0.50
NASPOT11	1.2	0.01	0.61	0.2	0.0	0.1	1.0	0.01	0.51
Gloria	2.9	0.0	1.45	1.7	0.0	0.85	1.2	0.0	0.60
UMUSPO/3	**1.8**	**7.8**	**4.80**	**1.1**	**6.2**	**3.65**	**0.7**	**1.6**	**1.20**
Mean	3.2	1.1	2.20	1.8	0.66	1.23	1.3	0.39	0.92
Range	1.2-7.2	0.0-7.8	0.61-4.8	0.2-6.2	0.0-6.2	0.1-3.65	0.7-3.1	0.0-1.6	0.4-1.85
S E M	1.9	1.08	1.53	1.4	0.84	1.15	1.20	1.18	1.00
Sig, Level	P<0.01	P<0.01	P<0.01	P<0.05	P<0.01	P<0.01	P<0.01	P<0.01	P<0.01

Utilizing Harvest Index for the Selection of High Storage Root Yielding Sweet Potato Landraces for Commercial Sweet Potato Production

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ABSTRACT
The experiments were conducted in 2019 and 2020 cropping seasons. Seventeen sweet potato landraces were evaluated in Umudike, Abia State and Otobi Benue State with the objective to select sweet potato landraces with high harvest index. The experiments were designed in a randomized complete block design (RCBD) replicated three times. A plot consisted of 30 stands of sweet potato genotypes planted 30cm apart within row and 100cm between rows on the ridges. Data collected were on root yield components such as: total number of storage root and weight of total roots. Other data collected were weight of above ground biomass. Data were analyzed using standard ANOVA Techniques. Results indicated that varieties with high harvest index as yield criterion per unit area was used for selecting high storage root yielding variety/varieties. The following varieties were selected as high yielding and were recommended for registration and release for farmers for commercial storage root production: Ex-Igbariam (0.3), Nwoyorima (0.3), Buttermilk (0.4) and Solo-Abuja (0.5).

Keywords: Sweet potato, landraces, harvest index, high yielding, commercial roots

INTRODUCTION
Sweet potato landraces adapted to their local areas have developed resistance to local entomological and pathological stresses. These sweet potato landraces have gained recognition from farmers as a result of their good qualities and farmers depend on them for survival. Sweet potato landraces are of immerse importance to crop improvement in that they could be used for genetic recombination, commercial sweet potato storage roots and seed vine production and for export. The potential contributions of the various sweetpotato landraces to food, medicine, research, crop improvement and for industrial utilization have not been properly documented in Nigeria due to their non-release as varieties. The yield and morphological attributes of these sweet potato landraces should be documented for official recognition, registration and release as varieties. Stathers *et al*. (2005) observed that these sweet potato landraces are farmers best varieties and as such, they should be conscientiously conserve, protect and maintained in the nation germplasm for the greater benefit of mankind. Farmers are well placed to take responsibility for the improvement of local landraces and this is generally considered a straightforward activity. Selection of seed for next season's planting is also a form of improving local landraces (Paolo, 2009). It is most effective in cross-pollinating crops and can be readily adopted by individual farmers. In self-pollinating crops, like rice, local landraces are improved by occasionally practicing line selection. This more usually occurs as a collaborative activity within communities with farmers sharing the results. Kreuze (2002) noted of a growing concern, which is the effects of institutionally bred, genetically uniform, modern varieties on farmer seed systems, as this was leading to genetic erosion and creating dependency and loss of ownership of farmers over their sweet potato landraces. They stressed the importance of farmer seed systems as a reliable, robust and major source of seeds especially for resource poor

farmers who depend on the sweet potato landraces and highlighted the need to protect farmers' ownership and control over the sweet potato genetic resources which they have nurtured, and on which they depended upon for survival. Famers are self-reliant and competent in selecting and managing genetic diversity in the sweet potato landraces. In both cross and self-pollinating crops, attention has to be given to achieving the appropriate selection intensity. That has been how farmers select the best sweet potato landraces for cultivation. This requires proper sweet potato seed vine production practices, involving pre- and/or post-harvest selection prior to harvesting the sweet potato seed vine for the next planting season. The objectives of this study was to select sweet potato landrace with high harvest index.

MATERIALS AND METHODS

The experiments were conducted at the National Root Crops Research Institute (NRCRI) Umudike, Abia State and Otobi substation Benue State in 2019 and 2020 cropping seasons. Seventeen sweet potato landraces were evaluated. Umudike, Abia State is located in the rainforest agro-ecology of Southeastern Nigeria, while Otobi, Benue State situates in derived Savannah agro-ecology of North central Nigeria. The experiments were designed in a randomized complete block design (RCBD) replicated three times. A plot consisted of 30 stands of sweet potato genotypes were planted 30cm apart within row and 100cm between rows on the ridges. The following data were collected on root yield components such as: total number of storage roots which were made up of, number of large roots and number of small roots. Total weight of storage roots; also made up of weight of large roots and weight of small roots. Other data collected were weight of above ground biomass (fresh foliage yield cut at soil level). Data were analyzed using standard analysis of variance (ANOVA) techniques.

RESULTS AND DISCUSSION

The yield components such as the total number of storage roots which included number of large storage roots and number of small storage roots, are given in Table 1, while the total storage root weight which were made up of: weight of large roots and weight of small roots plus the above ground biomass yield of the white fleshed sweet potato landraces are presented in Table 2.

Total number of storage root: The combined mean for total number of storage roots in the two locations varied significantly ($p<0.01$) from 4.0 produced by Tina to 22.0 roots produced by TIS87/0087 a check variety with grand mean of 6.9 roots/plot. However, in the two locations, total number of storage roots differs significantly ($p<0.01$). For instance, in Umudike, TIS87/0087 produced the highest total number of storage roots (26 storage roots/per plot) followed by Buttermilk (18 storage roots/per plot) while Johnny variety produced the least number of total mean storage roots yield (2.0 roots/per plot and 8.8 storage roots/plot. While in Utobi, Buttermilk gave the highest number of total roots (22.0 storage roots/per plot) followed by TIS87/0087 (18.0 storage roots/per plot) while the least total number of storage roots was produced was by Erima (4.0 storage roots/per plot) and Chinyere (9.0 storage roots/per plot). Variety with highest total number of storage roots were selected as high yielding variety. However, high number of total storage roots in sweet potato is a function of high yielding variety and a good index for selection. Number of storage roots for the farmer is an indication of yield function of a crop but does not indicate the amount of fresh matter accumulation of the crop. However, the weight of the fresh matter of the storage root in tons per hectare showed the estimated amount of fresh matter accumulation of the sweet potato crop.

***Total weight of storage roots*:** The fresh matter yield is the weight of the storage root yield of the varieties evaluated. Weight of fresh matter yield in Umudike varied significantly ($p<0.01$) from 0.2t/ha produced by Tina to 16.8t/ha yielded by TIS87/0087 (check variety) with mean of 4.2t/ha. In Utobi, the total storage root weight ranged from 0.1t/ha yielded by Erima variety to as heavy as 10.0t/ha as yielded by TIS87/0087 a check variety with mean of 3.5t/ha. The combined total storage root yield weight of the varieties evaluated varied significantly

(P<0.01) which range from 0.5t/ha for Erima and Chinyere respectively to as heavy as 13.7t/ha as produced by TIS87/0087. The result indicated that TIS87/0087 is the variety with heaviest fresh matter accumulation while Tina and Chinyere had lowest fresh matter accumulation in the two locations. However, high storage root yield of sweet potato variety alone is not enough criterion for selecting high weight of storage root yielding variety without using the harvest index as yield per unit area for selecting high yielding variety.

***Harvest index*:** This is the ratio of storage root yield and above ground biomass. High storage root yielding varieties has high harvest index. Harvest index refers to the storage root yield per unit area. Harvest index could be used to select high yielding varieties. One of the limiting factors of sweet potato landraces are low yield in terms of number of storage roots per stand or in terms of fresh matter accumulation per unit area. The harvest index could be used to select high yielding varieties among the varieties evaluated. Significant (p<0.01) variation in the harvest index was observed among the varieties tested and these ranged from 0.1 for most varieties to as high as 0.5 with mean of 0.2 (Table 1). High harvest index variety accumulate large amount of fresh matter within short period of the growing season. Based on this result, it indicated that Solo-Abuja has high yielding per unit area.

CONCLUSION

High number of storage root and high storage root weight are not good indices for selecting sweet potato varieties for high yielding. Harvest index as yield criterion per unit area was used for selecting high storage root yielding variety/varieties. The following varieties with harvest index above the grand mean were selected as high yielding and were recommended for registration and release for farmers for commercial storage root production: Ex-Igbariam (0.3), Nwoyorima (0.3), Buttermilk (0.4) and Solo-Abuja (0.5).

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Table 1: Above ground biomass and total number of storage root yield

	Total number of storage roots/plot			**Above ground biomass yield (t/ha)**		
Varietal name	**Abia**	**Benue**	**mean**	**Abia**	**Benue**	**mean**
Ex-Igbariam	5	7	6.0	2.0	10.0	6.0
Solo-Abuja	8	5	6.5	3.5	2.0	2.8
Erima	6	4	5.0	4.2	2.2	3.2
Solo-1	3	6	4.5	4.8	7.2	6.0
Nwoyorima	16	9	12.5	20.6	19.1	11.9
Buttermilk	18	22	20.0	23.2	25.1	24.1
Kwara	9	13	11.0	11.9	16.0	14.0
Maxa	7	9	8.0	10.3	13.2	11.8
Nkwori	4	6	5.0	12.1	16.4	14.3
Centinma	6	5	5.5	10.6	11.9	11.2
Jonny	2	7	4.5	3.3	13.2	8.3
Tina	3	5	4.0	5.1	9.2	7.2
Chinyere	6	4	5.0	11.3	7.7	9.5
TIS8164	13	15	14.0	24.7	20.2	22.5
TIS87/0087	26	18	22.0	39.9	23.9	16.8
Mean	8.8	9.0	6.9	12.5	13.1	4.2
Range	2-26	4-22	4-22.0	2-39.9	2-25.1	2.8-24.1
S.E.D	3.1	3.1	=	3.7	3.3	=
Pro. level	P<0/01	P<0.01	=	P<0/01	P<0.01	=

Table 2: The combined mean Harvest index and Mean storage root weight yield components of the white fleshed sweetpotato landraces in the two locations

Varietal name	Abia	Benue	Mean	Harvest index (HI)
Ex-Igbariam	1.6	1.8	1.7	0.3
Solo-Abuja	1.8	1.2	1.5	0.5
Erima	0.6	0.1	0.5	0.2
Solo-1	0.5	0.9	0.7	0.1
Nwoyorima	9.2	4.0	6.6	0.3
Buttermilk	7.7	9.8	8.8	0.4
Kwara	12.3	13.0	2.7	0.2
Maxa	1.9	2.0	1.9	0.2
Nkwori	0.7	0.8	0.8	0.1
Centinma	0.8	0.4	0.6	0.1
Jonny	0.3	1.1	0.7	0.1
Tina	0.2	0.9	0.6	0.1
Chinyere	0.8	0.2	0.5	0.1
TIS8164	7.2	6.4	6.8	0.3
TIS87/0087	16.8	10.6	13.2	0.4
Mean	4.2	3.5	3.2	0.2
Range	0.2-16.8	0.1-13.0	0.3-13.2	0.1-0.5
S.E.D	2.1	1.9	=	=
Pro.level	P<0/01	P<0.01	=	=

Effects of Seedbed, Cover Crops and Densities on Growth and Yield of Yam in Yam /Maize / Cassava Intercrop at Ishiagu, Ebonyi State, Nigeria

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ABSTRACT
A two-year field experiment was carried out at the Teaching and Research Farm of the Federal College of Agriculture Ishiagu- Ebonyi State during the 2014 and 2015 planting seasons, to determine the effect of seedbed, cover crop species and densities on the growth and yield of yam in yam/cassava/maize intercrop. The study was a split -split plot experiment fitted into randomized complete block design and replicated three times. The main plot was seedbed consisting of ridge and flat, the sub plots were cover crop species of egusi melon, pumpkin and sweet potato, the sub-sub plots were cover crops densities of 0, 10,000, 20,000 and 30,000 plants/ha. Data were collected on the following parameters, yam vine lengths and yield of yam tubers. Collected data were subjected to analysis of variance (ANOVA) and significant means separated using least significant difference (LSD) at 5% probability level. Seedbed had no significant effect on yam vine length while cover crop species significantly affected the yam vine length. Density of cover crops had no significant effect on yam vine length. Seedbed, cover crop and density interaction was not significant. Density of cover crops significantly (P=0.05) reduced the yield of the yam tubers for the two growing seasons at a. However, other treatments did not improved yam yield for the 2014 but were effective in 2015.
Keywords: Seedbed, Cover crop species, Density, Intercrop, Yield, Ishiagu

INTRODUCTION
Seedbed preparation is the most important operation in crop production system. It involves the use of imparted forces to change the soil properties using technical operations like ploughing and harrowing It is the pulverization of the soil to obtain a fine tilt for seed germination, root anchorage and nutrient absorption (Reddy 2012). Seedbed preparations control weeds, provide suitable seed bed for the crop plants, incorporate crop residues into the soil, make the soil loose, enhance chemical reaction and improves the physiochemical conditions of the soil which in turn affect the growth and the development of crop plants (Rahman *et al.*, 2004). However, it might have a possibility of depletion of nutrients and soil organic matter due to deep ploughing and excessive pulverization. Therefore, tillage/seedbed preparation in terms of number of passes and depth of tillage / beds should be examined for better crop productivity and soil fertility. Intercropping is the growing of two or more crops in close proximity simultaneously in a definite pattern, rows or set of rows within the same plot (Ouma and Jeruto, 2010). It is aimed at maximizing plant cooperation rather than plant competition for maximum crop yield per unit area (Sullivan, 2001). The most common goal of intercropping is to produce a greater yield on a given piece of land, making use of resources or ecological processes that would otherwise not be utilized by a single crop (Altieri and Liebman, 1986). Intercropping gives higher income per unit area than sole cropping. It acts as an insurance against crop failure in abnormal year. Intercropping maintains soil fertility as nutrient uptake is made from both upper and lower layers. It has been reported that pumpkin,

cucumber and water melon are the most popular vegetable crops intercropped with other staple cereal crops, being vine prostrate and dense crops have the potential to act as live mulch to suppress weed germination. Thus this experiment was designed to study the effect of seedbed type, cover crop species and density on the growth and yield of yam in an intercropping system.

MATERIALS AND METHODS

The experiment was carried out at the Teaching and Research Farm of the Federal College of Agriculture Ishiagu located in the southern part of Ebonyi State and lies on Latitude 5^0 57^1N and longitude 7^0 34^1E with a mean annual rainfall of 1350mm with average humidity of 88% and a mean annual temperature of 29^0C (FCAI, 2009) and with a gentle slope topography. The soil of the study area is ultsoil, with vegetation typical of the derived savannah ecological zone of Nigeria. The area has a tropical wet and dry climate with mean annual temperature of 29^0C and 1350mm of rain fall (Nwite *et al*., 2008). The land was slashed manually, ploughed and harrowed. The plots were made into ridges as treatments A1and flats as treatment A2.

Experimental design and treatments

The experiment was a split –split plot arrangement laid out in a randomized complete block design, replicated three times. The seedbed as the main plot treatments had ridges and flats. The cover crop was the sub plot treatment, made up of egusi melon, sweet potato and pumpkin. The sub-sub plot treatment was the cover crop density with four levels (control) 0, 10,000, 20,000 and 30,000 stands /hectare of the cover crops. The main plot size was 25m x 13m ($325m^2$) the sub plot size was 25m x 3m ($75m^2$) while the sub-sub plot was 5m x3m ($15m^2$) with one meter (1m) in between plots and blocks.

Crop Establishment and Cultural practices

Setts of *Dioscorea rotundata* cultivar 'agboghohu' of 100g were planted on the crest of the ridges and on flats at a distance of 1m x 1m. Fifteen stands of yam were planted per sub-sub plot (10,000 stands/ ha). *Manihot esculantus* stem cuttings, variety TMS 0581 were planted on the mid ridges/flat, at distance of 1m x 1m by the right side of yam stands, 10,000 stands /ha.'Oba super 2' variety of maize, *Zea mays* seeds were planted three seeds per hole and later thinned to one at 2 weeks after planting (WAP) to give population of 10,000 stands/ha. While Seeds of *Citrullus vulgaris* (Schard) ('egusi' melon) and Pumpkin, *Cucurbita moschata* (L) 'Anyu' were planted four per hole at a depth of 4cm. The seedlings were thinned to respective densities of 10,000, 20,000 and 30,000 plants/ha 2 WAP, while there was none planted in the control (0). *Ipomoea batatas* (L.) sweet potato vines of variety TIS 2498, spreading type obtained from National Root Crops Research Institute Umudike were planted mid-way on the ridges and flats at a spacing of 1m x 1m for 10,000 plants/ha (15 stands), 0.5m x 1m for 20,000 plants/ ha, (30 stands) and 33.3cm x1m for 30,000 plants/ha (45stands) while none was planted in the control (0) plots. Yam vines were staked at 5WAP using sticks. While manual weeding was carried out on all the plots at 2 WAP and 6 WAP**.** A blanket application of NPK 15:15:15 fertilizer was carried out at 2 WAP.

Data collection and analysis

Data were collected on yam vine lengths and yam fresh tuber yield from three randomly selected and tagged yams per plot, Vine length were measured from the base (peg) to the terminal bud and the average was taken. Yam fresh tuber yield/hectare was obtained by multiplying the yield of the harvested yams with the population of the yam crop per hectare. All the data collected were subjected to analysis of variance (ANOVA) using Gensat3 version software and means that were significant were separated using LSD at P=0.05 according to Wahua (2010).

RESULTS AND DISCUSSION

Plant height: Yam vine length was not significantly affected by the seedbed types and cover density in both years (Table 1). However, pumpkin improved the yam vine lengths more than

Egusi melon and sweet potato. This increase in yam vine length may be due to improved soil nutrient status. This is in agreement with Rahman and Ranamu (2003) who reported increases in the status of carbon, organic matter and the pH of the soil under cover crops. SARE (2012) also reported that cover crops have a beneficial effect on soil organic matter, encourage beneficial soil microbes, retain soil moisture, prevent erosion and help control insects and diseases. Jokela and Nair (2014) found that nitrate leaching was reduced by 50 % using a rolled cover crop of cereal rye in organic broccoli and pepper production. The seedbed, cover crop and cover crop density interaction was significant in 2014 but not in 2015.

***Yam fresh tuber yield*:** The seedbed practices and cover crops species did not improve the yam tuber yield in 2014, but were significant in 2015 (Table 2). The cover crops density reduced the yield of the yam tubers for the two years, as the control had highest yield mean values for the years, this may be due to competition between the cover crops and main crops.

CONCLUSION

Sweet potato may not be good to be intercropped with other tuber crops as it reduced the yam vine length more than other cover crops. while pumpkin and egusi melon improved yam vine length more than sweet potato. Yam fresh tuber yield was reduced by high cover crop density. These results were obtained as based on the inputs size used and the condition of the experimental site at Ishiagu.

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Table 1: Effect of seedbed, cover crop and cover crop density on yam vine length (cm) in 2014 and 2015

Seedbed	Cover crop	Cover crop density								Seedbed means	Cover crop means
Flat		No cover crop		10,000		20,000		30,000		Mean	
		2014	2015	2014	2015	2014	2015	2014	2015		
	Egusi (melon)	153.8	172.2	161.8	162.0	164.5	168.2	168.5	171.8	165.3	
	Pumpkin	192.8	180.2	152.8	181.2	187.3	219.0	177.3	231.0	190.2	
	Swt potato	149.0	178.5	164.5	168.8	144.0	180.2	161.0	176.5	165.3	
	Mean	165.2	176.9	159.7	170.6	165.2	189.1	168.9	193.1	173.5	
Ridge											
	Egusi melon	129.0	188.8	132.5	164.8	180.5	183.8	180.5	179.5	167.4	166.3
	Pumpkin	156.8	183.8	172.0	196.5	196.8	199.8	193.0	181.8	185.0	187.6
	Swt potato	165.8	169.5	**146.0**	180.2	172.2	172.2	174.8	174.8	169.4	167.3
	Means	150.5	180.7	**150.2**	180.5	165.8	185.2	182.7	178.7	172.7	
	Density means	157.8	178.8	**154.9**	175.5	178.2	187.1	175.8	185.9		

LSD for 2 seedbed means =NS, LSD for 2 cover crops means = 16.80 LSD for 2 covers crop density means = NS , LSD for 2 seedbed means at the same or different levels of cover crop and cover crop densities =NS*

Table 2: Effect of seedbed, cover crop and cover crop density on yam tuber yield (t/ha) in 2014 and 2015

Seedbed	Cover crop	Cover crop density									Seedbed means	Cover crop means
Flat		No cover crop		10,000		20, 000		30, 00		Mean		
		2014	2015	2014	2015	2014	2015	2014	2015			
	Egusi melon	0.87	0.67	0.64	0.33	0.73	0.32	0.62	0.32	0.56		
	Pumpkin	1.09	1.33	0.75	0.83	0.80	0.81	0.71	0.80	0.89		
	Swt Potato	1.15	2.03	0.86	0.86	0.64	0.83	0.57	0.68	0.95		
	Mean	1.04	1.34	**0.75**	0.67	0.72	0.65	0.63	0.60		**0.80**	
Ridge												
	Egusi melon	1.15	1.36	0.63	0.41	0.64	0.47	0.54	0.67	0.73		0.64
	Pumpkin	0.62	0.68	0.75	0.52	0.87	0.46	0.58	0.62	0.63		0.76
	Swt Potato	1.11	0.68	0.76	0.43	0.55	0.34	0.51	0.21	0.57		0.76
	Means	0.96	0.90	0.71	0.45	0.68	0.42	0.54	0.50		**0.73**	
	Density means	1.00	1.12	0.73	0.58	0.70	0.57	0.58	0.55			

LSD for 2 seedbed means= NS, LSD for 2 cover crop means= NS, LSD for 2 cover crop density means =0.15, LSD for 2 seedbed means at the same or different levels of cover crop and densities = NS*

Flood Control: Road Map to Sustainable Forest Development

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ABSTRACT
Recent floods and consequences all over the world are becoming too frequent and threat to sustainable forest development which human rely upon for their daily sustenance. Nigeria is one of the luckiest countries on earth in respect to water resources. But we must acknowledge that flooding and water stress in Nigeria, Africa and across the world, are environmental challenges that need intervention to ensure sustainability. Increasing flood risk is now being recognized as the most important threat from climate change in many parts of the world, the reason for this is the general rise in sea level globally, due to global warming as well as the saturated nature of the wetlands in many parts of the world such as Nigeria which has altered the ecosystem. The aim of this paper is to evaluate the conceptual framework, impact of flooding and flood control measure in other to promote the sustainable forest development through government and other professional bodies to collaborate and implement preventive measures, while ensuring entire forest development.
Keywords: Sustainable, Ecosystem, Development, Climate change, Flooding

INTRODUCTION
Floods are major disasters affecting many countries of the world annually especially in most flood plain areas. Floods do not only damage properties and endanger the lives of human and animals but also produce other secondary effects like outbreak of diseases such as cholera and malaria (Obeta, 2014). Flooding is commonly caused by heavy downpours of rains on flat ground, reservoir failure, volcano, melting of snow and or glaciers etc. Flood risk is not just based on history, but on a number of factors: rainfall, river flow and tidal-surge data, topography, flood control measures, and changes due to construction of building and development on flood plain areas. In Nigeria, flooding and solutions to its impacts are critical issues (Obeta, 2014). With history of devastating floods which affected millions of human populations and caused fiscal losses amounting to billions of US dollars, the importance of exploring more realistic flood risk mitigation measures for Nigeria should be paramount (OCHA, 2012). Flooding in Nigeria are fluvial (resulting from rivers overtopping their natural and manmade defenses), coastal (affecting mainly the coastal areas) and pluvial (flash, arriving unannounced following a heavy storm) in nature and have been a major cause of concern for rural areas and cities within the country (Houston *et al*., 2011; Andjelkovic, 2001; Bashir *et al*., 2012; Douglas *et al*., 2008). Whilst stakeholders' efforts towards tackling the hazard have not yielded satisfactory results, they have been criticized as ad-hoc, poorly coordinated, non-generalizable and not well established (Obeta, 2014). However, in the light of 'best practices' in flood risk reduction and 'lessons learned' from other countries' experiences of flooding, it can be argued that such stakeholders' efforts are limited due to lack of quality data, which are needed to systematically tackle flooding, poor perception of flooding among the general populace, lack of funds and improved technology as well as poor political will power. The growing number of flood victims and the constrained sustainable development caused by flooding within the country suggest that much of what is known regarding flooding in the country is deficient on remedies. More critical is the subject-matter of Nigeria being one of the

most populated countries of the world with population size estimated at over 170 million people.

Meaning of flooding

According to Merriam-Webster (2012) flood is a rising and over flowing of a body of water especially onto normally a dry a land. The word "flood" originates from the Old English language; /flod/, a word common to Germanic languages (compare German /Flut/, Dutch /vloed/ from the same root as is seen in /flow, float/; also compare with Latin /fluctus/, /flumen/), and was first used in 1663. There is no universal definition of what constitutes the term flood (WHO, 2013).

Causes of flooding

Climate Change is also an attribute that cause flooding, because when the climate is warmer it results to the following:

a. Heavy rains
b. Relative sea level continue to rise around most shore
c. Extreme sea levels will be experienced more frequently

Therefore, Climate change is likely to increase flood risk significantly and progressively over time. Particularly increased risk will be low-lying coastal areas, as sea levels rise and areas not currently prone to fluvial or tidal flooding as more intense rainfall leads to significantly higher risk of flooding from surface runoff and overwhelmed drainage system.

Natural or Human cause

According to Etuonovbe (2011) flooding in Nigeria could be as a result of the causes as follows:

Natural

a. Heavy rainfall
b. Oceans storms and tidal waves usually along the coast.
c. Lack of Lakes
d. Silting

Human

While other human causes of flooding in Nigeria may be due to one of the following factors;

a. Burst water from main pipes
b. Dam failures
c. Population pressure (especially in the city of Lagos and Port Harcourt)
d. Deforestation (such as in the North part of Nigeria)
e. Trespassing on water storm drains (key cause in Southern Nigeria)
f. Unplanned urbanization (in many cities it’s the key cause of urban flooding).
g. Poor Sewerage Management
h. Neglecting warnings from hydrological system data (major cause of 2012 flooding in Nigeria)
i. Lack of flood control measures (especially by government)

Impact of Flooding

Flooding is generally linked to poor urban planning and climate change (Adeloye and Rustum, 2011: Action Aid, 2006; BNRCC, 2008). The impacts have been severe and every part of the country's life stream is affected with significant economic losses (mainly through destruction of farmlands, social and developmental infrastructure) and economic disruption (most notably in oil exploration in the Niger Delta, traffic congestion in many cities in Nigeria, disruption in telecommunication and power supply) (Ogunbodede and Sunmola, 2014:: Fadairo and Ganiyu, 2010). In 2012, the country experienced the worst flooding in more than 40 years as a result of heavy storms that lasted many days. The incidence affected 32 states with 24 considered severely affected (NEMA, 2013). The floods lasted from July to October that year and affected 7.7 million people with more than 2 million others reckoned as internally displaced (IDPs).

More than 5000 people were physically injured along with over 5900 houses which were destroyed.

Measures to Control Flood

Flood control according to Bariweni *et al*. (2012) refers to all methods used to reduce or prevent the detrimental effects of flood waters. The consequences of flooding are detrimental as Kolawole *et al*. (2011) highlight the basic consequences of flooding to include loss of human lives, submerging of residences and streets, inflow to sewage, municipal pollution, damage to properties, health hazards, cleanup cost, disruption of services, traffic obstruction, aesthetic discoloring, economic loss and infrastructural damage. Thus, taking all measures to combat floods are more than necessary in any society. Some methods of flood control that have been in practice in the past include: planting vegetation to retain extra water, establishing flood forecasting systems, drainage and dams' constructions, ensuring population awareness and preparedness, proactive town planning and discouragement of development in flood prone areas, and development of other institutional capacities that are charged with environmental consciousness and management. Jeb and Aggarwal (2008) opine that reduction of flood risk will depend largely on the amount of information on floods that is available and knowledge of the areas that are likely to be affected during a flooding event. Agbonkhese *et al* (2014) suggest "Early Warning" as a proactive measure to curbing flood menace in Nigeria.

Early warning is a proactive mechanism in which certain recognized bodies or agencies take to the study of climate and human interactions with the environment towards foretelling the occurrences of floods and thus issuing warnings to both individuals and government structures with a view of effectively being prepared and curbing the occurrence of floods, averting loss of lives and properties and checking the outbreak of epidemics (Agbonkhese *et al*., 2014). Also, Aderoju *et al* (2012) believe that it is necessary to use modern day techniques in developing measures that will help government and relief agencies in identification of flood prone areas and in planning against flooding occurence in the future.

The knowledge of remote sensing and geographical information system (GIS) is a tool which can be used to investigate and map areas that are less or more vulnerable to flooding in conjunction with forecasting techniques to predict the precipitation intensity and duration in the nearest future (Aderoju *et al*., 2012). Among the objectives to tackle floods by national government of Nigeria in 2003, include providing a master plan for flood control and relief measures for victims; mitigate floods through the relevant land use laws and edicts; proactive planning in controlling development especially along the flood prone areas; improve institutional capacity for flood prediction and public awareness programmes and minimize the impact of floods through the provision and maintenance of appropriate infrastructure. The construction of structures for irrigation and the use of excess run-off water for inter-basin transfer as an alternative to absorb excess water from the Cameroons; check dams will reduce peak flows; levees and flood walls confines flow within predetermined channels; Adequate drainage systems will reduce peak flow stages of flood and divert excessive flow (Kubal *et al*., 2009).

CONCLUSION

The prevalence of flooding within Nigeria which has been generally attributed to climate change and poor urban planning is an issue of critical importance within the context of national development. Over the period 1985 to 2014, flooding in Nigeria has affected more than 11 million lives with a total of 1100 deaths and property damage exceeding US$17 billion. Although more frequent floods are recorded in Niger, Adamawa, Oyo, Kano and Jigawa states possibly due to the influence of rivers Niger, Benue, Ogun and Hadeja, Lagos state seems to have experienced most of the floods in the country (Nkwunonwo, 2016). With rapid population growth and urbanization in the country the risk of flooding to human lives and properties assumes critical dimensions. Critically, poor awareness of the hazard is a major impasse towards its management. This creates a significant gap in the knowledge of how to improve on the current efforts towards addressing the challenges of flooding in Nigeria. Since attempts to tackle the hazard appear to be limited, the present study is driven by the need to identify those limitations in the flood management efforts in Nigeria (Nkwunonwo, 2016). Possible way-forward are suggested based on a critical review of flooding and its management in Nigeria, allied with globally acknowledged 'best practices' in flood risk reduction.

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Effect of Soil Erosion on Crop Production in Nigeria: A review

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ABSTRACT
Erosion is defined as the action of surface processes like flow of water or wind that removes soil, rock, or dissolved material from one location on the earth's crust. Soil erosion and its effects on crop productivity have become emotional issues and have attracted the attention of agriculturists, environmentalists, and the public as a whole. Soil erosion and its effects on crops attributed to differences in soil profile characteristics, nutrient status, crops grown, and prevailing climatic conditions. Erosion resulted in yield reduction. Accelerated erosion affects productivity both directly and indirectly. It reduces crop yields is attributed to loss of rooting depth, degradation of soil structure, decrease in plant-available water reserves, reduction in organic matter, and nutrient imbalance. Due to all these, soil erosion can be prevented by planting crop rotation which reduces erosion and by also practicing diversion structure, contour farming, terrace farming, strip farming and grass waterways. All these factors will help the farmers to get rid of soil erosion and get good and abundant yield at harvest.
Keywords: Soil erosion, root crop, tuber crop and Nigeria

INTRODUCTION
What is erosion
Erosion can be defined as the action of surface processes like flow of water or wind that removes soil, rock, or dissolved material from one location on the earth's crust. It transports them to another location. Erosion is also defined as the process by which the surface of the earth gets worn down. Soil erosion and the effects of soil erosion on crop productivity have become emotional issues and have attracted the attention of agriculturists, environmentalists, and the public as a whole. In spite of heavy investments in research and development, the global rates of accelerated erosion are now presumably higher than ever before. However, the data from available records obtained by diverse methods are incomparable, unreliable, confusing, and often vary by several orders of magnitude. Reports of erosion-caused alterations in crop productivity and soil properties in Nigeria. Soil erosion and its effects on crops attributed to differences in soil profile characteristics, nutrient status, crops grown, and prevailing climatic conditions. Erosion resulted in yield reduction. Accelerated erosion affects productivity both directly and indirectly. It reduces crop yields is attributed to loss of rooting depth, degradation of soil structure, decrease in plant-available water reserves, reduction in organic matter, and nutrient imbalance. Due to this result of the adverse effects of erosion on the crop yield, it can be compensated by adding nutrients both macronutrients (N, P, K) and macronutrients together with organic matter supplementation (Rattan et *al.*, 2008). Erosion can be caused by natural elements (wind). But anyone who has ever seen a picture of the Grand Canyon knows that nothing beats the slow steady movement of water when it comes to changing the Earth. In physical erosion, there is a removal of rock or soil as clastic sediment while in chemical erosion simply means the removal of soil or rock material from an area by dissolution (Louvat . *et al,* 2008).

Causes of soil erosion

Below are the causes of soil erosion:

- Wind: Wind erosion (soil drifting) is the removal, transportation, and deposition of topsoil by high air velocity close to the ground. It is a problem on flat land and mainly in a dry climate.
- Topography: The topography of the land determines the velocity at which surface runoff will flow, which in turn determines the erosivity of the runoff. Longer, steeper slopes are more susceptible to very high rates of erosion during heavy rains than less steep slopes.
- Water: It can also be carried away by rain or irrigation water which is of two basic types. They are the following:

(a) S*heet erosion* is usually caused by direct rainfall whereby soil materials are removed uniformly from the top layer.

(b) R*ill erosion* is caused by poor surface drainage, little streamlets of water cause rills and eventually gullies to form.

- Vegetative cover: Vegetation also acts as an interface between the atmosphere and the soil by increasing the permeability of the soil to rainwater and decrease runoff. It protects soil from strong winds, which results in decreased wind erosion. The roots of the plants bind the soil together, and interweave with other roots, forming a more solid mass that is less susceptible to both water and wind erosion. The removal of vegetation increases the rate of surface erosion.
- Tillage: It occurs when tilling activity drags the soil downhill. The extent of the erosion varies depending on the grade of the slope and the depth and speed of tillage.

How to prevent soil erosion

- Crop Rotation: This is the act of rotating crops in a high-residue like corn, hay, and small grain. It reduces erosion as the layer of residue protects topsoil from being carried away by wind and water.

- Diversion Structures: Used often for gully control, diversion structures cause water to flow along a desired path and away from areas at high risk for erosion.
- Contour Farming: This is the process of planting in row patterns that run level around a hill instead of up and down the slope. It has been shown to reduce runoff and decrease the risk of water erosion.
- Terrace Farming: Many farmers have successfully combated erosion by planting in flat areas created on hillsides in a step-like formation.
- Strip Farming: It is mostly done in the areas where a slope is particularly steep or there is no alternative method of preventing erosion, planting fields in long strips alternated in a crop rotation system.
- Grass Waterways: The process of planting grass in areas of concentrated water flow, farmers can prevent much of the soil erosion that results from runoff, as the grass stabilizes the soil while still providing an outlet for drainage.

CONCLUSION

Due to all the problems soil erosion is causing to our farming activities, we have to be practicing crop rotation which reduces erosion and by also practicing diversion structure, contour farming, terrace farming, strip farming and grass waterways. All these factors will help the farmers to get rid of soil erosion and get good and abundant yield at harvest.

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Spatial Variability and Mapping of Some Soil Properties for Precision Farming in Suleja Area of Niger State

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ABSTRACT
Spatial variability has been identify as a treat to crop production, In these regard this study was undertaking to assess the spatial variability of two fields in Suleja, Niger state, Nigeria purposely for precision farming. The field measuring 8 hectares each was divided into 100 m × 100 m grids and soil samples were collected from (0 – 15 cm) depth from each grids intersection were analysed in the Laboratory for soil physical properties (soil texture), soil chemical properties (pH, organic Carbon, Total Nitrogen, Available phosphorous and Potassium). Results showed the dominant textural class of the soils in both farm land A and B is loamy sandy. Variability ranking was done according to Drees and Wilding guideline, Result shows Soil pH is with low variability of (< 25%) for both Farm A and B ranged between 6.0 - 6.8. Organic carbon (OC) for Farm A was variably low while Farm B was variably high. Result shows Total Nitrogen indicate low variability in both farm Land of (< 25%), Available Phosphorous was low in Farm A ranged from 0.7 – 49.9 mg kg^{-1} and high in Farm B ranged from 0.7 – 53.4 mg kg^{-1} and Potassium content in both Farm A and B was variably low which range from 0.0 - 0.4 cmol kg^{-1}.
Keywords: Precision farming, Soil chemical properties, Spatial variability, textural class

INTRODUCTION
Soil properties vary spatially within a field and inherently in nature because of geological and pedological soil forming factors. Iqbal *et al.* (2005) reported that soil factors interact with each other across spatial and temporal scales. Most of the variations in soil result from complex geological and pedological processes; soil management can also induce variation (Bocchi *et al.*, 2000). Growing population, together with pronounced climate changes put a considerable pressure on agricultural land (FAO and ITPS, 2015). Sustainable land management practices are necessary to meet the changing human needs and to ensure long term productivity of farm land (Halbac *et al.*, 2019). Land use and management practices are closely interrelated with soil quality, and the adoption of appropriate land management practices and land use planning would be helpful to both restore the degraded soil physical and chemical quality and ensure steady and sustainable productivity (Oyetola and Philip, 2014).

METHODOLOGY
The study area for Farm A is Located between latitudes 09° 21'107" N and longitudes 07° 18'516" E and 186.4 m above mean sea level and Farm B is located between latitude 9° 34' 104" N and longitude 7° 05' 516" 213" E respectively in Suleja. A major satellite town close to the Federal Capital Territory densely populated by the low income earners of about two hundred and fifteen thousand people (National Population Census, 2006). Both locations are in the southern Guinea savanna agro ecology zone of Nigeria. The study areas had mean annual air temperature of 32 °C and annual rainfall of 1338 mm. The rainy season commences between March/April and lasts till October/November. About 74 % of the annual rainfall occurs between

June and September with the peak in August (Alabi and Ibiyemi, 2000). A total field area of Eight hectare farm land each in Suleja were survey in a systematic grid design using Arc GIS. Each grid was at a fixed distance of 100 x 100 meters intervals in the north to south and east to west directions, and soil samples were collected at inter section points from (0 – 15 cm) soil depth, since geostatistical analyses requires at least 50 - 100 measuring grid points.

RESULTS AND DISCUSSION

Result shows that the soil texture in both Farm lands is loamy sandy which is suitable for cultivation of arable crops. Soil pH for Farm A varied from 6.1 to 6.8 while Farm B varied from 6.0 – 6.8 which is neutral pH and ideal for plant growth. Organic carbon (OC) for Farm A ranged from 0.9 - 4.3 g kg^{-1}, while Farm B ranged from 0.7 - 5.4 g kg^{-1}, The mean value of Organic carbon in the study area was very low, while 80 % of the analysed soil samples had a content of soil organic matter (SOM) lower which indicates the presence of agricultural soil degradation (Liu *et al.,* 2006) and can lead to a decline in soil quality (Loveland and Webb, 2003). Total Nitrogen was variable low, Farm A ranged from 0.1 – 0.2 g kg^{-1}, while Farm B ranged from 0.1- 0.2 g kg^{-1}. Available P for Farm A ranged from 0.7 – 49.9 mg kg^{-1} and Farm B ranged from 0.7 – 53.4 mg kg^{-1}, Available phosphorus was highly variable .and Potassium for Farm A range from 0.0 - 0.4 cmol kg^{-1}, while farm B ranged from 0.1 – 0.3 cmol kg^{-1} and these indicate low variability status.

CONCLUSION

The fertility status of the soil is, however, poor and requires external inputs for optimal crop production. Variability within soil properties was high, a phenomenon that could be attributed to human influence. Soil organic carbon and available phosphorus can be adequately managed for precision agriculture. It is important to know how these soil properties vary in different land use contexts so that best management practice options can be recommended to farmers based on the limited nutrients and for optimum crop production, moderate application of phosphorus and potassium are required and more in-depth research should be conducted in order to understand the pattern of distribution on the studied area.

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Assessment of some Physical and Chemical Properties of sequence of Soils Developed from Nupe Sandstone in Bida, Niger State, Nigeria

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ABSTRACT
This study was carried out to assess some physical and chemical properties of sequence of soils from Nupe Sandstone origin in Bida, Niger State, Nigeria. Rapid reconnaissance survey was carried out to delineate the site into upper (KT!), middle (KT2) and lower (KT3) slope positions. A profile pit was dug in each physiographic unit, described and soils samples were collected and analysed in the laboratory following the standard procedures. Results showed that sandy loam underlain by loamy sand was the dominant soil textural. Soil pH ranged from pH 5.90 to 6.54 which was slightly acidic to neutral. Organic carbon (OC) was low (1.69 to 4.89g kg^{-1}), total nitrogen (N) was high (1.40 to 2.52 g kg^{-1}), available P ranged from (2.97to 76.19mg kg^{-1}) and potassium content was low (0.00 to 0.48 cmol kg^{-1}). All the soils from upper, middle and lower slope positions have potentials for arable agriculture.
Keywords: Physiographic unit, profile pit, reconnaissance survey, Sandstone

INTRODUCTION
Knowledge of the kinds and properties of soils is critical for decisions making with respect to crop production and other land use types. It is through precise measurement and full understanding of the nature and properties of soils as well as proper management of the nutrient and moisture requirements that one can maximize crop production to the allowable potential limits (Buol *et al.,* 2003). Soil is an important component in human's total stock of natural resources and it underpins food production. Soil was described as a product of its environmental factors of climate, vegetation/organic material, geology, local relief and time (Ezeaku, 2011). Furthermore, soil exhibits the signatures of the fore stated factors and as well as certain processes which combined to produce that specific characteristic (Asadu *et al*., 2012). Topography is a major factor which control most surface processes taking place on earth, i.e. soil formation and soil development. Topography has influence on soil chemical and physical properties and also on pattern of soil distribution over landscape (Kalivas *et al*., 2002), (Esu *et al*, 2008). For instance, the impact of rainfall is great where landscape is sloppy with regards to erosion and deposition. Soils on hill slopes differ from those at summits or valleys in terms of moisture distribution, soil depth, cations distribution, and organic matter contents (Asadu *et al*., 2012).

In Nigeria, many works on relationship between landscape positions and soil properties were documented. For instance, Ogban *et al*. (1999) deduced that nutrient status and soil properties are related to topography of the land area. Also, (Osodeke *et al.,* 2005) reported differences in quantity and forms of sesquioxides as influenced by geomorphic positions. They also observed that the soils of the profiles at higher slopes were dominated by the crystalline forms of iron (Fe) and aluminum (Al) oxides while the soils of the valley bottom were dominated by the amorphous forms of Fe and Al. Also observed a wide variation in phosphorus (P) distribution along a toposequence in south-eastern Nigeria; where total P was found to be highest at the upper slope and lowest at the middle slope. Similarly, Yaro *et al*. (2006) observed plinthites in soils on different landscape positions except in adjacent valley floors in a location in northern Guinea savannah of Nigeria. With emphasis being shifted to precision farming in Nigeria to meet up food requirement of rapidly growing population, investigations on properties of soils on different landscape positions is absolutely necessary.

Potentials of soils can readily be tapped when information on its physical, chemical and biological properties are available. In order to evaluate the quality of our soils and their potential to produce food, fodder, fibre, and fuel on sustainable basis, detailed information on soil properties is required. Assessment of soil for land use planning is increasingly important due to increasing competition for land among many land uses and the transition from subsistence to market based farming in many countries (Ezeaku, 2011). Niger State Nigeria been an agrarian state where data on soils are limited (Lawal *et al*. 2013) Therefore, the aim of this study was to assess some physical and chemical properties soils of Nupe Sandstone Origin.

MATERIALS AND METHODS

The study area falls within Latitude 8^{0}24'00" N and Longitudes 6^{0}02'00" E. The area receives annual rainfall of between 1000-1500 mm with average monthly temperature ranging from 23°C to 29°C. Soils are predominantly light and well drained, with geology majorly basement complex rock origin. Crop and livestock farming is the major occupation of the people and rice is cultivated mostly under rain-fed conditions. The study area is located within the Southern Guinea Savannah vegetation zone.

Field work

Rapid reconnaissance survey was carried out to delineate the site into upper (KT1), middle (KT2) and lower (KT3) slope positions. a profile pit was dug with a dimension 2m by 1m interval and 2m depth in each physiographic unit described and soil samples collected.

Laboratory Analysis

The soil samples were air-dried, gently crushed in a mortal and sieved with 2 mm mesh and analysed for selected soil properties. Bulk density was also determined using clod method (ISO, 2017). Particle size distribution was by Bouyoucos hydrometer method (Bouyoucos, 1962). Soil pH (1:2.5) in water was determined using a glass electrode pH meter. Organic carbon content using the chromic acid oxidation procedure of Walkley and Black (Walkley and Black, 1934). Total Nitrogen was analysed by the micro-kjeldahl digestion method (Bremmer, 1996), followed by distillation and titration. Available phosphorus was extracted using Bray P1 method (Bray and Kurtz, 1945). Exchangeable potassium (K) was extracted with neutral 1N NH_4OAC solution. Potassium in the extract was determined using flame photometry (Thomas, 1982).

RESULTS AND DISCUSSION

The results of selected physical properties are presented in Table 1below. All slope positions have sandy loam texture underlain in all pedons by loamy sand. Sand dominated the mineral fraction in the slope positions in the study site which may be partly attributed to parent mineral, an essential component in granite (Wilson, 2012), and partly to geological processes involving sorting of soil materials by biological activities, clay migration through eluviation and illuviation, or surface erosion by run-off or their combinations (Malgwi *et al*., 2000).

Table 1: Physical properties of the soils of study site

Soil Mapping Unit	Soil Depth (cm)	Sand	Silt (g kg^{-1})	Clay	Textural class
KT1	0- 20	833	111	56	LS
	20 – 34	764	130	106	SL
	34 – 82	734	150	116	SL
	82 – 193	813	131	56	SL
KT2	0 – 32	834	101	65	LS
	32 – 73	823	111	66	LS
	73 – 100	804	130	66	SL
	100 – 134	813	131	56	SL
KT3	0 – 25	784	130	86	SL
	25 – 53	814	111	75	LS
	53 – 85	773	131	96	SL
	85 – 93	824	110	66	LS
	93 – 103	803	131	66	SL
	103 – 152	794	130	76	SL

Note: SL = sandy loam, SCL = sandy clay loam

Chemical properties of the soils

Results for some selected chemical properties are shown in table 2. The soil reaction, especially for surface was rated strongly acid to slightly acid with pH values 6.00, 6.32 and 5.98 for KT1, KT2 and KT3 respectively. Soil pH range of 5.5 to 7.0 has been established as favourable for release of most crop/plant nutrients (Bray and Weil, 2002). The soil organic carbon ranged 1.88 to 3.95 gkg^{-1} across the three slope positions which were low according to Esu (1991) fertility classification. Reason for low organic matter might be due to the annual bush burning. Organic matter plays an important role in soil by binding soil mineral particles and provides exchange sites for nutrients. Practices that encourage the return of residues back to the soils should be put into consideration for proper management. Total nitrogen was moderately high across the three slope positions. Available Phosphorus ranged from 5.16 to 76.19 mg kg^{-1} across the three slope positions. High level of available P at the upper slope (KT1) may be due to its low solubility/mobility in soil. However, high available P content in the subsoil of lower slope (KT3) may be due to deposition of P, as also reported in a study by (Osodeke *et al.,* 2006). Potassium was rated low in all the three slope positions.

Table 2: Chemical properties of the study site

Soil Mapping Unit	Soil Depth (cm)	pH (H_2O)	OC (g kg^{-1})	N	P (mg kg^{-1})	K (cmol kg^{-1})
KT1	0 – 20	6.00	3.58	1.40	5.22	0.02
	20 – 34	5.96	3.01	2.52	48.41	0.03
	34 – 82	6.00	2.07	1.54	11.41	0.01
	82 – 193	5.90	3.39	1.82	76.19	0.05
KT2	0 – 32	6.32	2.63	1.82	46.02	0.01
	32 – 73	6.00	1.88	1.68	9.09	0.00
	73 – 100	6.18	3.01	1.96	5.16	0.00
	100 – 134	6.25	2.45	2.10	5.61	0.00
KT3	0 – 25	5.98	2.45	2.24	8.51	0.06
	25 – 53	5.99	3.58	1.96	12.50	0.01
	53 - 85	6.20	3.95	1.68	50.15	0.07
	85 – 93	6.33	1.88	1.40	14.44	0.00
	93 – 103	6.00	2..26	1.82	26.69	0.02
	103 – 152	6.28	3.20	1.68	8.12	0.01

Note: OC = organic carbon, N = total nitrogen, P = phosphorus, K = potassium

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Soil Fertility Evaluation of Some Selected Kola Plantations in Ondo State, Nigeria

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ABSTRACT
The study was carried out to evaluate the soil fertility status under Kola plantation in Ondo state for increased productivity. The stratified random technique at depths 0-15cm, 15-30cm and 30-45cm was employed for soil sampling. Results showed that the pH of the soil ranged from 6.00-7.32 in Idanre Local Government area and 5.3- 6.4 at Oke Igbo/Ile- Oluji local government area. The organic carbon contents, Available Phosphorous (P), Exchangeable cations (K^+, Ca, Mg) were found suitable for Kola production in the two local government areas evaluated compared to Nitrogen contents which was far below the critical level recommended for Kola production in Nigeria. It is therefore recommended that Nitrogen based fertilizer be applied for sustainable Kola production in these area to augment the deficiencies. However, the amount to be applied must be calculated based on the results of the soil analysis of the areas.
Keywords: Assessment, Kola, Plantation, soil analysis, soil sampling

INTRODUCTION
The kolanut is nature to Africa in Nigeria as the Primary producing country. An estimated 140,000 tons were produced in 1960, in Nigeria. A few hundred tons are exported to the United States where they are used in the preparation of beverages and pharmaceutical products. In Africa, the kolanut is cherished for its alkaloids properties (caffeine), thirst and hunger seem to be a site preference for white kolanut over red one's (Somorin 1999; Russell 2004). Adequate soil fertility is an important component of a sustainable kola production system. Presently, the demand for kolanut exceeds its production. Hence, there is need to increase its plantation acreage and nut yield per tree. These can be achieved through detailed study of existing conditions of the farms. Nutrient removal from the soil through pod harvest results in nutrient running which necessitated replacement of soil nutrient removed (Ogunlade et al., 2017). Therefore, the objective of this study was to investigate the soil nutrient fertility status of kola plantations in some selected Local Government Area of Ondo state for a purposeful good agricultural management practices for a sustainable kola production in the local government area and Nigeria at large, hence the need for the study.

MATERIALS AND METHODS
Soil samples were collected in kola plantation in some selected locations from two local government areas of Ondo state namely (Idanre and Oke -Igbo/ Ile- Oluji L.G.A). In each of the location visited, 20 cores samples at 0-15 cm, 15-30cm and 30-45cm were randomly collected using soil auger and bulked into composite samples to obtained representative soil sample for each location. The well labeled samples were brought to the laboratory for processing and analysis. The samples were air dried, sieved through 2mm sieve and some physico-chemical properties determined the following standard laboratory procedure (IITA, 1979).

RESULTS AND DISCUSSION

Particles Size and pH

Table 1 and 2 showed the results of soil analysis for both locations selected in Ondo state. The results indicated that the sand, silt and clay contents at 0-15cm depth were 695.2g/kg, 132.8g/kg and 172g/kg respectively at Idanre Local Government Area while at Oke-Igbo/ Ile-Oluji, the sand, silt and clay contents were 695.2g/kg, 98.8g/kg and 212g/kg soil. At 15.30cm depth, the values recorded were 655.2, 132.8 and 212g/kg sand, silt and clay at Idanre while 655.2, 92.8 and 252g/kg were recorded at Oke- Igbo/Ile- Oluji. Also the result of analysis indicated that at 30-45cm depth, the sand, silt and clay content recorded were 655.2, 112.8 and 232g/kg at Idanre while at Oke-Igbo/Ile-oluji, the value recorded were 655.2, 92.8 and 272g/kg soil. The values decreased with depth. Texturally, the soils in these areas are classified as sandy loam. The soil pH of kola ranged from 5.3-7.32 with mean pH value of 6.57 at Idanre and 5.9 at Oke-Igbo/Ile- Oluji respectively. Hence, the soil falls between slightly acidic and slightly natural. The pH value of the two locations fall within the ranged required for kola production.

Organic Carbon (OC)

The organic carbon content of Idanre ranged from 9.3-10.2g/kg with a mean value of 9.43g/kg soil. The upper depth (0-15cm) had organic carbon value of 10.2g/kg soil, this values is very low and fall below 30g/kg required for sustainable kola production in Nigeria (*Egbe et al*., 1989). The organic carbon contents of Oke-Igbo/Ile- Oluji soil was slightly higher than that of Idanre L.G.A but lower than the critical value (30g/kg) required for tree crop production in Nigeria. At the deeper depth of 15-30cm and 30-45cm, the organic carbon contents were 9.3 and 9.7g/kg at Idanre while at Oke-Igbo / Ile- Oluji, the value recorded was 9.7 and 7.6g/kg respectively. The higher organic matter contents at the upper depth (0-15cm) may be attributed to accumulation and decomposition of large amount of leaf litter falls over the years. This result is in agreement with findings of Iloyanomon and Ogunlade (2011).

Nitrogen (N)

The total nitrogen (N) at the upper depth (0-15cm) for both locations ranges from 0.6 to 0.8g/kg in Idanre and 0.4 -0.7g/kg in Oke-Igbo/Ile-Oluji soil respectively. However, these values fall below the critical range value of 10g/kg soil (Egbe *et al*., 1989). The N contents decrease with increase depth with higher N found at Idanre soil (0.8g/kg) compared to Oke-Igbo/Ile-Oluji (0.7g/kgsoil).

Available Phosphorus (P)

The soil available phosphorus contents of the study area were adequate and far above the critical level of 6.0mg/kg as reported by Egbe *et al*., (1989). However, in the upper depth, available phosphorus is slightly higher at Oke-Igbo/Ile-Oluji(17.40mg/kg) soil relative to Idanre(17.25mg/kg) soil.

Potassium (K)

The exchangeable potassium (K) of the site was found to be adequate for kola production at both locations. The upper depth (0-15cm) of soil in Idanre had 0.15cmol/kg soil while the soil K value at Oke-Igbo is 0.14cmol/kg soil. These values were higher than the critical value of 0.12cmol/kg soil as reported by Egbe et al (1989). This could be as possible fixation of potassium in the study area which makes it easier for the roots to absorb nutrients. This will invariable improved the root formation and enhance effective uptake of soil moisture and other essential nutrients by the roots.

Calcium (Ca)

Calcium contents of Idanre soil ranged from 12.73cmol/kg at 30-45cm depths to 15.67cmol/kg at 15-30cm depths, the surface soil (0-15cm) had 14.58cmol/kg. At Oke-Igbo/Ile-Oluji the values ranged from 11.76-13.81cmol/kg with surface depths (0-15cm) recording the least value (11.76cmol/kg). However, the Ca contents of both locations under study were adequate and above the critical value of 0.8cmol/kg (Egbe *et al*., 1989). The Ca contents in Oke -Igbo/Ile-Oluji soil decreased with increased depth.

Magnesium (Mg)

The soils under consideration were rich in Magnesium contents. Idanre soil magnesium values ranged from 1.62-2.17cmol/kg with 15-30cm depths having more Mg contents compared to (0-15) and (30-45) cm respectively. Oke –Igbo/Ile –Oluji soil Mg on the other hand, ranged from 0.75 to 0.99 cmol/kg with mean value of 0.87cmol/kg. Comparable with the critical level, both sites contained adequate Mg contents; hence there may not be need for magnesium based fertilizer.

Sodium (Na)

The sodium (Na) contents of soil in both locations were similar. At Idanre the Na values ranged 0.86cmol/kg at 30-45cm depths to 0.95cmol/kg at 15-30cm. Similarly, Oke- Igbo/Ile-Oluji soil had Na ranged from 0.89cmol/kg at 0-15 and 30-45cm to 0.92cmol/kg at 15-30cm depths. The mean Na values for both locations were similar.

CONCLUSION

The study was carried out in two Local government areas of Ondo state (Oke-Igbo/Ile-Oluji) and Idanre L.G.A) to evaluate the fertility status of some selected kola plantations in the areas for sustainable kola production. Results indicated that the areas are slightly acidic with low N and Organic carbon contents. However, soil K, P, and Mg were adequate for optimal kola production. In conclusion, N based fertilizers and good agricultural practices must be employed for sustainable kola production in the study area.

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Table 1: Physico Chemical Properties of Soil in Idanre L.G.A

Location	Soil Depth(cm)	Sand (g/kg)	Clay (g/kg)	Silt (g/kg)	pH	O.C (g/kg)	N (g/kg)	P (mg/kg)	K (cmol/kg)	Ca (cmol/kg)	Mg (cmol/kg)	Na (cmol/kg)
	0-15	695.2	172	132.8	7.32	10.2	0.8	17.25	0.15	14.58	1.62	0.92
	15-30	655.2	212	132.8	6	9.3	0.7	17.31	1.05	15.67	2.17	0.95
	30-45	655.2	232	112.8	6.4	9.7	0.6	17.4	1	12.73	1.88	0.86
Mean		668.53	208.33	126.13	6.57	9.73	0.7	17.31	0.74	13.66	1.89	0.91

Table 2: Physico Chemical Properties of Soil in Oke-Igbo/Ile-Oluji L.G.A

Location	Soil Depth(cm)	Sand (g/kg)	Clay (g/kg)	Silt (g/kg)	pH	O.C (g/kg)	N (g/kg)	P (mg/kg)	K (cmol/kg)	Ca (cmol/kg)	Mg (cmol/kg)	Na (cmol/kg)
	0-15	695.2	212	92.8	6	16.4	0.7	17.4	0.14	11.76	0.87	0.89
	15-30	655.2	252	92.8	6.4	9.7	0.7	17.57	0.15	13.35	0.99	0.92
	30-45	655.2	272	92.8	5.3	1.6	0.4	18.26	0.18	13.81	0.75	0.89
Mean		668.53	245.3	86.13	5.9	9.23	0.6	17.74	0.16	12.97	0.87	0.9

Evaluation of Different Varieties of Maize for Growth and Yield Contributing Characters

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ABSTRACT

This research was conducted at the Research Farms, Kano University of Science and Technology, Wudil located at Gaya, a Sudan Savannah zone of Nigeria during 2019 raining season to evaluate the performance of maize varieties for growth and yield contributing traits. The genotypes involve in this research were ten different varieties of maize. The experiment was laid out in randomized complete block design (RCBD) replicated three times. One row plot was done. Two Seeds was sown per hole and then later thin to one. The inter and intra row spacing is 75cm by 25cm respectively. The result indicated no significant difference ($P \leq 0.05$) among the genotypes for all the traits measured except for fresh weight indicating that substantial variation among the genotypes for the affected traits. Number of plant per plot (1.9), plant height (57.71cm), plant diameter (0.25cm), days to 50% flowering (0.82 days) to 50% silking (0.3), lodging (0.82%), fresh weight (11604.28) and dry weight (2488941.08). It is concluded that both 200SYN, 99EVDT and WSRT performed best among the genotype and the should be further improve to ascertain the finding of this research

Keywords: Fresh weight lodging, Maize, silking, traits

INTRODUCTION

Maize (*Zea mays L.*) is produce on nearly 100 million hectares in developing countries with almost 70% of the total production in the developing world coming from low and lower middle income countries (FAOSTAT, 2010). By 2050 demand for maize will be doubled in the developing world (Rosegrant *et al*., 2008). Heisey and Edmeades (1999) estimated that one quarter of the global maize area is affected by drought in any given year. It is a cross pollinated crop, its population comprises of freely interbreeding individuals in heterozygous at most loci and heterozygous. The crop is therefore advised to heterozygosity, which is an essential feature of maize cultivar (Thornton *et al*., 2009). Heterozygosity is either maintained during breeding process, or is restored at the end. Inbreeding leads to inbreeding depression resulting in reduction in vigour, size and appearance in lethal and sub-lethal (Thornton *el al*., 2009). The cultivar may be open pollinated (OP) population or hybrid. The choice of cultivar depends upon resources, stage of breeding programmed, seed production and social-economic factors. Hybrid guarantees have the advantage of higher yield potentials and uniformity. They are preferred over OP populations when there is sufficient heterosis. But their seed production is of high cost and complicated (Thornton *et al*., 2009). Major breeding methods are germplasm introduction, population improvement, and hybrid breeding. All these methods involve selection, which is the most important step in breeding program. Discriminating among individual numbers of offspring contracted to the next generation. It brings about changes in genes and genotype frequencies and result in improvement of genotypic value of the traits under consideration. Selection only act on already existing variability that has its own origin in spontaneous mutation and that get disrespected through natural hybridization, gene segregation and recombination. The naturally occurring variability may be augmented through index mutation and planned hybridization (Thornton *et al.*, 2009). Variability refers to the presence of difference among the individuals of plant population, the knowledge of variability present in the crop species plays an important role in formulating a successful breeding program to evolve superior cultivars (Abdurakhmonov and Abdukarimov, 2008). Genetic variability among individuals in the population offers effective selection (Rather *et al.*, 2003). Diversity among maize lines can be examined based on morphological traits (Xia *et al.,* 2005). Grain weight and grain yield; kernel weight and days to maturity, ear height, days to silking and cob length (Anjorin and Ogunniyan, 201); days to 50% anthesis, days to 50% silk emergence, days to maturity, grain yield, plant height and ear height (Muchie and Fentie, 2016) are variables that can contribute to genetic diversity assessment. Maize yields remain low and highly variable between years across sub Saharan Africa at 1.6 t ha[1], only just enough to reach self-sufficiency in many areas (2001 FAOSTAT, 2010). Therefore, this study was conceived to the agronomic performance of different maize varieties in the Sudan savannah agro-ecological zone of Nigeria.

MATERIAL AND METHODS

Experimental Site

The experiment was conducted during 2019 raining season at the Kano University of Science and Technology, Wudil research farm located at Gaya (Latitude 11° 52'N and longitude 9° 20'E with average of 800mm rainfall and soil type is sandy loam). It lies in the Sudan savannah agro-ecological zone (Kalawole and Ojo, 2007).

Source of maize varieties

The materials used in the experiment were ten different genotypes of maize collected from International Institute of Tropical Agriculture (IITA), Kano station. The genotypes used in the experiment are EVDT maize, TZE maize, Sammaz17, sammaz15, Sammaz25, 2000 SYN, Sammaze18, 99EVDTWSTR, IWDX2SYN, KUST maize.

Experimental design

The experiment was laid out in randomized complete block design (RCBD) which was replicated three times. One row plot was done. Two Seeds was sown per hole and then later thin to one. The inter and intra row spacing is 75cm by 25cm respectively. All the standard cultural practice use in maize production was carried out. Weeding was done manually at 2 and 6 weeks after sowing (WAS). Fertilizer was applied in split, using NPK (15:15:15) at 2 WAS and Urea at 4 weeks after first application. Data was collected on the following growth parameters: number of plants emerged, plant height, plant diameter, days to 50% flowering, days to 50% silk, lodging percentage, weight of plant per plot, fresh weight, dry weight

Statistical analysis

The data collected was subjected to analysis of variance (ANOVA) in accordance with general linear model (GLM) of SAS 9.0 (2001) and means were separated using Duncan Multiple Range Test (DMRT) at 5% probability.

RESULTS AND DISCUSSION

There is no significance difference ($P \leq 0.05$) among the genotypes for all the traits measured except for fresh weight indicating that substantial variation among the genotypes for the affected traits (Table 1). Number of plant per plot (1.9), plant height (57.71), plant diameter (0.25cm), days to 50% flowering (0.82), days to 50% silking (0.3), lodging % (0.82), fresh weight (11604.28kg) and dry weight (2488941.08kg as presented in Table 2The non-significant difference observed for most of the traits measured indicates that all the genotypes are the same with respect to the affected traits. This is in agreement with the results of-Akbar *et al.* (2008) have also reported that there are high different yield controlling traits in maize. The significant difference observed in fresh weight indicates substantial variation among the genotypes for the affected traits. This corroborates the findings of Pandey *et al* (2012) who reveal that ear length, yield per plot panicle length in maize. The results in Table 2 shows that genotypes SAMMAZ 25, SAMMAZ 17, KUST maize, TZE 99EVDT WSRT had the highest mean for NPE (9.33, 10.00, 9.33, 9.67and 9.33) respectively. The results also show that the mean for plant height ranges from the highest entry 44.20cm for SAMMAZ 25 to the lowest entry 32.76cm for SAMMAZ 17 with a CV of 10.40cm. For plant diameter the mean ranges from 3.03cm for KUST MAIZE to 1.93cm for SAMMAZ 17 and TZE maize with CV of 15.00% respectively. The mean for days to 50% flowering ranges from 55.67 for 2000syn to 54.33 for 99 EVDT WSRT and TZE with a CV of 1.58%. The mean of days to 50% silking ranges from 65.00 for 99 EVDT WSRT to 63.33 for SAMMAZ 25 with a CV 1.8%.

The mean for lodging percentage ranges from 1.33% for SAMMAZ 18 to 0.33 for 2000 SYN with the CV of 89.20, the mean for fresh weight ranges from 331.10 for SAMMAZ 15 to 274.00 for SAMMAZ 18 with the CV 7.73. The mean for Dry weight ranges from 234 for IWDC SYN to 149 SAMMAZ 17 with the CV 435.36. The least mean for plant height in SAMMAZ 17 indicates that it is less prone to lodging there's agreement with work of Dugje *et al* (2014). Since all varieties in this study received the same treatment, these differences may be attributed to the genetic composition.

The highest mean for KUST maize indicates that the plants may have bigger cobs thus increase the yield. Mehasen and El-Gizawy (2010) also aligned with same observation. There is negative relationship between plant diameter and days to 50% silk. The significant negative relationship observed between number of plants emerged and lodging percentage and 50% silking indicates that increase in number of plants emerged will result to decrease in lodging percentage (Table 3). This may be due to large number of plants population. The significant positive relationship was observed between plant diameter may increase in 50% flowering due the close spacing, the days to 50% silking the significant positive relationship May increase in plant diameter. The significance negative relationship between 50% flowering may decrease due to fresh weight.
It is concluded that both 200SYN, 99EVDT and WSRT performed best among the genotype and the should be further improve to ascertain the finding of this research.

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Table 1: Mean square for eight traits of maize varieties genotypes evaluated at Kano University of Science and Technology wudil farm during 2019 raining season.

Source of variation	DF	NPE	PH(cm)	PD(cm)	DFF	DFS	LGP	FWT(kg)	DWT(kg/plot)
Replication	2	1.49	57.71	0.25	0.82	0.3	0.82	11604.28	2488941.08
Genotype	9	1.24	30.47	0.29	0.88	1.81	0.53	1212.62	68106740.69
Error	18	0.9	18.37	0.16	0.76	1.48	0.35	516.29	834068.3

*, ***significant at 5% and 1% levels of probability respectively*

Df: Degrees of freedom, NPE: number of plant emergence, PH: plant height, PD: plant diameter, DFF: days to fifty percent(%) flowering, DFS: days to fifty percent silk, Lgp: lodging percentage, FWT: fresh weight, Dwt: dry weight

Table 2: Mean performers of eight traits of maize varieties genotypes evaluated at Kano University of Science and Technology wudil farm during 2019 raining season

Geno type Traits	NPE	PH	PD	DFF	DFS	LGP	FWT	DWT
SAMMAZ 25	9.33a	44.20a	2.80a	54.67ab	63.33a	0.33ab	314.90ab	157b
SAMMAZ 17	10.00a	32.76b	1.93b	54.67ab	56.00a	0.33ab	285.50cb	149b
SAMMAZ 15	8.67ab	42.53a	2.86a	54.67ab	65.33a	1.00ab	331.10a	157b
SAMMAZ 18	8.67ab	41.53a	2.67a	56.00a	64.33a	1.33a	274.00c	151b
99 EVDT WSRT	9.33a	40.33ab	2.53ab	55.33ab	65.00a	0.00b	279.07cb	153b
KUST MAIZE	9.67a	40.66a	3.03a	55.00ab	63.67a	1.00ab	276.30cb	162b
EVDT MAIZE	7.67b	42.76a	2.70a	54.67ab	63.33a	1.00ab	312.77cab	153b
2000 SYN	9.00ab	41.33ab	2.80a	55.67ab	63.33a	0.33ab	304.50cab	152b
IWDC2 SYN	9.00ab	43.83a	2.77a	54.67ab	64.33b	0.67ab	281.73cb	5234a
TZE MAIZE	9.33a	42.30a	1.93ab	54.33b	64.67a	0.67ab	275.93cb	166b
Mean	9.06	41.19	2.65	54.96	69.23	0.66	293.58	663.35
CV	10.51	10.40	15.00	1.58	1.89	89.20	7.73	435.36

*, ***significant at 5% and 1% levels of probability respectively*

Df: Degrees of freedom, NPE: number of plant emergence, PH: plant height, PD: plant diameter, DFF: days to fifty percent(%) flowering, DFS: days to fifty percent silk, Lgp: lodging percentage, FWT: fresh weight, Dwt: dry weight

Table 3: Correlation of eight traits of maize evaluated during 2019 raining season

	NPE	PH	PD	DFF	DFS	LGP	FWT	DWT
NPE	1.00	-0.31	0.06*	-0.15	-0.01*	-0.44	-0.17	-0.01
PH	-0.31	1.00	0.36	0.07	0.11	0.09	-0.13	-0.03
PD	0.06	0.03*	1.00	0.09*	-0.43	0.15	0.20	0.06
DFF	-0.15	0.07	0.09	1.00	0.03	-0.19	-0.04	0.21
DFS	-0.01	0.11	-0.43*	0.03	1.00	0.01	-0.55	0.10
LGP	-0.44*	0.09	0.15	-0.19	0.01	1.00	0.14	-0.19
FWT	-0.17	-0.13	0.20	-0.04**	-0.55	0.14	1.00	-0.04
DWT	-0.01	-0.03	0.06	0.21	0.1	-0.19	-0.04	1.00

**, **significant at 5% and 1% levels of probability respectively*

Df : Degrees of freedom, NPE: number of plant emergence, PH: plant height, PD: plant diameter, DFF: days to fifty percent(%) flowering, DFS: days to fifty percent silk, Lgp: lodging percentage, FWT: fresh weight, Dwt: dry weight

Effects of Nitrogen Forms on Growth and Yield of Amaranth (*Amaranthus hybridus*) in Southwest, Nigeria

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ABSTRACT
A field experiment was carried out at the experimental site of the Federal College of Forestry, Ibadan, Nigeria to investigate the growth and yield response of Amaranthus hybridus as affected by different Nitrogen sources. The experiment was laid out in a randomized complete block design (RCBD), replicated three times. The treatments were: (T1) Gliricidia sepium, (T2) Tithonia diversifolia, (T3) Chromoleana odorata, (T4) Urea and (T5) Control. Plant data collected include: number of leaves, stem girth, height and dry matter yield. The data collected were subjected to Analysis of variance and means were separated using least significant difference (LSD) at 5% level of significance. The results showed that there were significant (P < 0.05) differences among the treatments used with respect to plant height stem girth, number of leaves and yield respectively. Urea treated plot gave the highest number of leaves (19.17) while the least by control plot (T5) (11.33). The application of organic nitrogen sources gave good results in terms of yield most especially those treated with C. odorata. Therefore, it can be recommended that the use of C. odorata as source of nitrogen fertilizer will boost the organic production of A. hybridus as observed in this experiment.

Keywords: Amaranthus hybridus, Productivity, Organic and Nitrogen

INTRODUCTION
African leafy vegetables (ALVs) including amaranths are grown and consumed as leafy vegetables in various parts of Africa (Opiyo *et al.*, 2015; Smith and Eyzaguirre, 2007). Amaranthus are promising leafy vegetable crops considering their increasing availability in retail and supermarkets and have been ranked among the most preferred indigenous vegetables (Agong and Masinde, 2006). *Amaranth hybridus* L. belong to the family Amaranthaceae, and it is known to be domesticated in the highlands of tropical and subtropical Africa (Costea *et al*., 2001). Amaranth leaves are rich in calcium, phosphorus, folic acid, potassium, iron and vitamins A, B and C (AVRDC. 2003; Okpara *et al*., 2003; Oyedeji *et al*., 2014). The leaves and young plant are consumed as vegetables in soups and often gathered as pot-herbs (Juan *et al.*, 2007) It has a growing period of 5 to 6 weeks thus making it an advantage for 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 *et al*., 2011). Low soil fertility is a major cause of low yield of amaranth in Nigeria (Fasina *et al*., 2015). Among the essential nutrient for plant growth, nitrogen play a dominant role in plant growth as it is required for chlorophyll production as a constituent of enzymes, protein, nucleic acid and cell walls (Marschnerand, *et al*., 2011). To increase the availability of high quality amaranth, there is a need to use organic fertilizers such as manure and compost which are the most available or can be found in large quantities in local areas. However, this study is focused at assessing the effectiveness of locally available organic fertilizer and urea.

MATERIALS AND METHODS

The study was carried out at Federal College of Forestry (FCF) Jericho (latitude 7^0 23^IN, and longitude 3^0 15^IE) Ibadan, Oyo state. The annual rainfall pattern of between 1400mm and 1500mm with bimodal pattern and has a minimum temperature of 21.9 ^{0}C and maximum of 35.5^{0}C.

Field studies

A total land area of 90 m^2 was partitioned into fifteen plots, with each plot (vegetable bed) measuring 2m x 3m. Each plot was demarcated into three rows and separated from adjacent bed by 0.75m. Amaranthus seeds were obtained from Institute of Agricultural Research and Training IAR&T) Ibadan was broadcasted and later thinned after emergence to avoid overcrowding. The experiment was laid out in a 5 x 3 factorial in a randomized complete block design (RCBD), replicated three times. The treatments were: (T1) *Gliricidia sepium*, (T2) *Tithonia diversifolia*, (T3) *Chromolean aodorata* (T4) Urea and (T5) Control.

Data collection and analysis

Two vegetable plants from the mid-row of the experimental unit were randomly selected and used for data collection on Plant height, Stem girth, Number of leaves on weekly basis. Data collected were analyzed statistically using statistical package for social sciences. Means were separated using Duncan Multiple Range Test at 5% level of significance

RESULTS AND DISCUSSION

The soil of the experimental site is classified as Alfisol (Smyth and Montgomery, 1962). It is moderate in zinc, low in potassium and phosphorus. Organic carbon and total nitrogen content of the soil were 0.18% and 0.016% respectively which are below critical range (Adeoye and Agboola, 1985), it has low pH with low levels of extractable Mn and Fe content of 57.0 and 74mg/kg respectively (Table 1). There was significant ($p<0.05$) difference among the plant's number of leaves as affected by the different soil treatments with treatment T4 (Urea) having a significantly higher number of leaves (17cm) compared to other treatments (Table 4). The increase in number of leaves for Amaranth under urea and organic manure application confirms the role of fertilizer in promoting vegetative growth in leafy vegetables (Tijani-Eniola *et al*., 2000). Also, treatments applied significantly affected the plant height, T3 gave the highest value of 15.92 cm followed by T2 (15.72 cm), followed by T5 (11.99 cm) while the least height was recorded in control (Table 3). Similar result was observed by Elbehri *et al* (1993) who reported increased Amaranthus height at higher Nitrogen application rate. Among the five treatment used, T4 recorded the highest value for stem girth (0.55mm) followed by T3 (0.51mm) while T5 recorded the least (0.40mm) stem girth value (Table 2). The increased stem girth observed in this study could be attributed to increased availability of nutrients in the soil and uptake of the applied nutrients which gave rise to increased stem girth which resulted in the retention of appreciable amount of assimilates in the stem for node and leaf production (Bano, 1987). In relation to dry matter yield, there was significant difference among the treatments with the highest yield obtained from T4 (0.933kg) while T5 recorded the least yield (0.433kg). Pearson correlation indicated a significant positive relationship between plant growth and mineral elements (Table 6). Results on plant biomass accumulation revealed a positive correlation with mineral elements concentrations in the amaranth plants. Increase in calcium concentration in plant shoot resulted to parallel increase in plant growth. This is in agreement with the findings of Roosta *et al*. (2016) who demonstrated that enhanced plant growth was accompanied by increased concentrations of Ca content in egg plants.

CONCLUSION

Application of both urea and organic manure increased all growth parameters and dry matter yield of *A. hybridus*. With the performance, *A. hybridus* with urea treatment recording the highest yield, Nitrogen sources of fertilizer can be used by farmers to increase *A. hybridus* growth and yield. The use of *C. odorata* as source of nitrogen fertilizer will help boost the organic production of *A. hybridus*. Amaranthus production for consumption should be grown under mixed nitrogen forms for optimal growth and nutritional benefits in terms of mineral elements. Further research may be considered on effects of N forms on plant physiological processes and profiling of different phytochemicals as a tradeoff between biomass production and stress management under different environmental conditions in both grain and vegetable amaranth.

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Table 1: Pre-planting soil physical and chemical properties of the experiments site and analysis of organic manure

Parameters	Content in soil	*Chromoleana odorata*	*Tithonia diversifolia*	*Gliricidia sepium*
pH (H_2O)	5.81			
Organic carbon (%)	0.18	2.95	3.27	2.03
Total nitrogen (g kg^{-1})	0.016	0.255	0.282	0.176
Available phosphorus(mg kg^{-1})	6.48	2.25	3.54	3.51
Exchangeable cations (cmol kg^{-1})				
Ca	0.85	0.5	0.56	0.46
Mg	7.81	1.56	1.4	1.20
K	0.19	0.33	0.59	0.30
Na	0.54	0.042	0.061	0.027
Extractable micronutrient (mg kg^{-1})				
Mn	57.0	44.0	42.0	32
Fe	74	160	150	140
Cu	1.8	4.8	39	1.2
Zn	1.70			
Exchangeable Acidity (cmol kg^{-1})	1.1			
Particle size distribution (g kg^{-1})				
Sand	87			
Silt	6.4			
Clay	6.4			
Textural class	Sandy loam			

Table 2: Effects of Nitrogen Forms on Stem Girth of *Amaranthus hybridus* Weeks after planting (mm)

Treatment	1	2	3	4	5
T1	0.2000	0.2667	0.3667	0.4667	0.4667
T2	0.1833	0.2833	0.3500	0.4667	0.4667
T3	0.2667	0.3000	0.4500.	0.5500	0.5167
T4	0.2507	0.3000	0.4167	0.5167	0.5500
T5	0.1167	0.1667	0.3000	0.4000	0.4000
LSD	0.051	0.0445	0.0541	0.0532	0.0532

Table 3: Effects of Nitrogen Forms on Plant Height of *Amaranthus hybridus* Weeks after planting (cm)

Treatment	1	2	3	4	5
T1	6.400	9.150	9.833	11.450	15.500
T2	6.384	9.050	9.718	11.723	15.717
T3	6.617	9.067	9.633	11.531	15.917
T4	6.450	9.283	9.917	11.907	15.633
T5	4.083	5.083	7.700	7.700	11.867
LSD	0.158	0.348	0.531	0.531	0.498

Table 4: Effects of Nitrogen Forms on Number of Leaves of *Amaranthus hybridus*
Weeks after planting

Treatment	1	2	3	4	5
T1	6	9	12	13	17
T2	6	9	10	12	16
T3	6	9	11	13	17
T4	7	9	11	13	19
T5	4	5	5	7	11
LSD	0.90	0.84	0.87	0.86	0.85

Table 5: Effects of Nitrogen Forms on Yield of *Amaranthus hybridus*

Treatments	Weight (kg)/ha
T1	0.067
T2	0.063
T3	0.078
T4	0.103
T5	0.048
LSD	0.210

Table 6: Relationship between plant growth and mineral elements

	Shoot dry weight	Root dry weigh	Leaf area	Calcium	Zinc
Shoot dry weight	1				
Root dry weigh	0.92**	1			
Leaf area	0.88**	0.68*	1		
Calcium	0.76**	0.59	0.69*	1	
Zinc	0.65*	0.78*	0.64*	0.57	1

Effect of Phosphorus Fertilizer Rates on Growth and Yield of Three Soybean (*Glycine max*) Cultivars n Southwest Nigeria

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ABSTRACT
A field experiment was carried out at the Teaching and Research Farm of Federal College of Forestry, Jericho, Ibadan, Oyo State to determine the effect of different levels of phosphorus on the growth and yield of soybean cultivars (Glycine max). The experiment was laid out in a 3x3 factorial in a Randomized Complete Block Design (RCBD), replicated three times. The treatments were three soybean cultivars (Samsoy 1, TGX536-02D, and TGX533-65C) grown at different phosphorus levels; 0, 26 and 60 kg ha^{-1}. Each experimental unit had fifteen stands of soybean plants. Data were collected on plant height (cm), number of leaves/plant, number of branches/plant, stem girth (mm) and yield. Among the three cultivars, there was no significant difference in plant height, number of leaves/plant, number of branches/plant and stem girth. In the three levels of phosphorus used for the experiment, TGX533-65C (10.9 g) had the highest weight of 100 seeds followed by TGX536-02D (10.2 g) and the least by Samsoy1 (9.6 g) at 60kg ha^{-1}. However, at 26 and 0 kg ha^{-1}, TGX533-65C had the highest weight of 100 seeds (8.8 g and 5.8 g) followed by TGX536-02D (8.0 g and 5.8 g) and the least by Samsoy1 (7.6 g and 5.0 g). Therefore, TGX533-65C at 60 kg/ha of Phosphorus per hectare performed best in all the growth and yield attributes measured.
Keywords: TGX533-65C, Samsoy 1, TGX536-02D, Phosphorus; Rate

INTRODUCTION
Soybean (*Glycine max*) is one of the most importance sources of protein and oil and is commonly used in both human and animal diets (Ariyo, 1995). It is sensitive to day length and their production is influenced strongly by latitude. Although Northern Nigeria has been considered as the Northern fringe area for commercial soybeans production, soybeans are of economic important to the nation. The crop and livestock reporting service, United State Department of Agriculture, estimated the 1976 soybean crop to be worth more than fifteen million Dollars (Hidayat, 2005). The cultivated area of soybean in Nigeria in 2007 was 4.90 million per hectare, the total production was 8.90 tonnes and the yield per unit area was 1330kg per hectare compared with the large soybean producing countries, the yield of soybean in Nigeria is obviously low. The main reason for this practice is that the scale of soybean cultivated by farmers is small and therefore, advance cultural practices have not been adopted. Along with economic developments and improvements in people's living standards, the demand for soybeans in Nigeria is increasing rapidly and the domestic production of soybean cannot meet these demands (FAO, 2009). There are several constraining factors that lead to low levels of soybean production, these include, but not limited to, biotic and abiotic factors such as drought and low soil fertility status (Singh *et al.*, 2003). For example, the low levels of crop production in Nigeria have been attributed partly to declining soil fertility (Ramaru *et al.*, 2000). One of the causes of declining soil fertility is continuous cropping systems without the use of either organic or inorganic fertilizers. Incorporation of soybeans into the existing

cropping systems can help in reducing the rate of soil fertility decline. This is because soybean crop is capable of fixing atmospheric nitrogen to meet its requirements and those of subsequence crops (Aulakh *et al*., 2003). Also research shows that low native soil phosphorus availability coupled with poor utilization of efficiency of added phosphorus is a major constraint limiting the productivity of soybean. However, the use of phosphorus fertilizer is limited by its high costs, whereas organic inputs generally do not provide sufficient phosphorus for optimum crop growth due to their low phosphorus concentration (Aulakh *et al*., 2003). The optimal use of phosphorus fertilizers leading to increased phosphorus use efficiency should be encouraged. However, recommended appropriate phosphorus rates have not been developed for emerging small scale farmers. Furthermore, it was observed that phosphorus fertilization stimulates root growth, photosynthesis and increase hydraulic conductivity of roots (Radin, and Eidenbock, 1984). Therefore, the objective of this study was to determine the response of soybean cultivars to different levels of phosphorus application.

MATERIALS AND METHODS

The experiment was conducted at the Federal College of Forestry, Jericho, (Latitude 07^0 23^1N Longitude 03^0 53^1E) Ibadan, Oyo state. The annual rainfall is 1500 mm with a bimodal pattern and has a minimum temperature of 21.9^0C and maximum temperature of 35.5^0C and relative humidity of 80%. The entire fieldwas partitioned into 9 experimental plots each measuring 1.5m x 1m,the design is 3 x 3 factorial in a randomized complete block design (RCBD) replicated three times. Three cultivars of soybean (Samsoy 1, TGX536-02D and TGX533-65C) and three levels of phosphorus (Single Super Phosphate) at a rate of 0 kg ha^{-1}, 26kg ha^{-1} and 60kg ha^{-1}was used. Each experimental unit had fifteen stands making a total of 135 stands and planted to a depth of 5cm.Weeding was caried out at 6, 13 and 24 weeks after planting.

Data collection

Three plants from the mid–row of the experimental unit were randomly selected and used for data collection on plant height, stem diameter, number of leaves, number of branches at 3, 5, 7, and 9 weeks after planting (WAP). Data was also collected on number of pods, pod weight, number of seeds and weight of 100 seeds.

Data analysis

Data collected was analyzed statistically using Genstat statistical software package and it was subjected to analysis of variance. Means was separated using Least Significantly Difference (LSD) at 5% level of significance.

RESULTS AND DISCUSSION

Some physical and chemical properties of the experimental soil are as presented in Table 1. The soil is moderately acidic and sandy loam texture. The bulk density was 1.2g cm^{-3} with saturated hudraulic conductivity value of 12.64 cm h^{-1} which indicated that it is well drained and classified as an alfisol (Smyth and Montgomery, 1962). The organic carbon content (11.25 g kg^{-1}) and total nitrogen (1.21 g kg^{-1}) were lower than the critical level of 15.08 g kg^{-1}and 1.5 g kg^{-1} respectively (Adeoye and Agboola, 1985). The available phosphorus value of (2.69 mg kg^{-1}) was lower than the critical value of 10-16 mg kg^{-1}.

The concentration of Fe and Zn were within the critical value of 5-200 mg kg^{-1} and 1-5 mg kg^{-1}. Generally, the soil can be said to be deficient in major nutrients with the exception of exchangeable K which is still within the critical level. Effect of phosphorus levels on plant height (cm) on soybean as shows in table 2, At 3WAP, Samsoy 1 had highest height at 26 kg\ha of P levels (26.33cm) and the least height was obtained from TGX533-65C (20.33cm) but there was no significant different in Phosphorus levels, but there was significant different between cultivars and levels of interactions. From 5 to 9 WAP there was no significant different on P levels, cultivars and levels of interaction, but cultivar TGX533-65C had the tallest height at 26 kg\ ha of P levels (93.5cm). This result confirmed the work of Ariyo (1995) who recorded the highest plant with an increase P levels on different soybean plant. Effect of phosphorus levels on number of leaves on soybean as shows in Table 3, at 3 WAP soybean cultivars gave significant difference to P levels in term of leaves number per plant. At 5 and 7 WAP Samsoy 1 gave highest number of leaves at an increasing levels of phosphorus 60 kg/ ha (77.70) follow by TGX536-O2D at P levels of 0 kg/ ha (69.30) also at P level of 60 kg/ ha, the least values was gotten from TGX533-65C with mean value (73.30). Also at 9 WAP Samsoy 1 gave highest number of leaves at P level 0 kg \ha with mean value (93.70) but there is no significant different in the level of P applied. At 5 WAP there is a significant different on cultivars and levels of phosphorus interaction. This result is in line with (Gibson, 2002) who recorded a significantly difference on levels P applied also on both cultivars and levels interaction.

Effect of phosphorus levels on number of branches on soybean plant as shows in table 4, at 3 WAP there is no significant difference on both cultivars and P levels but TGX 533-65C had highest number of branches at 0kg/ha of P levels with mean value (9.33) but there is a significant difference on both cultivars and levels interaction. At 5 and 7 WAP there is no significant difference on both levels of phosphorus applied and cultivars. Moreover, there is a significant difference on both cultivars and phosphorus levels interaction both weeks. But at 9 WAP there is no significant difference on cultivars and levels of phosphorus applied, there is significant difference on cultivars and levels interactionTGX533-65C has the highest number of branches at 26 kg\ ha of levels of phosphorus applied with mean value (14.33).

Effect of phosphorus levels on stem girth of soybean plant as shows in Table 5, at 3 WAP there is a significant difference on levels of phosphorus applied also on cultivars and P levels interaction. At 5 WAP there is a significant difference at phosphorus levels applied. At 7 and 9 WAP there is no significant difference on cultivars, levels of P applied also on cultivars and levels interaction but Samsoy 1 has the highest stem girth at 60kg/ha of phosphorus applied with mean value (1.10) While the least stem girth was gotten from TGX533-65C at 60kg/ha of levels of phosphorus applied with mean value (0.633). This result confirmed the work of Ahon (1996) who stated that increase in P levels increase stem girth of soybean cultivars. The data presented in Table 6 showed the effect of phosphorus levels on yield parameters of soybean. Among the three cultivars used for the experiment, TGX533-65C (10.9 g) had the highest hundred seed weight followed by TGX536-02D (10.2 g) and the least by Samsoy1 (9.6 g) at 60 kg ha^{-1}. Also, TGX533-65C (8.8 g) had the highest hundred seed weight followed by TGX536-02D (8.0 g) and the least by Samsoy1 (7.6 g) at 26 kg ha^{-1}. However, at 0 kg ha^{-1}, TGX533-65C had the highest hundred seed weight (5.8 g) followed by TGX536-02D (5.8 g) and the least by Samsoy1 (5.0 g). The result is in line with Ikeogu and Nwofia (2013) who recorded that highest yield parameters occurred based on an increase in Phosphorus levels on the growth and yield of soybean.

CONCLUSION

Phosphorus fertilizer application influenced the yield to variable degrees. Hundred seed weight differed throughout the experiment and ranged from 5.0 g in the control plot to 10.9 g in TGX533-65C plots where 60 kg $ha^{-1}$of phosphorus was applied. Farmers who are interested in the vegetative yield of soybean, the three cultivars can be used for pasture purpose and TGX533-65C at 60 kg P $ha^{-1}$is recommended for grain yield of soybean especially in the study area.

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Table1: Pre-planting soil physical and chemical properties of the experimental site

Soil parameters	Content in Soil
pH [H_2O]	5.10
Organic carbon [g kg^{-1}]	11.25
Total Nitrogen [g kg^{-1}]	1.21
Available Phosphorus [mg kg^{-1}]	2.69
Exchangeable Cations [cmol kg^{-1}]	
Ca	0.49
Mg	1.21
K	0.28
Na	0.48
Extractable Micro nutrients [mg kg^{-1}]	
Mn	192.0
Fe	125.0
Cu	2.61
Zn	2.61
Exchangeable acidity [cm kg^{-1}]	2.5
Particle size distribution [g kg^{-1}]	
Sand	780.0
Silt	74.0
Clay	146.0
Textural Class	Sandy loam
Bulk density (g cm^{-3})	1.2
Saturated Hydraulic Conductivity (cm hr^{-1})	12.64

Table2: Effect of phosphorus levels on Plant Height (cm) on soybean plant

		Weeks after planting (WAP)			
Cultivars	**levels kg/ha**	**3**	**5**	**7**	**9**
C 1	0	18.67	39.33	62.5	75.3
	26	26.33	47.67	67.0	70.8
	60	25.17	53.67	69.2	77.0
C2	0	24.83	46.50	64.5	87.3
	26	21.00	39.17	56.00	77.8
	60	22.00	46.00	63.7	82.8
C3	0	26.00	42.83	65.3	83.0
	26	20.33	40.67	60.8	93.5
	60	19.17	36.50	58.5	77.7
LSD Cultivars		3.158^{ns}	4.093^{ns}	6.28^{ns}	5.49^{ns}
LSD Levels		3.158^{ns}	4.093^{ns}	6.28^{ns}	5.49^{ns}
LSD Cultivars × levels		0.1401 *	0.2215^{ns}	0.3640^{ns}	0.4202^{ns}

**= P ≤ 0.05, **= P 0.01 ns = not significantly different*

Table 3: Effect of phosphorus levels on the Number of leaves on soybean plant

		Weeks after planting (WAP)			
Cultivars	**levels kg/ha**	**3**	**5**	**7**	**9**
C 1	0	13.67	23.00	59.30	73.70
	26	14.33	33.70	64.00	93.70
	60	15.00	56.00	77.70	92.30
C2	0	15.67	50.30	73.70	88.00
	26	12.67	35.00	77.00	83.70
	60	13.00	39.30	69.30	85.70
C3	0	15.33	34.70	72.00	80.00
	26	11.33	31.00	70.30	79.30
	60	11.33	27.00	73.30	81.00
LSD Cultivars		1.726*	8.71^{ns}	16.41^{ns}	20.09^{ns}
LSD Levels		1.726*	8.71^{ns}	16.41^{ns}	20.09^{ns}
LSD Cultivars × levels		2.989^{n}	15.08**	28.43^{ns}	34.80^{ns}

**= P ≤ 0.05, **= P ≤ 0.01 ns = not significantly different*

Table 4: Effect of phosphorus levels on the Number of branches on soybean plant

		Weeks after planting (WAP)			
Cultivars	**levels kg/ha**	**3**	**5**	**7**	**9**
C 1	0	3.33	7.33	10.00	11.33
	26	6.67	8.33	11.00	12.67
	60	7.33	10.00	11.67	12.67
C2	0	8.67	11.67	13.00	13.33
	26	7.67	1.00	12.67	11.30
	60	5.67	9.67	11.33	11.33
C3	0	9.33	10.33	10.67	11.33
	26	6.33	6.67	12.33	14.33
	60	6.00	8.67	9.67	10.33
LSD Cultivars		1.537^{ns}	1.694*	1.683 *	1.548^{ns}
LSD Levels		1.537^{ns}	1.694*	1.683^{ns}	1.548^{ns}
LSD Cultivars × levels		2.662**	2.934*	2.916**	2.682**

*= P ≤ 0.05, **= P ≤ 0.01 ns = not significantly different

Table 5: Effect of phosphorus levels on the stem girth (mm) on soybean plant

		Weeks after planting (WAP)			
Cultivars	**level kg/ha**	**3**	**5**	**7**	**9**
C 1	0	0.200	0.367	0.600	0.700
	26	0.400	0.700	0.800	0.900
	60	0.567	0.633	1.000	1.100
C2	0	0.267	0.400	0.733	0.767
	26	0.267	0.333	0.667	0.733
	60	0.167	0.300	0.567	0.533
C3	0	0.333	0.367	0.667	0.633
	26	0.300	0.467	0.600	0.733
	60	0.233	0.267	0.667	0.633
LSD Cultivars		0.0809 ^{ns}	0.1279 ^{ns}	0.2105 ^{ns}	0.2426 ^{ns}
LSD Levels		0.0809*	0.1279**	0.2105 ^{ns}	0.2426 ^{ns}
LSD Cultivars × levels		0.1401*	0.2215 ^{ns}	0.3640 ^{ns}	0.4202 ^{ns}

**= $P \leq 0.05$, **= $P \leq 0.01$ ns = not significantly different*

Table 6: Effect of Phosphorus levels on yield parameters of soybean

(kg) Cultivars seed weight	Levels kg/ha	NP	Yield Parameters PW	NS	Hundred
C1	0	0.018	0.0053	0.0513	0.0053
	26	0.016	0.0058	0.0838	0.0080
	60	0.029	0.006	0.0863	0.0102
C2	0	0.025	0.0036	0.0457	0.0050
	26	0.026	0.0073	0.0773	0.0076
	60	0.030	0.0010	0.0787	0.0096
C3	0	0.027	0.006	0.0583	0.0058
	26	0.026	0.0093	0.0917	0.0088
	60	0.034	0.0106	0.1017	0.0109
LSD Cultivars		0.009	0.0028	0.0183	0.0006

**= $P \leq 0.05$, **= $P \leq 0.01$ ns = not significantly different*
C1 = TGX536-02D, C2 = Samsoy 1, C3 = TGX533-65C

Differential Soil Conservation Techniques and its Implication on Productivity of Arable Crop Farmers in Kogi State, Nigeria

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ABSTRACT

The study estimates the Total Factor Productivity and its determinants among arable crop farmers in Kogi State, Nigeria with a view to examining the implication of soil conservation techniques on their productivity. Data were collected from 184 farmers using multistage sampling technique. Data analyses were carried out using descriptive statistics, Total Factor Productivity (TFP) and regression analysis. Prevalent soil conservation Techniques were; application of inorganic fertilizer (19.6%), crop rotation (16.8%), alley cropping (14.7%), application of organic manure (13.6%), mulching (11.9%), bush fallowing (12.5%) and cover cropping (10.9%). Result also indicates that 36.4% of the sampled household heads were productive, i.e. have their productivity value above average across all the soil conservation technique categories. Determinants of TFP estimate reveals the following factors as having a significant contribution to productivity at ($p<0.05$) in the study area; age (-1.801), household size (-0.310), access to credit (-0.056), alley cropping (.357), crop rotation (.380), application of inorganic fertilizer (.503), mulching (.560) and organic manure (.373). While the age, household size and access to credit of household heads impacted negatively on productivity, all others impacted positively in the study area. The study concludes that soil conservation techniques are productivity enhancer. Promoting sustainable soil conservation techniques that are farm or farmer specific is recommended.

***Keywords**: Arable Crop Farmers, Determinants, Household Heads, Soil Conservation Techniques and Total Factor Productivity*

INTRODUCTION

Soil degradation is one of the most severe global environmental problems of this generation (Antonio, 2016). Even though degradation status is different from place to place, it is touching every corner of the world (Ouyang *et al*., 2018). This worldwide depletion of soil resources continues to be a serious threat, particularly, in the least developing countries, where agriculture is the main pillar of their economy (Zhu, 2014). It is threatening their survival on this planet as well as national prosperity. In Sub-Sahara Africa (SSA), smallholder farming dominates the agricultural landscape operating on less than 2 hectares in total land holding. These are the farmers that supply the urban population with food as well as contribute to the national economies of their individual countries. Yet, smallholder agriculture is constrained by many inter-related factors including low soil fertility, frequent dry spells, drought and unsustainable management practices. Traditional agricultural practices have diminished soil productivity to the extent that many agricultural soils are depleted of nutrients and unable to naturally sustain crop productivity. In the coming decades, a crucial challenge for agriculture in SSA will be meeting food demands without undermining further the environment. Increasing productivity and economic returns to smallholder farming in a sustainable manner is a central challenge to achieving global poverty reduction and environmental management objectives (FAO, 2012a). This calls for a rethinking on the current soil conservation practices employed by farmers for agricultural production Soil conservation according to Ezeaku (2012) is a set of management strategies for prevention of soil being eroded from the earth's surface or becoming chemically altered by over use, salinization, acidification, or other chemical soil contamination. It comprises the combination of all methods of management and land use to guard against soil depletion or deterioration by natural or man-induced factors. Traditionally, farmers employ several soil conservation practices ranging from simple agronomic practices, soil management and use of mechanical methods of soil management. The earth has about 7.86 billion acres of land potentially suitable for agriculture, half of which has been put into use (Schiller 1980). To boost agricultural production, there are two possibilities of either by bringing the rest of the land into cultivation or by increasing the output per acre. If the first option is to be heeded, there is imminent trouble staring at the human populace because a time shall come when there could be no more land to farm. Therefore, the importance of soil conservation in agriculture cannot be over emphasized. Based on this brief review of theory, the objectives of the present study are in three folds. First, to isolate the different soil conservation techniques prevalent among the arable crop farmers in the study area. Second, to estimate the productivity gap of the farming household heads stemming from the different soil conservation management practices most frequently practiced and third, to evaluate the determinants of total factor productivity in the study area.

MATERIALS AND METHODS

The Study Area

The study was carried out in Kogi State. It was carved out of former Benue and Kwara States of Nigeria. The state lies between latitude 6.33^0N and 8.44^0N of the equator and longitudes 5.22^0E. It thus spans the tropical rain forest on the southern fringes and the woody derived savannah and guinea savannah in the northern extreme. The state has a land mass of 29,833 square kilometers (km^2). According to the 2006 National Population Census (NPC), Kogi State has a population of 3,595,798 million. In the 1999 Village Listing Survey (VLS), about 80% of her population lives in the rural areas and are predominantly small scale farmers with approximately 228,964 farm families. The cultivation of arable crops such as rice, yam, cassava, sorghum, maize, millet, cowpea and groundnut predominate the agricultural practice.

Sampling Procedure

The study population was arable crop farmers living in the study area; the data used were collected from the 2015 production season. A three stage sampling technique was used in the study. The first stage was the random selection of four (4) local government areas from the state, the second stage was the random selection of twelve (12) communities/ villages from the selected local government areas with the number of communities/villages selected from each local government based on probability proportional to the number of communities/ villages in each local government. The last stage was the selection of the farmers from the selected villages/communities. A total of 200 copies of questionnaire were administered with only 184 returned with useful information that was used for the analyses as shown in Table 1.

Table 1: Sampling Procedure for the Selection of Farmers

State	LGAs	Communities	Number of questionnaire administered	Number of questionnaire retrieved
Kogi	Adavi	Edavi Eba, Inoziogolo and Osara	50	48
	Bassa	Gbokolo, Oguma and Sheria	50	44
	Igalamela	Akpanya, Amaka and Ogboligbo	50	45
	Yagba	Ilafin Ishanlu, Itedo	50	47
	East	Ishanlu and Mopo	200	184

Source: Field Survey, 2015

Analytical Technique

This study employed a number of analytical tools based on the objectives of the study. The tools include total factor productivity, and multiple regression. Total Factor Productivity Model as employed by Adepoju and Salman (2013) was used to estimate the productivity value of the farming household heads based on the soil conservation techniques most frequently practiced. Total Factor Productivity (TFP) is a method of calculating agricultural productivity by comparing an index of agricultural inputs to an index of outputs (Jean-Paul, 2009). Total factor productivity is therefore measured as the inverse of unit cost following Key and Mcbride (2003). This is the ratio of outputs in naira value to the total variable cost (TVC) of production:

$$\text{TFP} = \frac{Y}{TVC} \qquad (1)$$

Where Y = Output in Naira value in line with Mwuese and Okorji, (2014), TVC = Total Variable Cost.

$$\text{TFP} = \frac{Y}{\sum P_i X_i} \qquad i = 1, 2, \ldots..n \qquad (2)$$

Where Y = quantity of output in Naira and TVC = Total Variable Cost
Where P_i = unit price of ith variable input and X_i = quantity of ith variable input

The inputs used in line with Fakayode *et al*., (2008) are: Cost of labour, Cost of planting materials, Cost of inorganic fertilizer, Cost of herbicide, and Cost of pesticide. Following Akintayo and Rahji, (2011) to examine the impact of some socio-economic variables as well as soil conservation techniques on the Total Factor Productivity (TFP), the TFP estimate was subjected to ordinary least square regression to obtain the coefficient of multiple determinations (R^2), F- Statistics, standard error and their values. The ordinary least square regression model is a best linear unbiased estimator whose estimate possesses the desirable properties of unbiasedness, efficiency and consistency.

Model Specification

$$Q^* = f(x_1, x_2, x_3, x_4, x_{5 \ldots\ldots}\ x_{14\ .\mu}) \qquad (3)$$

Where,
Q* = TFP estimate
The Cobb-Douglas production function is specified as:

$$Q_i = A\ \pi_i\ Z_i^{\ bi};\ i = 1, 2, \ldots 14 \qquad (4)$$

The expanded form is:

$$Q_i = A\ Z_1^{\ b1} Z_2^{\ b2} Z_3^{\ b3} Z_4^{\ b4} Z_5^{\ b5 \ldots\ldots}\ Z_{14}^{\ b14} e^{ui} \qquad (5)$$

Following Gujarati (2004), the empirical model to be used for this study can be cast in double-log form as follows:

$$\ln Q_i = \ln A + b_1 \ln x_1 + b_2 \ln x_2 + b_3 \ln x_3 + b_4 \ln x_4 + b_5 \ln x_{5 \ldots\ldots\ldots}\ b_{14} \ln x_{14} + u\ 9 \quad (6)$$

Based on the view of Hussain and Perera, (2004) and as adopted by Adepoju and Salman, (2013) the following factors were hypothesized as the determinants of TFP of arable crop farmers in the study area.
x_1 = Age of household heads (years), x_2 Number of years of formal education, x_3 = Household size (number)
x_4 = Farming Experience (years), x_5 = Access to credit (Dummy Variable; Yes = 1 otherwise = 0)

x_6 = Farm Size (ha), x_7 = Extension contact (Dummy Variable; Yes = 1 otherwise = 0)
Vector of index of soil conservation techniques (Dummy Variable; Yes = 1 otherwise = 0)
x_8 = Alley cropping, x_9 = Bush fallowing, x_{10} = Cover cropping, x_{11} = Crop rotation, x_{12} = Application of inorganic fertilizer, x_{13} = Mulching , x_{14} = Application of organic manure
μ = error term which is assumed to be normally distributed and with mean zero and constant variance.

RESULTS AND DISCUSSION

Table 2: Household Soil Conservation Techniques

Land management Practices	%
Organic Manure	13.6
Bush Fallowing	12.5
Crop Rotation	16.8
Inorganic Fertilizer	19.6
Alley Farming	14.7
Cover Cropping	10.9
Mulching	11.9
Total	100.00

Source: Field Survey, 2015

Productivity Estimate in the Study Area

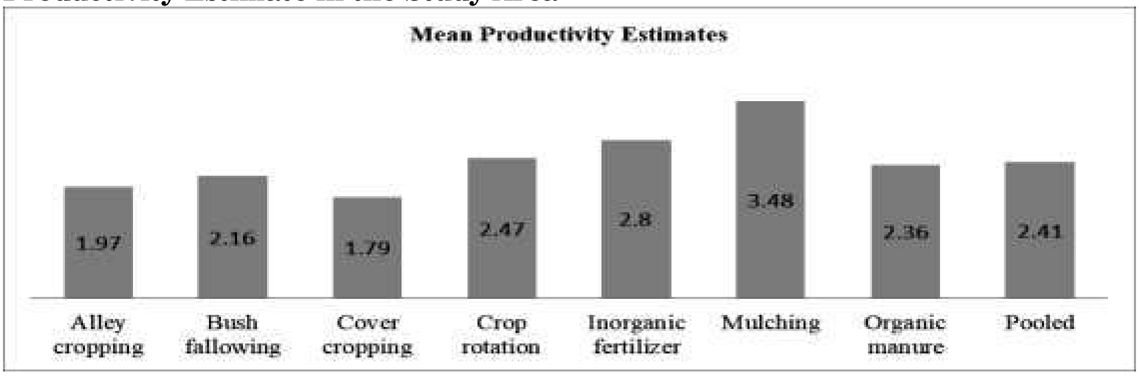

Figure 1 Presents the Total Factor Productivity estimate among arable crop farmers in Kogi State based on the soil conservation techniques they used most frequently.

As shown in Table 3, the adjusted coefficient of determination (R^{-2}) for arable crop farmers (0.91) indicates the presence of a high degree of association between productivity (dependent variable) and all independent variables. This implies that 90.79% of the variation in the farmers' productivity is explained by the variations in the independent variables. The F-statistics of the farmers (F-test= 139.82., $P<0.001$) was found to be highly significant, implying that the independent variables were collectively important in explaining the variation in the dependent one.

Of the fourteen explanatory variables specified, eight were statistically significant. These were age, household size, access to credit, alley cropping, crop rotation, inorganic fertilizer application, mulching and organic manure application. The negative coefficient ($p<0.01$) on age suggests that farmers were less productive as they age. Older farmers are not physically able to produce as much as younger household heads because farm experience is countered by declining physical strength and, perhaps, by negative attitudes toward innovation. The negative coefficient, which implies that a unit increase in farmers' age decreased productivity by 1.801, agrees with the findings of Ahmed and Elrasheed (2016).

Table 3: Factors Affecting Productivity of Arable Crop Farming Household Heads in Study Area

Variables	Coefficients	Standard error	T	P> | t |
Age	-1.801	.305	-5.90 ***	0.000
Education	.077	.055	1.40	0.165
Household size	-.310	.102	-3.02***	0.003
Farming experience	-.228	.156	-1.46	0.148
Access to credit	-.056	.023	-2.40**	0.018
Farm size	-.027	.025	-1.07	0.285
Access to extension	-.016	.024	-0.69	0.493
Alley cropping	.357	.199	1.79*	0.076
Bush fallowing	. .044	.198	0.22	0.824
Cover cropping				
Crop rotation	.380	.193	1.97**	0.051
Inorganic fertilizer	.503	.213	2.36**	0.020
Mulching	.560	.189	2.96***	0.004
Organic manure	.373	.195	1.91**	0.058
Constant	1.055	.937	1.13	0.262
R^2	0.914			
R^{-2}	0.9079			
Prob>F	0.0000			
F(13 147)	139.82			
N	184			

*** 1% significance level; ** 5% significance level *10% significant level

The coefficient of household size was negative and significant ($p<0.01$), implying that household size made a negative but significant contribution to productivity. This implies that a unit increase in household size will tend to reduce productivity by 0.31. The possible explanation could be that money and other resources which could be used to expand the farm and produce more are being used to meet the needs of the large family. It could also mean that the families have a high proportion of young children and aged people who consume family resources without contributing to family output. The result is consistent with the findings of Fawole and Rahji (2016). The coefficient of access to credit was negative but significant at ($p<0.05$) level, implying that a unit increase in the use of credit tends to reduce the productivity of respondents by 0.056. This is contrary to a priori expectation of a positive relationship between access to credit and output. The reason for the negative result could be due to the diversion of agricultural credit to non-agricultural uses. A negative coefficient is consistent with the findings of Mwuese and Okorji (2015). Though not significant, the positive coefficient in respect of education implies that a unit increase in the variable increased productivity by .077% while a negative coefficient in respect of farming experience, farm size and access to extension implies that a unit increase in these variables leads to .228, .027 and .016% reduction in productivity. In addition, all the land management practices were positively related to TFP, implying that increased use of any of the management practices lead to increased productivity. Although bush fallowing and crop rotation were not significant, cover cropping, inorganic fertilizer application, mulching and organic manure application were significant.

CONCLUSION

The result of Total Factor Productivity estimate indicates that arable crop farmers practicing mulching were the most productive while those practicing cover cropping were least productive. Practicing alley cropping, crop rotation, mulching and application of organic manure enhanced arable crop farmers' productivity in Kogi State. Since age is negatively related to productivity, it is therefore recommended that youth empowerment programme in the area should accord priority attention to agriculture so as to further encourage relatively young farmers into arable crop production. Household size is negatively related to productivity.

Hence, controlling the increase in family size should be a priority so as to address problems of resource degradation. Policy related to family planning, education and other means of reducing family size and dependency ratios will help reduce land degradation and increase crop production and per capita income. Soil conservation techniques are productivity enhancer; the need to promote sustainable soil conservation techniques that are farm or farmers specific is hereby recommended.

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Effect of Sowing Date and Fungicide on Number of Tillers of Pearl Millet Genotypes Infected with Downy Mildew Disease at Bauchi and Maiduguri

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ABSTRACT
Downy mildew caused by Sclerospora graminicola (Sacc.) Schroet is a major limiting factor to the production of pearl millet globally. Field trial was conducted in Bauchi and Maiduguri to evaluate the effects of different sowing dates and a fungicide on tiller production of three pearl millet genotypes infected with downy mildew disease. Randomized Complete Block Design was used with a factorial arrangement of treatments, which comprised three pearl millet genotypes (Gero, Maiwa, Dauro), three sowing dates (late-June, mid-July and late-July) and metalaxyl fungicide (treated and untreated). Findings showed that mean values of tillers significantly decreased from 8.7 - 3.4 tillers/plant, with every successive delayed sowing. Fungicide treatments generally indicated higher number of tiller/plants in the treated (5.9 - 7.4 tillers/plant) than untreated seed (4.7 - 5.8 tillers/plant) across the locations.
Keywords: Downy mildew, Sowing date, Metalaxyl, Tiller, Pearl millet genotypes

INTRODUCTION
Downy mildew disease, *Sclerospora graminicola* (Sacc.), tops all the diseases of pearl millet, both in terms of symptom expressions and yield losses (Mathur and Dalela, 1971). The disease manifests stunted growth and sterile/dead tillers at the vegetative growth stage, and green ear at the flowering stage (Khairwal *et al.,* 2007). Consequently, a wide range of yield losses from 15 - 65% occurs under different cultivars, disease management options and environments (Rajni *et al.,* 2017). Genetic resistance to downy mildew has been exploited in the Gero millet type, but Maiwa and Dauro millet remain untapped for this purpose (Angarawai *et al.,* 2016). While different cultivars react differently to infection, fungicides equally control the disease in the crop and thereby permit vigorous growth of the crop (Rajni *et al*., 2017). Sowing date captures variability in the growth environment within the season. Likewise, Metalaxyl, synthesized since 1973 by Ciba Geigy, has remained the major ingredient for the control of downy mildew as seed dressing chemicals (Singh and Shetty, 1990). Therefore, appropriate and well-matched options need to be adopted for the control of the disease. The objective of the study is to assess the effect of sowing date and fungicide (metalaxyl) on number of tillers infected with downy mildew disease of pearl millet.

MATERIALS AND METHODS
Three pearl millet cultivars; Gero, Maiwa, and Dauro were used at two trail sites in Northern Sudan Savanna of Maiduguri and Northern Guinea Savanna of Bauchi in Northeastern region of Nigeria. The sites were ploughed, harrowed, levelled and divided into plots sized 5.0 m x 4.5 m. Infector rows with a highly susceptible variety (7042S) was established between blocks,

three weeks before the test varieties, to serve as a source of inoculum. Seeds of the susceptible cultivar were mixed with infected leaf containing oospores ground into fine powder collected from the previous season to ensure maximum infection. The experiment was in a Randomized Completely Block Design (RCBD). There were 18 treatment combinations; each was replicated 3 times, making a total of 54 plots in the experimental units. Data were collected on number of tillers/plants to assess mortality due to downy mildew. Data collected were subjected to analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Effects of millet genotype, sowing date and fungicide on number of tillers at Bauchi and Maiduguri in 2018 and 2019 are shown in Table 1. Results in respect of genotypes at Bauchi indicated significant ($p<0.05$) difference in mean tiller counts, which ranged from 4.4 - 6.2 tillers in 2018, while the range was 5.1 - 6.9 tillers in 2019. Similarly, tiller counts in Maiduguri differed significantly ($p<0.05$) from 4.9 - 6.2 tillers in 2018, and 5.6 - 7.7 tillers in 2019. Results in both years and locations showed that Maiwa produced significantly more tillers than in Gero, which also gave higher tillers compared to Dauro. Results consistently showed that number of tillers differed significantly ($p<0.05$) among sowing date treatments in all years and locations. Mean tiller count among sowing dates at Bauchi ranged from 3.8 - 7.1 tillers and 4.1 - 7.6 tillers in 2018 and 2019, respectively. At Maiduguri, the range varied from 3.4 - 7.8 tillers and 4.1 - 8.7 tillers in 2018 and 2019, respectively.

These results consistently showed significant ($p<0.05$) decrease in tiller production as sowing was delayed. Thus, first sowing date by late June gave significantly higher number of tillers than in the second (mid-July), which was in turn higher than the third (late July). Results in respect of the fungicidal treatments also indicated significant ($p<0.05$) difference in which tillerability for treated and untreated check of 6.0 vs 4.7 tillers, and 6.3 vs 5.1 tillers, at Bauchi as against 6.2 vs 4.9 tillers and 7.4 vs 5.8 tillers at Maiduguri in 2018 and 2019, respectively. Thus, results consistently showed that number of tillers in the treated was significantly higher than in untreated check in both years and locations. However, Maiwa gave more tillers at Maiduguri than Bauchi in both years. Table 2 gives the interaction effects of genotype x sowing date on tiller production at Maiduguri in 2018.

Mean number of tillers among the different genotype x sowing date treatments significantly ($p<0.05$) ranged from 3.3 - 9.7 tillers, with highest and the lowest tiller production obtained in Maiwa in the first and third sowing dates, respectively. Maiwa gave significantly higher number of tillers under the first sowing date than Gero and Dauro. However, there was no significant difference in terms of tiller production among the genotype in the second and third sowing dates. Furthermore, tiller production in all genotype significantly decreased with each delayed sowing, except between first and second sowing dates in Gero, and second and third sowing date in Dauro. Table 3 shows the result for sowing date x fungicide interaction on tiller production in 2018 at Maiduguri. Number of tillers significantly ($p<0.05$) varied from 3.3 - 9.1 tillers. With the highest obtained with seed treatment in the first sowing date, while the lowest was obtained from the untreated in the third sowing date. Results for both first and the second sowing dates revealed significantly higher tiller production from seed treatment over the untreated. Conversely, seed treatment did not result in significant increase in tiller production over the untreated in the third sowing date.

CONCLUSION

In order to develop integrated package for management of downy mildew of pearl millet, it is apparent that certain agronomic practices have to be studied to achieve that goal. The study revealed that correct genotypes and proper agronomic practices have to be considered to improve pearl millet tiller production. Early planting increased tiller production than planting late. Treatment of seeds with metalaxyl before sowing increased tiller production of pearl millet.

Based on the findings, this study recommends that Maiwa is most appropriate for cultivation in the study areas and early sowing of Maiwa in late June and seed dressing using metalaxyl at the rate of 2.0 g a.i./kg, will effectively increase pearl millet tiller production.

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Table 1: Mean tiller production for millet genotypes, sowing date and fungicide treatment at Bauchi and Maiduguri, 2018 and 2019

Treatment	**Mean tiller count**			
	Bauchi		**Maiduguri**	
	2018	2019	2018	2019
Millet type (A)				
Gero	5.5	5.1	5.6	6.4
Maiwa	6.2	6.9	6.2	7.7
Dauro	4.4	5.1	4. 9	5.6
SE±	0.37	0.29	0.30	0.33
$LSD_{0.05}$	1.0603	0.8230	0.8760	0.9593
Sowing date (B)				
Late june	7.1	7.6	7.8	8.7
Mid july	5.1	5.3	5.3	7.0
Late july	3.8	4.1	3.4	4.1
SE±	0.37	0.29	0.30	0.33
$LSD_{0.05}$	1.0603	0.8230	0.8760	0.9593
Seed treatment (C)				
Treated	5.9	6. 3	6.2	7.4
Untreated	4.7	5. 1	4. 9	5. 8
SE±	0.30	0.23	0.25	0.27
$LSD_{0.05}$	0.8657	0.6720	0.7152	0.7833
Interaction				
A x B	Ns	Ns	*	Ns
A x C	Ns	Ns	*	Ns
B x C	Ns	Ns	Ns	Ns
A x B x C	Ns	Ns	Ns	Ns

*, ** = Significant at 5% and 1% probability level of the F-test

Table 2: Interaction effects of millet type x sowing date on tiller production at maiduguri, 2018

Millet type	First (late-June)	Second (mid-July)	Third (late-July)
		Maiduguri, 2018	
Gero	7.2	6.0	3.5
Maiwa	9.7	5.5	3.3
Dauro	6.7	4.5	3.5
SE±	0.53		
$LSD_{0.05}$	1.5172		

Table 3: Interaction effects of sowing date x fungicide on tiller production at Maiduguri, 2018

Sowing date	Treated	Untreated
	Maiduguri, 2018	
Late-June	9.1	6.6
Mid-July	6.0	4.7
Late-July	3.6	3.3
SE±	0.43	
$LSD_{0.05}$	1.2388	

Morphological Description of Some Soils in Dama, Minna, Niger State

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ABSTRACT
Adequate soil data is necessary for agricultural production and sustainable land use. The research was conducted in Dama, Minna. The study area was surveyed using the rigid grid method of soil survey. Two soil units (DAM-A, DAM-B) were identified; four Pedons were dug to represent the two soil units and were described using the FAO guideline. The morphological properties of the soils revealed that the surface soils were characterized by very dark brown (10YR 3/3) colour in DMP1, dark yellowish brown (10YR 3/4) colour in DMP4, dark greyish brown (10YR 4/2) colour in DMP2 and very dark greyish brown (10YR 3/2) colour in DMP3. The texture of the soils ranges from sandy loam (DAM-A) to clay loam (DAM-B) at the surface to sandy clay loam and clay (DAM-A, DAM-B) at the sub-surface soil.
Keywords: Morphological properties, soil survey, sustainable land use

INTRODUCTION
Soil, a major component of the earth's ecosystem is the mixture of minerals, organic matter, gases, liquids and countless organisms that support plant life. It is considered to be the "Skin of the earth" with interfaces between the lithosphere, hydrosphere atmosphere of earth, and biosphere. Soil is the end product of the influence of the climate, relief, organism and parent materials; and it continually undergoes development by way of numerous physical, chemical and biological processes. It offers plants with physical support, air, water, temperature modulation, nutrient and protection form toxins. Soils provide readily available nutrients to plant and animal by converting dead organic matter into various nutrient forms (Adeyolanu *et al*., 2017). Soil morphology refers to soil properties such as soil colour, texture, structure, consistence, which are observed and studied on the field and it gives very important information of changes or evolution that occurred in the soil body. It also serves as the initial information in soil classification (Mansyur *et al.,* 2019). The productive potential of any soil depends on its morphological characteristics and properties such as structure, texture, and consistence can influence the fertility status of soils (Nsor and Ibanga, 2008). Proper management of the world soil resources can ameliorate the global problem of hunger and malnutrition (Brady and Weil, 2010).

The population of the world and that of the sub-Saharan Africa in particular since the late 1960's is increasing at an alarming rate with no corresponding increase in food production to meet the teaming population (Wahua, 2002). Owing to this increase in population, there is an increasing demand on land which in many instances, prime land is converted to non-agricultural use such as construction activities, increased urbanization, and industrialization, thus increasing food insecurity. To meet the increasing demand for food, farmers have to produce more and on the other hand, land is limited, so it is essential to understand the nature and properties of soils in order to preserve soils for future generations and for their most efficient use (Selassie *et al*., 2014). Thus, this study is aimed at generating information on the morphological properties of the soils of Dama in Bosso Local Government Area of Niger state.

METHODOLOGY

The Study Area

The study area is located in Dama, Bosso Local Government Area, Minna, under Southern Guinea Savanna and lies within latitude 9°33'5" N and latitude 9°33'40" N, and longitude 6°28'10" E and longitude 6°27'30" E. Minna falls under sub-humid tropical climate with two distinct seasons, namely dry and rainy season with mean annual rainfall of 1229 mm, and its temperature of 35°C is high throughout the month of March and June (Ojanuga, 2006: Nwaloka *et al*., 2018).

Field Study

A reconnaissance field survey was first carried out to have an overview of the study site and to generate information. About 102.16 ha land area was covered for the survey. Rigid grid method of survey was adopted for soil examination and delineation of soil mapping units, with traverse at 100 m interval along an established baseline and auger observations were at intersect traverses of 100 m interval. Two soil mapping units were identified and at least two profile pits (pedons) were dug in each soil mapping unit and the pedons were described according to the FAO (2006) manual. Observations of soil morphological characteristics in each horizon included soil colour using Munsell Soil Color Charts, texture by feel method, structure, consistence.

RESULTS AND DISCUSSION

Morphological Characteristics

The results on morphological properties of the pedons studied are presented in Table 1. Under soil unit DAM-A, the soil colour for DMP1 changes from dark brown (10YR 3/3) to brown (10YR 4/3) to light brownish grey (10YR 6/2) to yellowish brown (10YR 5/4) and that of DMP 4 changes from dark yellowish brown (10YR 3/4) to dark brown (10YR 3/3) to brown (7.5YR 4/4) to yellowish red (5YR 4/6) to yellowish red (5YR 5/6) across all the horizons with mottles at the first and third horizons of DMP1. The brown colour suggests that the soils are well drained. Also the yellowish colour in DMP1 and DMP4 may be as a result of the presence of sesquioxides in hydrated form (Lawal *et al*., 2013). The soil texture ranged from sandy loam in the first and second horizon to sandy clay loam in the third and clay in DMP1 and from sandy loam in the first and second horizon to sandy clay loam in the third horizon and clay in the fourth, fifth and sixth horizons in DMP4. Soil Structure ranged from massive granular at the first and second horizon and angular blocky at the third and fourth horizon with a clear smooth to gradual wavy horizon boundary in DMP1 and from massive granular in the first and second horizon to massive sub-angular blocky in the third and fourth horizon and massive angular blocky in the fifth and sixth horizon with a gradual wavy to diffuse wavy horizon boundary in DMP4. Soil consistency varied from friable at the first horizon, loose in the second horizon, firm in the third horizon and very firm in the fourth horizon and slightly sticky in the first horizon, non-sticky in the second horizon and sticky in the third and fourth horizon in DMP1 and varied from loose at the first horizon, friable in the second and third horizon and firm in the fourth, fifth and sixth horizon and non-sticky in the first horizon, slightly sticky in the second and third horizon and sticky in the fourth, fifth and sixth horizon in DMP4. Under soil unit DAM-B, the soil colour for DMP2 changes from dark greyish brown (10YR 4/2) to greyish brown (10YR 5/2) to light brownish grey (10YR 6/2) to light grey (10YR 7/2) and in DMP3 from very dark greyish brown (10YR 3/2) to dark yellowish brown (10YR 4/6) to yellowish brown (10YR 5/4) to light yellowish brown (10YR 6/4) across all the horizons with mottling across all the horizons of DMP2. The greyish colour with mottles in DMP2 may be due to poor internal drainage of the soil (Esu, 2010). The soil texture ranged from clay loam at the first horizon to clay in the second, third and fourth horizon in DMP2 and from clay loam in the first and second horizon to sandy clay in the third, gravelly in the fourth due to the presence of large stones and clay in the fifth horizon in DMP3. Structure across all the horizons were massive sub-angular blocky with gradual wavy horizon boundary in DMP2 and varied from weak sub-angular blocky in the first and second horizon to crumby in the third horizon and coarse gravelly in the fourth horizon and massive angular blocky in the fifth horizon with gradual wavy horizon boundary in DMP3. Soil consistency varied from friable in the first horizon, firm in the second and third horizon and very firm in the fourth and slightly sticky in the first horizon and sticky in the second, third and fourth horizon in DMP 2 and from frim in the first and second horizon, friable in the third horizon and firm in the fifth horizon and slightly sticky in the first and second horizon and sticky in the third and fifth horizon in DMP3.

CONCLUSION

The morphological properties of the soils of Dama shows that the soils are deep, DAM-A predominantly had brownish soils which is evidence of a well-drained soil while the soils of DAM-B predominantly had greyish soils which is evidence of imperfectly drained soil. The texture of the soils ranged from sandy loam in DAM-A to clay loam in DAM-B at the surface to sandy clay loam and clay in both DAM-A and DAM-B at the sub-surface.

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Table 1: Morphological properties of the soils

Soil Unit	Pedon	Horizon	Soil Depth (cm)	Colour (moist) Soil Matrix	Colour (moist) Mottles	Texture*	Structure*	Consistence*	Boundary*
DAM – A	DMP1	1	0– 14	10YR 3/3	7.5YR 6/8	sl	2mg	wss,mfr	cs
		2	14– 24	5YR 4/3		sl	1mg	wns,ml	as
		3	24– 98	10YR 6/2	10YR 7/8	scl	1mabk	ws,mf	dw
		4	98– 173	10YR 5/4		c	2mabk	ws,mvf	gw
	DMP4	1	0– 14	10YR 3/4		sl	1mg	wns,ml	dw
		2	14– 29	10YR 3/3		sl	1mg	wss,mfr	gw
		3	29– 42	7.5YR 4/4		scl	1msbk	wss,mfr	gw
		4	42– 81	5YR 4/6		c	2msbk	ws,mf	dw
		5	81– 106	5YR 4/6		c	3mabk	ws,mf	dw
		6	106– 195	5YR 5/6		c	3mabk	Ws,mf	dw
DAM – B	DMP2	1	0– 20	10YR 4/2	7.5YR 6/8	cl	1msbk	wss,mfr	gw
		2	20– 51	10YR 5/2	7.5YR 5/8	c	2msbk	ws,mf	gw
		3	51– 105	10YR 6/2	Mottled	c	3msbk	ws,mf	gw
		4	105– 161	10YR 7/2	Mottled	c	3msbk	ws,mvf	gw
	DMP3	1	0– 18	10YR 3/2		cl	1msbk	wss,mf	gw
		2	18– 44	10YR 4/6		cl	2msbk	wss,mf	gw
		3	44 – 105	10YR 5/4		sc	2sg	ws,mfr	gw
		4	105 – 163			gr	1cgr		
		5	163 – 180	10YR 6/4		c	3mabk	ws,mf	gw

*Texture: sc = sandy clay, sl = sandy loam cl = clay loam, l = loam, scl = sandy clay loam, c = clay
*Consistence: m=moist, w = wet, l = loose, fr = friable, vfr = very friable, vf = very firm, f = firm, s = sticky, ss = slightly sticky, ns = non sticky.
*Structure: 0 = Structureless, 1 = weak, 2= moderate, 3 = strong, m = medium, f = fine, c = coarse, sbk = sub-angular blocky, abk = angular blocky, ma = massive, cr = crumb.
*Boundary: a = abrupt, w = wavy, s = smooth, c = clear.

Effects of Pig and Goat Droppings on Soil Physico-Chemical Properties and Yield of Cucumber *(Cucumis sativus L)*

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ABSTRACT
This study was carried out at the Teaching and Research Farm, Lagos State Polytechnic Ikorodu to determine the effects of different levels of goat and pig droppings on the performance of cucumber (Cucumis sativus). The experiment was laid out on Randomized Complete Block Design with five treatments replicated three times. The treatments applied were goat and pig droppings at 0, 5 and 10 tonnes per hectare. Data collected were vine length (cm), vine girth (cm) number of leaves, number of branches, and days to 50% flowering, weight of fruit (kg), number of fruits, length of fruit (cm) and width of fruits (cm). The result of the data analysis indicated that number of branches of cucumber, its length and diameter were significantly affected by the different rate of goat and pig droppings application. Based on the outcome of the study, 5 tonnes per hectare of goat manure should be adopted for farmers in Ikorodu Local Government Area of Lagos State to improve soil physio-chemical properties and to enhance crop growth and yield. However, further research should be carried out to determine the rate of manure suitable for the optimum yield of cucumber (Cucumis sativus)
Keywords: Pig droppings, Goat dropping, soil physiological properties, yield, cucumber

INTRODUCTION
Cucumis sativus is a widely cultivated plant in the gourd family, Cucurbitaceae. It is a creeping vine that bears cucumiform fruits that are used as vegetables. There are three main varieties of cucumber: slicing, pickling, and seedless. Within these varieties, several cultivars have been created. The cucumber is originally from South Asia, but now grows on most continents. Many different types of cucumber are traded on the global market (Nonneck, 1989; Wells, 2016). Production of cucumber in Nigeria has increased probably due to awareness being created by its market demand and economic returns, short duration in maturity or due to its nutritional and medicinal values. Hence it has become a popular vegetable crop in Nigeria. Both older and young people enjoy the cucumber fruit of which many in their leisure time usually eat with fried groundnut in their offices, homes, and market place or recreational areas. This crop required high amount of soil nutrients from seedling stage to maturity and highly sensitive to excessive water or water-logs environment and adequate soil tillage for easy fragile root penetration, is required prior to sowing or planting (Nweke *et al*., 2014). Nigeria soil has high potential for crop production but yields levels obtained under farmer's condition are usually low due to poor soil management and conservation method, because of problems associated with the use of chemical fertilizers as its scarcity, high cost, ineffectiveness due to blanket use, soil acidity, nutrients, hence the use of organic fertilizers to solve all these problems. This necessitates the need to carry out research for good and economical soil management practices in other to improve the soil condition and reduce harm caused by the use of inorganic fertilizers thereby increasing the productivity of arable land. The main objective of this study is to

determine the effect of variable rates of pig and goat droppings on the soil physiochemical properties and yield of cucumber (*Cucumis sativus*).

MATERIALS AND METHODS

Experimental location, land preparation, experimental design and treatments

The experiment was carried out at the Teaching and Research Farms of Lagos State Polytechnic, Ikorodu, Lagos State Nigeria. The experimental site has been under continuous cultivation for over three years without any forms soil amendments. The land was ploughed and harrowed to a fine tilt using a disc plough and harrow. The experiment was laid out in Randomized Complete Block Design (RCBD) because of the heterogeneity of soil at the experimental location. The experiment was carried out on a total area of land measuring 100.8m^2 which was divided into 3 blocks of 18m x 1.2m (2.6m^2), each plot size is 1.2m x 3m (3.6m^2) with a discard of 0.5m to give a total number of 15 plots. Pig and goat droppings were obtained from nearby farm (Farm Settlement Odogunyan, Ikorodu, Lagos State). The droppings were cured and applied two weeks before planting by broadcasting method to allow for mineralization (Eifediyi and Remison, 2010). Five (5) treatments was used throughout the study which are; Goat droppings (5 and 10 tons ha^{-1}), pig droppings (5 and 10 tons ha^{-1}) and the control plot, which were replicated three times.

Crop establishment and maintenance

Cucumber seeds were obtained from agro-allied store Sabo market Ikorodu, Lagos State. Planting was done directly on the main field at a spacing of 60cm x 75cm (Chude *e tal*., 2004) at two seeds per hole then thinned to one stand each at one week after planting and transplanting was also done to supply missing stands to give a total of 8 plants per plot and a total of 120 plants. Manual weeding was carried out on a weekly basis with the use of hoe, which was due to the high grasses infestation and the high rains during the course of the project. Spraying of insecticides and fungicide was done at biweekly intervals to ensure effective chemical control of insects and fungi attacks at seedling stage.

Data collection and Statistical Analysis

Four (4) plant stands was randomly sampled and tagged per plot for data collection. Data that were collected include: Growth Parameters; number of leaves, vine length (cm), and number of branches. Yield Parameters; number of days to 50% flowering, number of fruits per plot, length of the fruits (cm), fruits diameter (mm), weight of fruits per plot (kg). Data collected were subjected to Analysis of Variance (ANOVA), and means of treatments were compared using Duncan Multiple Range Test (DMRT) at 5% level of probability using SAS (version 9.4).

RESULTS AND DISCUSSION

Effect of goat and pig droppings on number of leaves of Cucumis sativus

Table 1 showed that the number of leaves of cucumber was not significantly affected by different rate of application of goat and pig droppings at 5% level of significance. At 2 WAP, the highest mean number of leaves (4.83) was observed from *C. sativus* grown with 10tons/ha of pig droppings. However, at 4 WAP the highest mean number of leaves (14.11) was observed from those grown with 10 tons/ha of goat dropping. Meanwhile, at 6 WAP the least mean number of leaves (19.67) was observed from cucumber grown without manure application (control 0 ton/Ha).

Effect of goat and pig droppings on vine girth (cm) of Cucumis sativus

Result in Table 1 shown that at 2 WAP, the thickest stem girth of 0.87 cm was achieved with 5 tons/ha of pig droppings, while the thinnest stem girth of 0.21cm was observed from cucumber grown without manure application (control 0 ton/ha). Whereas, at 4 WAP the thickest stem girth of 0.72 cm was 1.19 obtained from those supplied with 10 tons/ha of pig droppings. However, at 6 WAP the thickest stem girth of 1.19cm was also obtained from plot with 10 tons/ha of pig dropping.

Effect of goat and pig droppings on number of branches of Cucumis sativus

Table 1, revealed that at 4 WAP the treatments means were significantly different from one another, where the highest mean value of branches (10.58) was produced with no manure goat droppings while the least was observed from those grown with pig droppings of 5 tons/ha and it was also observed that plots with goat droppings at 5tons/ha had same mean value (8.0) as with 10 tons/ha of pig droppings. However, at 6 WAP *C. sativus* grown without manure application (control 0 ton/ha) had the highest (19.5) number of branches when compare to those with 10 tons/ha of pig droppings (16.0) and with goat droppings of 10 tons/ha (13.89).

Effect of goat and pig droppings on vine length (cm) of Cucumis sativus

From Table 1, the vine length of cucumber was not significantly affected by different rate of application of goat and pig droppings at 5% level of significance. At 4 WAP the longest vine (12.21 cm) was obtained from plot amended with goat droppings of 10 tons/ha and it was observed that goat dropping of 5 tons/ha and pig droppings of 10 tons/ha had same mean value (11.58 cm) while the shortest vine length (8.00cm) was obtained from *plots* without manure application (control 0 tons/ha). At 6WAP the longest vines (22.20) was observed from plots grown without manure application (control 0 tons/ha).

Effect of goat and pig droppings on days to 50% flowering of Cucumis sativus

Table 4, the different rate of application of goat and pig droppings had no significant effect on 50 days to flowering. *Cucumis sativus* grown with goat droppings at 5tons/ha had the highest (35.58) days to 50%flowering while the least days (32.17) was obtained from goat droppings at 10 tons/ha.

Effect of goat and pig droppings on number of fruits of Cucumis sativus

According table 4, Cucumber grown with 5 tonnes/ha of goat droppings significantly produced the highest fruits with mean value of 8.10 than 7.47 mean number of fruits obtained from Cucumber grown with 10 tonnes/ha of goat droppings which was also significantly different from Cucumber grown with 5 tonnes/ha of pig droppings (7.22), 10 tons/ha of pig droppings (7.15) and 6.41 mean number of fruits obtained from Cucumber grown with no manure application.

Effect of goat and pig droppings on fruits length (cm) of Cucumis sativus

From table 4, the application rate of goat and pig droppings had no significant effect on the fruit length of cucumber. Cucumber grown with 5 tonnes/ha of goat droppings produced the longest fruits with mean value of 19.78 cm, followed by 19.45 cm mean fruit length obtained from cucumber grown with 5 tonnes/ha of goat droppings while the shortest fruit with mean value of 12.72 cm was obtained from cucumber grown without manure application.

Effect of goat and pig droppings on fruits diameter (cm) of Cucumis sativus

According to Table 4, Cucumber grown with 5 tonnes/ha of goat droppings produced the fattest fruit with mean value of 23.55cm, followed by 20.40 cm mean fruit width obtained from Cucumber grown with 10tonnes/ha of goat droppings which was significantly different from 5.74 cm, 15.14 cm and 3.96 cm mean fruit width obtained from Cucumber grown with 5 tonnes of pig droppings, followed by Cucumber grown with 10 tonnes of pig droppings and Cucumber grown without manure application.

Effect of goat and pig droppings on fruits yield (kg) of Cucumis sativus

From Table 4 the fruits weights of cucumber were not significantly affected by different rate of application of goat and pig droppings at 5% level of significance. Cucumber grown with 5 tons/ha of goat droppings produced the highest fruits weight of 0.67 kg/plot while least fruits weight with mean value of 0.40 kg/plot was obtained from Cucumber grown without manure application.

Statistical analysis indicated that number of branches of cucumber was significantly affected by the different rate of application of goat and pig droppings. In terms of yield, goat droppings at 5 tonne per hectare performed best in most growth parameters followed by 10 tons/ha of pig droppings, although there was no significant different in terms of yield but however yield parameters had best performance from 5 tons/ha of goat manure, This result is support to the findings of Chiezey and Odunje (2009) who observed that application of organic manure gives significant improvement in crop growth and yield.

CONCLUSION

In terms of growth parameters 5 and 10 tonnes per hectare goat droppings had the best performance even if there was no significant difference but however, in terms of yield 5 tonnes per hectare of goat droppings had a better performance.

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Table 1: Effect of goat and pig droppings on growth of *Cucumis sativus* at 2 weeks after planting (WAP)

Manure Types and Quantity	No. of leaves	Vine girth (cm)
5 tons/ha Goat dropping	1.83	0. 28
10 tons/ha Goat dropping	3.42	0.29
5tons/ha Pig dropping	4.75	0.87
10 tons/ha Pig dropping	4.83	0.29
Zero manure application	4.33	0.21
	ns	ns

Table 2: Effect of goat and pig droppings on growth of *Cucumis sativus* over the period of 4 weeks after planting (WAP)

Manure Types and Quantity	No. of leaves	Stem girth (cm)	No. of branches	Vine length (cm)
5 tons/ha Goat dropping	13.25	0.62	8.00ab	11.58
10 tons/ha Goat dropping	14.11	0.65	6.94ab	12.21
5tons/ha Pig dropping	11.33	0.61	5.50b	9.88
10 tons/ha Pig dropping	12.17	0.72	8.00ab	11.58
Zero manure application	9.750	0.59	10.58a	8.00

Values represent treatment means. Means were separated using Duncan multiple range test and means within a column followed by different letters are significantly different at P≤0.05

Table 3: Effect of goat and pig droppings on growth of *Cucumis sativus* over the period of 6 weeks after planting (WAP)

Manure Types and Quantity	No. of leaves	vine girth (cm)	No. of branches	Vine length (cm)
5 tons/ha Goat dropping	45.42	1.17	12.25b	15.68
10 tons/ha Goat dropping	25.03	1.03	13.89ab	12.61
5tons/ha Pig dropping	20.67	1.11	11.00ab	12.10
10 tons/ha Pig dropping	22.17	1.19	16.00ab	12.50
Zero manure application	19.67	1.09	19.50a	22.20

Values represent treatment means. Means were separated using Duncan multiple range test and means within a column followed by different letters are significantly different at P≤0.05

Table 4: Effect of goat and pig droppings on yield component *Cucumis sativus*

	Number of days to 50% flowering	NF	FL (cm)	FD (mm)	FW (kg/ plot)
5 tons/ha Goat dropping	35.58	8.10	19.78	23.55	0.67
10 tons/ha Goat dropping	32.17	7.47	19.45	20.40	0.55
5tons/ha Pig dropping	33.58	7.22	15.33	15.14	0.53
10 tons/ha Pig dropping	33.17	7.15	14.16	5.74	0.53
Zero manure application	33.08 Ns	6.41 ns	12.72 ns	3.96 ns	0.40 ns

NF = Number of fruit, FL = Fruit length, FD= fruit diameter, FW= fruit weight

Performance Evaluation of Chickpea (*Cicer arietinum* L) Varieties in Jigawa State, Nigeria

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ABSTRACT
A field experiments was conducted during the 2020 raining season at Hadejia and Kazaure both in Jigawa State to evaluate the performance of some chickpea varieties (ICCV 93954, ICCV 95423 and ICCV 97105) sourced from International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) India. All plots received a uniform basal application of fertilizer at the rate of 20kgN/ha and 60kgP$_2$O$_5$/ha respectively. Plant protection measures and agronomic practices were carried out. The research shows that Variety had significant influence on grain yield in both locations. ICCV 93954 significantly out yielded the other two varieties. In both locations ICCV 95423 recorded minimum grain yield.
Keywords: Chickpea, grain yield, performance, varieties

INTRODUCTION
Legumes are an excellent source of good quality protein in human diets and they are also valuable as animal feed. Legumes also increase and sustain the productivity of soil and when grown in rotation with cereals reduce chances of build-up of diseases, insect-pests and weeds for the succeeding cereal crops (Sabaghpour, 2004). Chickpea (*Cicer arietinum* L), also called Garbanzo bean is a grain legume crop grown primarily for its nutritional value. Because of its high protein contents, it is considered as an economical source of quality vegetable protein in human diet (Hakoomat *et al,* 2004). As food grain, pulses stand next to cereals and are valued as food because of their high protein content (20-25 percent). They provide a balance diet to millions of people. Pulses are known as poor man's meat in developing countries while in developed world these are perceived as 'health food'. Gupta (1988) reported that chickpea contains 21 percent protein, 61 percent carbohydrates and 2.2 percent oil. It is not only a good source of protein but also a food of high nutritive value having considerable amount of vitamin A, B and C along with iron, phosphorus and calcium. Being leguminous, pulses maintain soil fertility by converting and fixing atmospheric nitrogen in available form through symbiosis with rhizobial strains. Chickpea is an important conventional pulse crop of Pakistan. Iran ranks fourth in the world in chickpea production after India, Pakistan and Turkey. Average chickpea productivity in Iran is 400kg.ha^{-1}. The average grain yield of 439kg.ha^{-1} as reported by Anonymous (2001) can be enhanced only through integrated crop and soil management practices. Generally, poor fertility status of soil is a major cause of low grains yield. Though Chickpea is a legume crop, requiring little nitrogen application, there is a need to derive the adequate level of phosphorus and nitrogen for obtaining higher yield with good quality (Jain and Singh, 2003). Phosphorus (P) is among the most needed elements for crop production in most tropical soils, which tend to be P deficient (Adetunji, 1995). The deficiency can be acute in some soils of the Savanna zone of Western Africa to the extent that plant growth ceases as soon as the P stored in the seed is exhausted (Mokwunye *et al*., 1986). P deficiencies primarily result from either inherent low levels of soil P or depletion through cultivation. Phosphorus, although not required in large quantities, is critical to pea yield because of its multiple effects

on plant nutrition (Muleba and Ezumal, 1985). Application of phosphorus to legumes also improves the seed yield considerably (Hussain, 1983). Further, Raut and Kohire (1991) reported that seed yield of chickpea was increased significantly with *Rhizobium* and phosphorus application. Patel and Patel (1991) also observed that nitrogen application as a starter dose along with phosphorus and seed inoculation has beneficial effect on yield of chickpea. Borgohain and Agarwai (1986) reported that seed yield of chickpea increases with increasing levels of phosphorus up to 80 kgP_2O_5/ha, similar report was also observed by Tomar *et al.* (1988). However, the objective of this study is to evaluate the performance of some chickpea varieties under rain fed conditions in Jigawa state, Sudan Savanna zone of Nigeria.

Brief Description of the test Crop

ICCV 93954: This is a semi erect, basal –branching variety. The seed is characterized by small-size and brown colour. This desi chickpea is adapted to rainfed, irrigated and late-sowing situations. It is a medium duration variety (80-100 days) and flowers between 35 to 45 days. Potential seed yield is 3570 kg/ha^{-1} (ICRISAT, 1999). It has 21 percent crude protein content and mean 100-seed weight of 18g.

ICCV 95423: This is a kabuli type chickpeas variety which is characterized by white or beige-colored seed with ram's head shape, thin seed coat, smooth seed surface, white flowers, and lack of anthocyanin pigmentation on the stem. As compared to desi types, the kabuli types have higher levels of sucrose and lower levels of fiber. This variety is resistant to the insect pest, pod borer (*Helicoverpa armigera*). The variety also is adapted to rainy and irrigated condition with potential grain yield of 2850 kg/ha^{-1}.

ICCV 97105: This is also a desi variety. The seeds are brown and larger than ICCV 93954. This variety matures earlier and flowers within 40 days. It is suited to both rainfed and irrigated conditions and the variety is adapted to medium and late sowing, with a mean potential grain yield of 3220 kg·ha^{-1} in India.

MATERIALS AND METHODS

The experiment was conducted during the 2020 rainy season in two locations; Binyaminu Usman Polytechnic Hadejia Research farm within latitude 12^0 22′ and 12^0 24′ N and longitude 7^0 46′ and 10^0 E and Jigawa State Research Institute farm Kazaure with latitude 12° 28' and 12° 32'N and longitude 8° 10' and 8° 38'E, all in Jigawa State, Sudan savanna ecological zone of Nigeria. Soil samples were collected from randomly selected spots on both fields at a depth of 0-15 and 15-30cm using tabular auger. The samples were analyzed for physical and chemical properties using standard procedures. These involve the determination of texture, total nitrogen, available phosphorus and exchangeable cations. The soils of the sites were sandy loam. The treatments consisted of three chickpea varieties (ICCV 97105, ICCV 93954 and ICCV 95423) sourced from International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) India and laid out in three replications using Randomized Complete Block Design. The plots were laid out in form of basins with borders. Two seeds were sown per hole in 40cm inter row spacing and 20cm intra row spacing. All plots received a uniform basal application of nitrogenous and phosphate fertilizer at the rate of 20kgN/ha and 60kgP_2O_5/ha respectively. Plant protection measures and agronomic practices were carried out. Harvesting was done at maturity by cutting the whole plants and allowed to properly dry under the sun before the pods were picked, threshed and winnowed. This exercise was all done manually by hand. Statistical analysis on the agronomic data was done using SAS version 9.1 (SAS, 2003) The data collected were subjected to analysis of variance (ANOVA) as prescribed by Snedecor and Cochran (1967) and the means were separated using Duncan's Multiple Range Test (Duncan, 1955). Correlation analysis was carried out to determine the optimum level of significance.

RESULTS AND DISCUSSION

Generally, yield per unit area is a function of the combined effect of all the individual yield components, which are influenced differently by the various agronomic practices and environmental factors. There was a statistical difference in plant height between ICCV 95423 and ICCV 97165 in both locations, ICCV 95423 being the tallest. While varieties ICCV 93954 and ICCV 97165 were statistically the same in both locations (Table 1). Number of days to fifty percent (50%) flower was presented in Table 2. Number of days to 50% flowering was significantly influenced by variety. ICCV 95423 had a higher number of days to produce flowers in both locations. ICCV 93954 and ICCV 97105 were statistically the same in both Hadejia and Kazaure**.** Treatment effects on number of days to physiological maturity were presented in Table 3. Days to physiological maturity was significantly influenced by variety. ICCV 95423 had a higher number of days to attain maturity in both locations. ICCV 93954 and ICCV 97105 were statistically the same in both Hadejia and Kazaure. Variety had significant influence on grain yield in both locations. ICCV 93954 significantly out yielded other two varieties. In both locations ICCV 95423 recorded the lowest grain yield. Regardless of the varietal differences in yield and its attributes, all the varieties produce higher yield and yield attributes in Kazaure area, and this could be due to the high available Phosphorus content in the location as compared to Hadejia (Table 1). Phosphorus was reported to greatly affect yield of peas as confirmed by Borgohain and Agarwai (1986); Hussain (1983) and Tomar *et al.* (1988).

CONCLUSION

The result of this field trial reveals that the performance of all the three varieties was good. The yield differences between Hadejia and Kazaure was due to high phosphorus content in Kazaure as compared to Hadejia.

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Table 2: Performance Evaluation of chickpea varieties at Hadejia and Kazaure, Northwest, Nigeria 2020

Treatment	Hadejia						Kazaure					
	Nodule number plant^{-1}	Nodule fresh weight plant^{-1} (mg)	Average pod weight	No of seeds pod^{-1}	100 seed weight	Grain yield (kg ha^{-1})	Nodule number plant^{-1}	Nodule fresh weight plant^{-1} (mg)	Average pod weight	No of seeds pod^{-1}	100 seed weight	Grain yield (kg ha^{-1})
Variety (V)												
ICCV 93954	18.7a	610.2a	18.8	1.1b	16.2b	3158.8a	18.8a	630.5a	19.9	1.3b	17.5b	3323.4a
ICCV 95423	17.3b	543.5c	19.6	1.5a	18.3a	2583.3c	17.5b	552.2c	20.4	1.4a	19.4a	2698.0c
ICCV 97105	17.7c	575.1b	18.9	1.5a	16.8b	3025.7b	17.9c	582.6b	19.2	1.7a	17.7b	3159.1b
SE±	0.44	42.21	0.43	0.07	0.81	420.02	0.98	26.23	0.58	0.15	0.90	260.24

Means followed by the same letter (s) are not significant at 5% level of significant of probability using Duncan multiple range test (DMRT). NS = Not Significant

Performance of Maize (*Zea mays* l.) Varieties as Influenced by Nitrogen rates in Samaru, Zaria

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ABSTRACT
A field trial was conducted during the 2015 rainy season at the Research farm of the Institute for Agricultural Research, Samaru in the Northern Guinea Savanna to determine the performance of maize (Zea mays L.) varieties under varying nitrogen rates. The treatments consisted of two maize varieties (SAMMAZ 16 and OBA 98) and 5 nitrogen rates (0, 30, 60, 90 and 120N kg ha^{-1}) which were laid in a Randomized Complete Block design (RCBD) and replicated three times. Plant height, number of leaves, leaf area index, chlorophyll content, intercepted photosynthetic active radiation and grain yield ha^{-1} were the parameters assessed. The result from this study showed that there was no significant difference between the two varieties used and the application of 60N ha^{-1}produced the highest values of all the parameters taken.

Keywords: Chlorophyll content, nitrogen rates, OBA 98, SAMMAZ 16

INTRODUCTION
Maize is a commonly cultivated crop in the savannah zones of Nigeria, as it is an important food for humans, and a source of fodder for animals. The grains are rich in vitamins A, C and E, carbohydrates, and essential minerals, and contain protein. They are also rich in dietary fiber and calories which are a good source of energy (https://www.iita.org/test-maize/). Nitrogen is one of the macronutrients which are required in relatively large quantities for good vegetative and reproductive development in maize. It is a component of protein and nucleic acids and when it is inadequate, growth is reduced (Adediran and Banjoko, 1995). It forms part of many important compounds like chlorophyll and enzymes responsible for many physiological processes in the plant. Nitrogen serves as an intermediary in the utilization of phosphorus, potassium and other elements in plants (Brady and Weil, 2007).

A blanket application of 120kg N ha^{-1} is usually applied in most maize fields in the Northern Guinea Savanna of Nigeria without taking much consideration of the inherent nitrogen content in the soil, variety of the maize used and even the financial capabilities of the farmers; as these small holder farmers have a high opportunity cost for their hard-earned money. Excessive application of nitrogen fertilizers often leads to low nitrogen use efficiency and subsequently, the increased loss of nitrogen through leaching and volatilization with its devasting effect on the ecosystem. This work is geared towards determining of performance of maize (*Zea mays* L.) varieties under varying nitrogen rates in Samaru.

MATERIALS AND METHODS
A field trial was conducted during the rainy season of 2015 at the Research farm of the Institute for Agricultural Research, Samaru (Lat 11^{0}11'N; Long 7^{0}38'E and 686m above sea level) which is located in the Northern Guinea Savannah ecological zone of Nigeria. The treatments consisted of two maize varieties [Open pollinated (SAMMAZ 16) and Hybrid (Oba 98)] and 5 nitrogen rates (0, 30, 60, 90 and 120N kg ha^{-1}). The treatments were laid out in a Randomized

Complete Block Design (RCBD) with three replications. The gross and net plot sizes were 36m^2 and 18m^2 respectively. The land was harrowed twice and ridged at a spacing of 75cm and the field was marked out. Seeds were dressed with Apron star at the rate of 10 g sachet per 3 kg of seeds and sown manually at the rates of 2 seeds/hill and intra-row spacing of 25cm. Urea as the source of Nitrogen was applied as per the treatment in two split doses. Weeds were controlled using a pre-emergence herbicide (Atrazine) at the rate of 4l ha^{-1} (2.0 kg a.i ha^{-1}) immediately after planting and hoe-weeding were carried out 3 and 6 weeks thereafter earthing up was carried out. Plant height and number of leaves both at 12 weeks after sowing (WAS), leaf area index, chlorophyll content and intercepted photosynthetic active radiation which were taken at 50% tasseling; and grain yield ha^{-1} were assessed. The data collected were subjected to analysis of variance as described by Snedecor and Cochran (1978). Treatment means were compared using Duncan Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

According to the ratings for soil data interpretation for Savanna areas, the analysis presented in Table 1 shows that the soil at the depth of 0-15cm was loam, moderately acidic with high organic carbon and low total nitrogen. It also had high levels of available phosphorus, calcium, magnesium, sodium and effective cation exchange capacity (ECEC) with medium level of potassium. For the soil at 15-30 cm depth, the soil was also loam, strongly acidic with a low organic carbon, medium available phosphorus and high total nitrogen. Calcium and sodium in this depth was high, with medium levels of magnesium and potassium and high effective cation exchange capacity. The results from Table 2 shows that application of 60N ha^{-1} resulted in the highest values for all the parameters except for the number of leaves, although comparable with 30, 90 and 120N kg ha^{-1} for the leaf area index and; at par with 90 and 120N kg ha^{-1} for intercepted photosynthetic active radiation and grain yield ha^{-1}. The high nitrogen content of the soil at the depth of 15-30 cm could have warranted this, as nitrogen is mobile in the soil solution and must have accumulated in the sub soil. (Agvise Laboratories, 2019). The leaf area index (LAI) is an important parameter in crop growth as it reflects the leafiness of the crop. The leafiness reflects the photosynthetic capability of the crop (Prabhugouda *et al*., 2018) which in turn influences the photosynthetic radiation that is being intercepted by the leaves which further translates into yield. An adequate supply of nitrogen is associated with high photosynthetic activity, vigorous growth, and dark-green plant vegetation (Reading and interpreting a soil test, 2019). There was no significant interaction between the treatment factors.

CONCLUSION

In this study, the application of 60 kg N ha^{-1} increased the vegetative growth and improved the physiological components of the maize which resulted to the highest yield. The nutrient status of the soil should be taken into cognizance especially at the subsoil before the application of nitrogen fertilizer, even if it is a shallow rooted crop to avoid wastage of resources and leaching of excess nitrates into the environment. Either of the two varieties produced comparable yields which will be at the discretion of the farmer to use any of them for production.

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Table 1: Physical and Chemical properties of soil in the Samaru during the 2015 rainy season

Location	**Samaru**	
Soil Depth(cm)	**0-15cm**	**15-30cm**
Physical Characteristics (g kg^{-1})		
Sand	420	200
Silt	420	360
Clay	160	440
Textural Class	Loam	Loam
Chemical Composition		
pH in H_2O (1:2.5)	5.8	5.5
pH in 0.01 M $CaCl_2$(1:2.5)	5.0	4.7
Organic Carbon (g kg^{-1})	6.1	3.2
Available Phosphorus (mg kg^{-1})	24.51	15.46
Total Nitrogen (g kg^{-1})	1.05	2.45
Exchangeable bases (cmolkg^{-1})		
Ca	7.39	9.72
Mg	1.47	1.57
K	0.19	0.16
Na	0.61	0.69
H+Al	0.80	1.20
ECEC	10.46	13.34

Soil as analyzed in Department of Soil Science Laboratory, Ahmadu Bello University, Zaria

Table 2: Effect of nitrogen rates on the plant height, number of leaves, leaf area index, chlorophyll content, intercepted photosynthetic active radiation and grain yield ha^{-1} of maize varieties during the 2015 rainy season in Samaru

Treatments	**Plant Height (Cm)**	**Number of Leaves**	**Leaf Area Index**	**CHLOROPHYLL CONTENT(SPAD)**	**IPAR (μmol $m^{-2}s^{-2}$)**	**Grain Yield ha^{-1} (kg ha^{-1})**
Varieties(V)						
SAMMAZ 16	193.27	13.56	0.93	36.97	0.45	2587.44
OBA 98	188.67	13.33	1.15	36.58	0.50	2830.15
SE±	5.520	0.184	0.127	1.343	0.036	265.849
Nitrogen(N) (kg ha^{-1})						
0	178.80b	13.28	0.64b	26.78b	0.34b	1668.62c
30	180.91b	13.72	0.90ab	36.20a	0.42b	2134.53bc
60	220.36a	13.50	1.45a	42.17a	0.62a	3781.48a
90	191.02b	13.17	1.19ab	39.53a	0.51ab	2903.83abc
120	183.77b	13.56	1.03ab	39.18a	0.45ab	3055.52ab
SE±	8.728	0.290	0.201	2.123	0.057	420.344
Interaction						
V*N	NS	NS	NS	NS	NS	NS

Means followed by the same letters within a treatment group are not significantly different at 0.05 level of probability using DMRT. NS= Not significant

Fertilizer Requirements for Rice (*Oryza Sativa* L.) in Dryland Savanna Using QUEFTS Simulation Model

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ABSTRACT
Nutrient use efficiencies of rice are low in the tropics due to conventional "blanket" and imbalance fertilizer application. Estimation of fertilizer requirements based on quantitative approaches can assist in improving yields and nutrient use efficiency. The main focus of this study was to employ and evaluate QUEFTS (Quantitative Evaluation of Fertility of Tropical Soils) model for establishing site specific fertilizer recommendation for N, P and K in rice. This study revealed that the indigenous soil nutrients supply (INS, IPS and IKS) were 54.34 – 94.50 kg N ha^{-1}, 12.16 – 28.84 kg P ha^{-1} and 90.53 – 156.30 kg K ha^{-1} with fertilizer recovery fractions of 0.35 – 0.50, 0.21 – 0.48 and 0.35 – 0.64 for N, P and K respectively. The recommended fertilizer dosage modeled by QUEFTS were 92 – 130 kg N ha^{-1}, 34 – 56 kg P ha^{-1} and 10 – 19 kg K ha^{-1}. It was higher than the conventional blanket fertilizer rate recommended over the years. The model also recommends higher N with lower K for FARO 55, but lower K for FARO 57 and FARO 52; thereby advocating for site specific nutrient management (SSNM) through the use of different fertilizer combinations for different soil conditions. Field validation of the QUEFTS model showed a good agreement between observed and simulated yields (R^2 = 0.85, RSME = 0.93, RSMEn = < 30% and d-stat = 0.71), thus confirming better performance of QUEFTS in the rice ecosystem under different nitrogen regime.
Keywords: NPK-fertilizer requirements, Upland Rice, Kadawa, QUEFTS model

INTRODUCTION
Estimating balanced nutrient requirements for rice (*Oryza sativa L.)* is generally essential to manage fertilizer application more effectively for increasing crop yields and reducing risk of negative environmental impact (Limin *et al*., 2013). "Blanket'' fertilizer recommendation for rice in Nigeria have been made through field experiment and extrapolate (FMARD, 2012) but it is not certain whether these values represent the range of nutrient requirement of modern high-yielding (improved) varieties found in various rice growing environment. Therefore, estimate of fertilizer requirements using quantitative approaches such as modeling had been advocated (Pathak *et al*., 2003). Although most existing models only address single nutrient and nutrient interaction is largely ignored but QUEFTS (Qualitative Evaluation of Fertility of Tropical Soils) takes care of the major nutrients (N, P and K) with integrated consideration of balanced inputs of nutrients (He *et al*., 2012). It is also described as one of the simplest models in making fertilizer recommendation (Maiti *et al*., 2006). The focus of this study was to estimate the indigenous nutrient supplying capacity of soil, determine the N, P, and K requirements of rice varieties under investigation and to evaluate the performance of QUEFTS model in simulating responses of three upland rice cultivars to different N-fertilizer regime.

MATERIALS AND METHODS

Description of the Study Site

Field trials were conducted during the 2012 and 2013 under wet season at the Irrigation Research Station, Institute for Agricultural Research (IAR) Kadawa (11.6437^{O} – 11.6439^{O}N, 008.4335^{O} – 008.4336^{O}E and 488 m above sea level).

Treatments and Experimental Design

The treatments consisted of two factors. Factor one was the rice varieties (V_1 = FARO 55, V_2= FARO 57 and V_3= FARO 52 while factor two consisted of forms of N fertilizers as USG at 45.08 kgNha^{-1} (N_1), 72.22 kgNha^{-1} (N_2) and 117.30 kgNha^{-1} (N_3); and PU at 45.08 kgNha^{-1} (N_4), 72.22 kg N ha^{-1} (N_5) and 117.30 kgNha^{-1} (N_6); The Prilled Urea (PU) were applied in two equal halves (at 2 weeks after transplanting and at panicle initiation); and N management based on Leaf Colour Chart (LCC) at critical level (N_7). A control, unfertilized plot (N_0) was also included. The experiments were laid down as a randomized complete block design (RCBD) in a factorial arrangement and replicated three times.

Field Experiments

The land was ploughed, harrowed and leveled manually. After land preparation, the field was dyked into basins of 3 m by 3 m (9 m^2) each, as the plot size. Rice seedlings raised from the nurseries for three weeks, transplanted at 2 seedlings per hill and at a spacing of 0.2 m × 0.2 m to give a total population of 500, 000 plants ha^{-1}. The available data from this experiment were soil properties such as soil organic carbon content, pH, electrical conductivity, texture, available N (measured with alkaline $KMnO_4$ extraction), Olsen P, ammonium acetate-extractable K, crop parameters (grain and straw yields; N, P and K in total above-ground plant dry matter) and levels of applied fertilizers (different forms) in different treatments) as described by Okalebo *et al*., 2002.

Validation of QUEFTS model

Coefficient of multiple determinations (R^2), the root means square error (RMSE), normalize root mean square error ($RMSE_n$) and an index of agreement (d) were computed to assess the goodness -of- fit statistics of the QUEFTS model using the following relationship (Wikarmpapraharm and KositsaKulchai, 2010):

$$\mathrm{RMSE} = \left[\sum_{i=1}^{n}(S_i - Ob_i)^2\right]^{0.5}$$

$$\mathrm{RMSE}_n = 100\left[\sum_{i=1}^{n}(S_i - Ob_i)/n\right]^{2\;0.5} / Ob_{avg}$$

$$d = 1 - \frac{\sum_{i=1}^{n}(S_i - Ob_i)^2}{\sum_{i=1}^{n}\left(|S_i - Ob_{avg}| + |Ob_i - Ob_{avg}|\right)^2}$$

Where: S_i = simulated values, Ob_i= Observed values, Ob_{avg} = Observed average value, **n** = observed data points and d index = measure of deviation between model prediction and measurement in relationship to the scattering of

the observed data (ranging from 0 to 1 which is perfect simulation)

RESULTS AND DISCUSSION

Nutrient omission plots and Indigenous nutrient supply of N, P and K

There was a large variation in soil properties such as pH, P, exchangeable K among others and this thereby transform to variability in indigenous nutrient supplies in the study among the rice varieties observed where the indigenous soil nutrients supply and apparent fertilizer recovery fractions (INS, IPS and IKS) were 54.34 – 94.50 kg N ha^{-1}, 12.16 – 28.84 kg P ha^{-1} and 90.53 – 156.30 kg K ha^{-1} as presented in Table 1. This work is in conformity with the findings of Pathak *et al*., 2003 who discovered large variability in the nutrient omission plot and indigenous nutrient supply for wheat in India.

Statistical evaluation and validation of QUEFTS model

The QUEFTS model calibration was conducted using data obtained from the omission plots in 2012 at the Irrigation Research Station Kadawa. The model was then validated using the data collected in the field experiment during 2013. In this study, the paddy yields at maturity were calibrated by comparing the observed data from the field experiment with simulated results with respect to grain yield (Figure 1 and 2). Combinations of graphical and statistical tools were employed to evaluate the model. It is evident from low RMSE that QUEFTS model predicted grain yields close to measured yields indicating its ability to simulate crop growth under optimal condition. An index of agreement (d) for grain yields close to 1 for all the varieties under observation also revealed that the model performed well in predicting the yield. The regression analysis gave a coefficient of determination (R^2) value of 0.85 which confirm the best of fit of the model as observed by Nyanga'u *et al* (2014) in his work on estimating Rice yield using CERES Rice model. The coefficient of determination (R^2) values ranged from 0.785 – 0.890. Again, the Root Mean Square Error ($RMSE_n$) of 0.496 – 1.550 (15.84 – 38.63 %) were also computed. Lastly, the index of agreement (d) ranging from 0.65 – 0.80 was used to test the goodness of fit of the QUEFTS model as presented in Figures 1 and 2. Based on the application of Quantitative Evaluation of Fertility of the Tropical Soils (QUEFTS) model, the fertilizer recommendation was generated using indigenous soil nutrient supplies as presented in Table 3. The fertilizer recommended varied greatly depending on the soil conditions and crop cultivars. The QUEFTS recommendations were 92 – 130 kg N/ha, 34 – 56 kg P/ha and 10 – 19 kg K/ha at Kadawa (Table 3).

CONCLUSION

The QUEFTS model used in this study allows for estimating nutrients (N, P and K) requirements to achieve a yield target of rice varieties taking into account the soil nutrient supply, relationship of grain yield against nutrient uptake. The field experiment validation in this study also confirmed that the QUEFTS model could be used as a practical tool to make fertilizer recommendation. The recommended fertilizer dosage modeled by QUEFTS were 92 – 130 kg N ha^{-1}, 34 – 56 kg P ha^{-1} and 10 – 19 kg K ha^{-1} for the rice varieties (FARO 52, FARO 55 and FARO 57) investigated.

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Table 1: Indigenous soil nutrient supply (N, P and K) at Kadawa

	2012			2013			Means		
Rice variety	**INS**	**IPS**	**IKS**	**INS**	**IPS**	**IKS**	**INS**	**IPS**	**IKS**
	← (kg/kg) →			← (kg/kg) →			← (kg/kg) →		
FARO 55	78.09	10.94	113.12	30.59	13.37	67.98	54.34	12.16	90.53
FARO 57	52.68	9.33	90.56	58.11	24.72	183. 58	55.40	17.05	137.07
FARO 52	106.40	23.62	122.88	82.60	34.08	189.72	94.50	28.84	156.30

INS =indigenous N supply, IPS = indigenous P supply, IKS = indigenous K supply

Table 2: Apparent fertilizer recovery fraction of NPK for rice variety at Talata Mafara and Kadawa

Rice Variety		2012			2013			Means	
	NRF	**PRF**	**KRF**	**NRF**	**PRF**	**KRF**	**NRF**	**PRF**	**KRF**
Faro 55	0.45	0.38	0.57	0.24	0.19	0.36	0.35	0.29	0.47
Faro 57	0.22	0.02	0.53	0.69	0.40	0.69	0.61	0.21	0.64
Faro 52	0.55	0.59	0.57	0.65	0.11	0.13	0.50	0.48	0.35

RFN = recovery fraction N, RFP = recovery fraction P and RFK = recovery fraction K

Table 3: Fertilizer Recommendation (kg/ha) modeled by QUEFTS at Kadawa

Rice variety	N	P	K
FARO 55	130	34	10
FARO 57	92	56	19
FARO 52	120	50	12

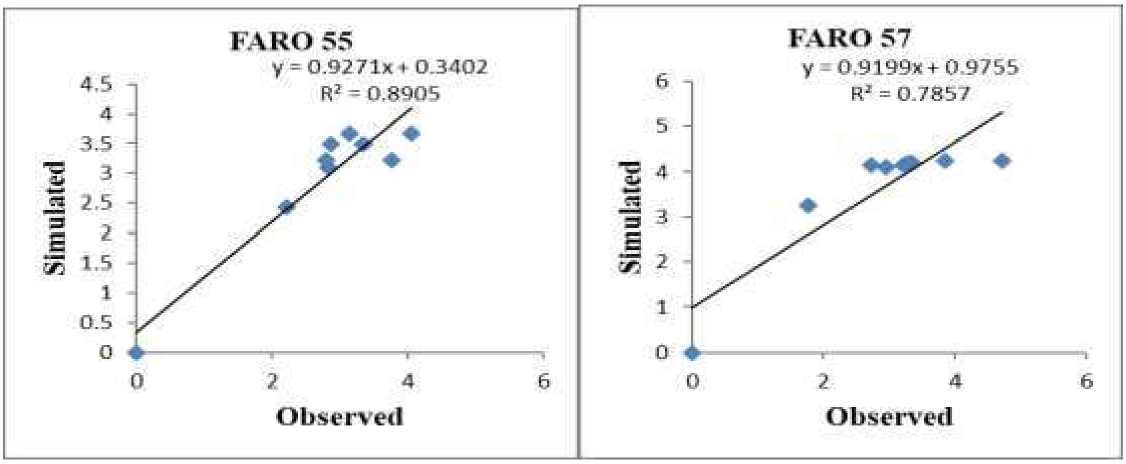

Figure 1: Comparison of observed and simulated mean grain yields of FARO 55 and FARO 57 at different nitrogen regimes in Kadawa

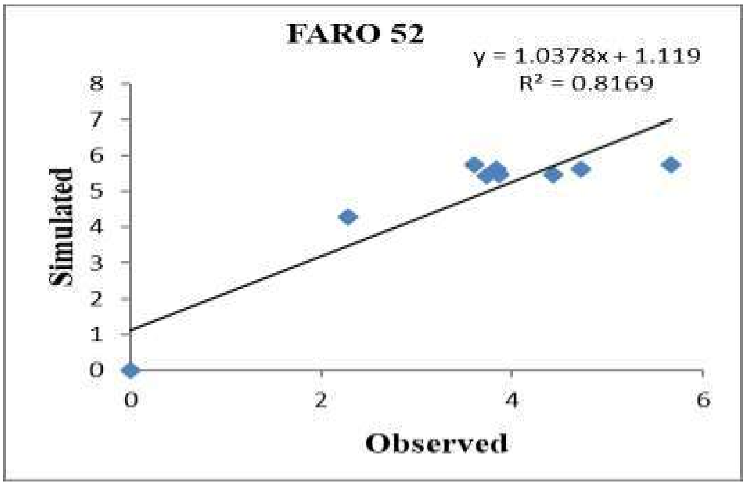

Figure 2: Comparison of observed and simulated mean grain yields of FARO 52 at different nitrogen regimes in Kadawa

Physio – Chemical Characteristics of Soil Under Different Land Management System in Babura Local Government, Jigawa State, Nigeria

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ABSTRACT
The study investigates soil characteristic under different land management system in Babura. Three (3) farm plots under different management were selected. These include large scale farm plot cultivated small holder farm cultivated and small holder plot uncultivated. Composite soil samples were collected and analys ites for soil physical and chemical properties determination using stand laboratory methods. Result obtained show some variations within the three management plots selected in general it can be seen that soil exhibit high percent send with clay or silt content below 15% percent which confirms that the scale farm and uncultivated plots have higher value of organic carbon, basic actions and cation exchange capacity (EEC) than the small holder cultivated plot were as Aluminum, Hydrogen and Sodium percent in the small holder cultivated exceed that of the large scale farm and uncultivated land.
Keywords: Cation exchange capacity, chemical properties, organic carbon

INTRODUCTION
Soil as a component of land is a limited resource which tend to be more heterogeneous in nature particularly where large variation in vegetation in vegetations, topography, drainage, status of soil may also vary drastically both vertically and horizontally over short distances within the same ecological unit (Ajayi E.O) the primary objectives of making an inventory of land is to provide some basic data and map for planning purposes. Interpretations of this data explain the behaviors. Of soils under different management systems. Interpretation is prediction and their reliability is only as good as the data used in their preparations. Interpretation may drainage as more is known about the soil characteristics. The heterogeneity of soils in cultivated land. Capes particularly in fields that have been put to contentious cultivated may be expected to be high because of additional variation due to management and pecuiar nature of the crop growing on the soil. For chemical properties, the obvious problem is that of fertility gradient. Backett (1967) Adeoyo 2001 have provide that a field is micro - heterogenious and micro uniform. Therefore, good knowledge and management practice of our soil is necessary for their efficient use to produce sufficient food; to the ever increasing population of the world soil ought to be properly students in term of its physical and chemical properties which are the parameters for ensuring its fertility status and evaluating its potential for agricultural production and engineering works. Unfortunately for many peoples, soil is simply trampled underfoot and sonorous with dirt. However, it should be understood that soil plays a vital and important role in both the natural world and the life of human food is obtained from crops grown in soil or from animals which graze on grass and other fodder crops also grown in the soil. Natural fibers such as cotton and flax, which provide us with clothing are grown is the soil, and soil material can be use to make bricks, aluminum and glass. Soil may involve getting to know the best use for many different types of soil, each used and managed according to its individual characteristics. Therefore, soil survey must be embraced in order to study, classify and map soil conditions in an area. The objective of this study was to carry out a preliminary

assessment of the characteristics of soil in three (3) farm land under different land use types (management practices) in Northwest, Nigeria.

MATERIAL AND METHODS

Location and environments of study sites

The study was conducted in three (3) land uses under different management practices near Babura; Talamiz Farm Limited, small holder cultivated plot and small holder uncultivated plot Babura Local Government Area (LG), of Jigawa State. The study area falls within latitude $12^{0}46$ North and longitude $09^{0}1$East. In the Northern most margins of the Sudan Savannah Zone of Northern Nigeria (Ahmad, 2003). Babura is situated at about 400m meters above level in Chad basin complex within the lowland areas. The climate is divided in to rainy season which last from 4 to 5 months and a long dry season of November – may. Rainfall highly variable ranging from 500mm to 300mm per annum and is concentrated within June to September (Ahmad, 2003). The temperature regime is warm to hot through with a slight cool period between December – Febuary in this period the temperature can fall as slow as 15^{0}C and in the hottest month March (April up to 39^{0}C J.R.I 2003). No detailed information is available about the nature of soils in the study area. However, on the general term the soils are classified as alfisol or ferruginous tropical soils. They are formed from wind shown deposits overlying basement complex and in many cases they divided from sedimentary deposit. The top soils are notably sandy and low in organic matters (Ado, 1993). A free survey technique was employed to established sample point. The researcher walked along limes where the field evidence suggested that one soil give another way to another, by occasions ally inspecting soil either side of the line to find the most accurate location of the boundary between the soil types. This technique assumed that change in soil conditions would be matched by corresponding changes in visible landscape features such as slope, drainage, vegetations etc. however the study area is homogenous in nature which ascertain the uniformly of the soil under natural conditions.

Field Techniques

In order to adhere proper sampling in the field fire samples were taken from each management practice at about 30cm depth. The fire samples located from the respective farm plot were combined to from a composite sample which was packed in polythene bag with label identifications. The composite samples were kept were in the laboratory to air dry.

Laboratory Method

Prior to the beginning of laboratory investigation, each soil sample was crushed with pestle in a mortar and passed through a 2mm sieve. The sieve samples were restore into separated polythene bags with corresponding label for easy identifications. The particle size distributions was determined using Bouycous Hydrometer methd (Klute, 1986) and the soil PH was measure with PH meter using a 1:2.5 soil/water paste organic carbon was determined using walked & Block (Titration method) Available phosphorus was analyzed using Bray No. 1 method. Basic carbon sodium and potassium using an atomic absorption spectrophotometer by flame emission spectroscopy. The each angeable acidity $H^{+} + AI^{+}$ using 1N potassium chloride as the extracting. Calcium and magnesium were determined by titration with EDTA. The carbon exchange capacity was by Ammonium saturation method, while the Electrical conductivity was measured with E.C portable meter using the soil extract used in PH determinations.

RESULTS AND DISCUSSION

The results obtained from the various field and laboratory observations and analysis conducted on the three farm plots under different management practices were collated using appropriate statistical methods. The basic data generated in this manner is contained in table.

Particle – size distribution

The particle size distribution analysis gives the percentage ratios of sand, silt and clay of the (3) composite sample A, B and C are presented in table1.

Table 1: physical properties of soils under different management practices

Variable	(A) Talamiz Farm	(B) Small Holder Farm	(C) Uncultivated Plot
PH	6.96	6.80	6.90
% Sand	79.96	80.60	78.96
% Silt	11.00	10.00	11.00
% Clay	9.04	9.40	10.04

Table1. indicate that sand % in the soil of the large scale farm is 79.96 where as it is 80.60% for small holder farm and 78.96% for the uncultivated plot. Thus trend showing decreases in fine particles and increase in sand particle may be due to disturbances in the cultivated plots indeed. It is known that tropical soils exhibit decrease in clay or silt content on cultivation. This observation supports the general view that cultivations tend to cause loss of fine particles. On the other hand, the values of sand particle between the three selected farm plots increased from the uncultivated plot to large scale farm and to the small holder cultivated plot.

Soil pH

The main reason for measuring the soil PH is that soil PH affects the availability of most plant nutrients. Plants essential nutrients in soil reach maximal or near maximal availability in the PH range of 6 – 7 and decrease above and below this PH range of 6 – 7. The PH of large scale farm is 6.96, for small holder farm cultivated is 6.80 and 6.90 for the uncultivated plot as shown in Table 1. The PH was almost neutral with a small difference between cultivated soils. Even though cultivated soils are expected to show acidity, the addition of basic cations to cultivated soil through manure and chemical fertilizer application among other practices probably explains the restrictions of the soil acidity.

Table 2. Soil Chemical Properties

Variable	(A) Large Scale Talamiz Farm	(B) Small Holder Farm	(C) Uncultivated Plot
% 0.carbon	0341%	0.35%	0.52
E.C	0.17	0.10	0.11
Available (p)	32.56 ppm	30.00 ppm	23.00 ppm
Na	0.03	0.04	0.02
$Mg^{+}Ca$	4.10	4.00	4.20
$Al^{2+}H^{+}$	2.50	3.10	2.30
C.E.C	6.70	6.50	6.90
K^{+}	0.04	0.02	0.03

Organic Carbon

The level of organic carbon declines further on cultivation especially if little or no organic matter are added. A decline in the levels of the organic carbon was observed between the cultivated plots and the value of organic carbon of large scale farm shows small variation with that of the uncultivated plot while the lowest value of 03.5 was observed in the small holder farm plot. The decline observed between the large scale farm and the small holder farm could be as a result of continues cultivation in both farms. However, the value of 0.41 observed in the large scale is due the soil, control and maintain its fertility. Thus values of 0.52 observed in uncultivated control plot indicate that vegetation existing in the plot and the followed – period have contributed in increasing the percentage organic carbon.

Phosphorus

Plant depend mainly on the phosphorus present in soil solution (H_2P0_4 and $HP0_4$) for their phosphorus uptake. Phosphorus forms insoluble compounds with cations like Ca^{2+}, Fe^{2+} and Al^{3+} in soil. Because of this, the amount of phosphorus in soil solution at anytime is very small depending on the soil PH. Table 2, above shows that large scale farm value 32.56 ppm, small holder plot 30.00 ppm and 23.00 ppm uncultivated plot, observed between the cultivated large scale plot, small holder plot and uncultivated plot are due to the application of manures and fertilizer to the cultivated soil. In similar study Essiet (1989) observed that the level of available (p) in soils of the kano area was adequate and the heavy annual application of phophosrus fertilizers should be avoided to prevent nutrient in balance. Another study on soils round Nothern Jigawa show medium to high levels of (p) (JRI 2000) as a result of dust blown from the Sahara during harmattan and this accounted for the increase in level of phosphosrus within the selected soils.

Potassium (K^+)

Table 2, shows that large scale plot value of (K) is 0.04, small holder cultivated 0.02 and 0.03 for the uncultivated followed plot. The low level of potassium observed between uncultivated and cultivated soils is attributed to the effect of continuous cultivation in small holder plot and the agricultural intensification of the large scale farm and that of uncultivated soil may be due to the followed period and absence of farming activities.

Cation Exchange Capacity (CEC)

The result indicated In table 2, shows that large scale farm has been cation exchange capacity value of 6.70, small holder 6.50 and uncultivated 6.90 respectively. The decline in C.E.C in cultivated soils is due to the decline in soil contents of clay and organic carbon observed. The clay and organic fractions are the main exchange sites in a soil and a decline in the cation exchange capacity is as result of the decline in the quality of clay and organic fractions.

Aluminum + Hydrogen

The level of acidity observed in table 2, shows that large scale farm is 2.80, small holder cultivated 3.10 and uncultivated plot Is the minimum value of 2.30. the low level of Al^{2+} H^+ exhibit between cultivated and uncultivated plots is due to the soil PH observed in which all the soil PH range between 6.50 – 6.96 indicating a neutral soil in approximation. It is necessary to identify how much Al^+ and H^+ is present in the soil, especially, if more intensive agriculture is to be practices. This is because Al^+ is toxic for most crops, acidity itself, especially at PH 5.5 or lower can inhibit the growth of sensitive species even at PH as low as 4.

Electrical Conductivity (EC)

The value of E.C in the large scale farm is 0.17, small holder farm 0.19 and 0.11 for the uncultivated plot. The electrical conductivity of soil influences water conduction in soil but soil pore properties have more influences on the electrical conductivity of soil. The values of E.C observed between the cultivated and uncultivated soil may be due to the sandy nature of the soils.

CONCLUSION

This study has further confirmed that there is clear indication of influencies of management practices on soil. Characteristics in the study area. For example, the results showed that all the soils are study in nature because sand increases with increase in disturbances on the other hand organic carbon content and clay particles decreases from cultivated through large scale plot to the small holder farm plot cultivated. This shows that organic carbon content and clay fractions decrease as soil cultivation increase. It may be conducted that the high values of most of the variables obtained in the uncultivated plot are due to the influence of vegetation cover and the limited interference with the soils under natural regeneration. It can be conducted further that small holder and large scale farm plot in the study area would be enhanced by currying out soil conservation measures and amendments. Since, this study is the first of its kind to be conducted on the soils of the study area. This piece of work will only add to findings of future researches. Consequently, the following recommendations are made. It is advisible that the farmers should adopt crop rotation in the cultivated plots for better results and use methods to improved the soil organic contents. The sandy nature of soils makes their susceptible to erosions hazards by both wind and water because of their loose structures and low organic matter. In this situation the option for more reliable rain fed crop production system will require the adoptions of soil water, conservation practices; variations and fast growing three species and incorporations of organic manure in to poorly aggregated soils. Soil conservation is particularly needed during the non – cropping season when over grazing, burning and other degrading activities should be cheked.

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Progressive Pearl Millet [*Pennisetum glaucum* (L.) R.Br.] Varietal Evaluation for Yield Components and Yield in Dutsin-Ma, Katsina State

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ABSTRACT

Pearl millet [Pennisetum glaucum (L.) R.Br.] is a highly cross-pollinated crop with protogynous flowering and wind-borne pollination mechanism. These peculiar characteristics help pearl millet to fulfill one of the essential biological requirements for hybrid development. Hybrids were generated from the crosses between pearl millet varieties that were resistant to downy mildew (Maiwa) and susceptible varieties of pearl millet (Gero). These hybrids were subject to a selection for the varieties that are high-yielding. Those selected were advanced further for selection in the second year. Out of the 20 hybrids, 15 hybrids were selected and evaluated for yield. The experimental layout was RCBD with 5 entries per block. The study aimed to select hybrids that are high yielding. Hybrids DGMH181004, DGMH181025, DGMH181014, DGMH181021, DGMH181009, DGMH181006, and DGMH181030 were selected for their potential for high yield components, and yield.

Keywords: High-yielding, hybrid, selection, pearl millet

INTRODUCTION

Pearl Millet [*Pennisetum glaucum* (L.) R.Br.] is a member of the Poaceae (Graminae) family and genus Pennisetum. It is a highly cross-pollinated crop with protogynous flowering and wind-borne pollination mechanism. Thus fulfilled one of the indispensable biological requirements for hybrid development. Pearl millet is diploid(2x=14) in nature (Lakshmana, 2008). They are small-seeded annual grasses including a variety of cereals that can be used both as human food and for animal forage. According to Arun Kumar *et al*.,2011, for about 3000 years, Millet is believed to have been domesticated as forage or cereal crop in Africa. Millet is superior in drought tolerance and adaptability to poor soils, hence, is largely contributive to food security (Sahri *et al*., 2014 and Vinoth and Ravindhran, 2017). Millet is gluten-free and ideal for people with sensitivity to modern wheat or other grains that contain gluten. This may be the explanation for millet's recent resurgence. Millet has high levels of protein with balanced amino acids, carbohydrates, and fat which are vital to the human diet. Selection of parental materials and good mating designs in conventional plant breeding are the keys to the successful plant breeding programme. However, there are several factors affecting the choices of mating designs. Mating design refers to the procedure of producing the progenies. In plant breeding, plant breeders and geneticists, theoretically and practically, use different form of mating designs and arrangements for targeted purpose. The choice of a mating design for estimating genetic variances should be dictated by the objectives of the study, time, space, cost and other biological limitations. In all mating designs, the individuals are taken randomly and crossed to produce progenies which are related to each other as half-sibs or full-sibs. A form of multivariate analysis or the analysis of variance can be adopted to estimate the components of variances (Athanase, et al.,2013)

MATERIALS AND METHODS

The pearl millet hybrids used for the experiment were obtained from the crosses between Gero and Maiwa cultivars in the off season of 2018. The factorial mating scheme of North Carolina Design II was used to obtain the crosses. (Athanase *et al*., 2013; Acquaah, 2012).

Experimental site

The research was conducted in the Department of Agronomy experimental farm in the main Campus of Federal University Dutsin-Ma, Katsina State. The farm is located within Latitude12^0 17' 40" N and Longitude7^0 27' 19" E. The field was designed using Complete Randomized Block Design (CRBD) in three replications. Hybrids were allocated to plots using random number table. *The ridges were five meters long with inter-row spacing of 75cm and intra row spacing of 50cm. Four ridges represented one plot. Few seeds were sown per hill and the plants were later thinned to two plant per stand and Compound fertilizer NPK (15:15:15) was applied two weeks after sowing and urea was used as a top-dress at six weeks after sowing (WAS). Other cultural practices: weeding and application of pesticides were observed.*

North Carolina Design II : In this design, each member of a group of parents used as males is mated to each member of another group of parents used as females. Design II is a factorial mating scheme. It is used to evaluate inbred lines for combining ability. The design is most adapted to plants that have multiple flowers so that each plant can be used repeatedly as both male and female. Blocking is used in this design to allow all mating involving a single group of males to a single group of females to be kept intact as a unit (Acquaah, 2012). The design is essentially a two-way ANOVA in which the variation may be partitioned into differences between males (m) and females (f) and their interaction.

Data on Plant height, Panicle Length, Number of harvested panicles per plot, Panicle circumference, Panicle exertion, Panicle compression, Panicle weight, Plant number at harvest, and Grain weight per plot were collected and analyzed using Science Analytical System

RESULTS AND DISCUSSION

The result in Table 1 showed the performance of the hybreds for Plant Height, the height ranges between 194.1 cm(DGMH181022) and 235.9 cm (DGMH181009); For panicle length, the length ranges from 24.17cm(DGMH181022) to 37.22cm (DGMH181030); the Panicle Circumference ranges between 8.61cm (DGMH181009) and 3.61cm (DGMH181017); the panicle exertion ranges between -1.167cm (DGMH181030) and 9.5cm (DGMH181022); the number of plant count at harvest ranges between 26.67 (DGMH181022) stands and 57.67 stands (DGMH181021); Number of Harvested panicles ranges between 63.67panicles (DGMH181023) and 119.33panicles (DGMH181025); Panicle Weight ranges between 1993.7 panicles (DGMH181017) and 4326.3panicles (DGMH181025), the Grain Weight ranges between 901g (DGMH181017) and 2672.7g (DGMH181025) and the threshing % ranges between 45.54 (DGMH181017) and 63.79 (DGMH181003).

Yield: In pearl millet breeding, the most important character of consideration to the breeder is the grain yield and disease resistant (Ati, 2020). Grain yield is a quantitative trait which is also influenced by environmental factors hence direct selection for yield would be difficult. To improve the grain yield, it is necessary to select for one or more yield components like panicle length, number of harvested panicles, panicle circumference and panicle weight. Out the15 hybrids used in these study, 14 of them were high yielding indicating that the hybrids have some degree of yield potencial Ati. *et al* (2015) had similar result on their work on pearl millet. Hybrids DGMH181025, DGMH181003 have the highest grain weight. Hybrids DGMH181004, DGMH181025, DGMH181014, DGMH181021, DGMH181009, DGMH181006, and DGMH18103 were high in yield related characters and yield (See table) hence they are selected for their potentials.

CONCLUSION

High yielding potential, early maturity, wider adaptability and resistance to diseases are the main focus in pearl millet breeding programme. Hence the development of superior hybrids This research make an an attempt to produce and select hybrids that were resistant to downy mildew disease which are also high yielding. This is because Downey mildew is a disease of considerable importance because downy mildew disease affects the yield, forage, and fodder value which are all of economic important to food security. Hybrids DGMH181004, DGMH181025, DGMH181014, DGMH181021, DGMH181009, DGMH181006, and DGMH181030 were selected for their yield components, and yield.

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Table 1: The yield performance of Pearl millet Hybrids

Designation	Plant_Height	Panlen	PanCIR	PanEx	AS	SC_at_Har	NHarpan	PanWt	GRWT	THR%
DGMH181003	226.57ab	27.78bc	9.61ab	5.333ab	1.6667ab	46ab	89bcd	3200ab	2005.3ab	63.793a
DGMH181022	194.1c	24.17c	9.273ab	9.5ab	2ab	26.667b	68.33cd	2635.7ab	1637.7bc	61.478a
DGMH181014	218.67abc	29.83abc	9.553ab	7.5ab	1.6667ab	44ab	84.67bcd	3172.7ab	1768.7bc	54.036ab
DGMH181023	206.37abc	26.66bc	9.943ab	8.833ab	1.6667ab	41.667ab	63.67d	2755ab	1580.7bc	57.236a
DGMH181011	218.67abc	29.88abc	10.663ab	5ab	2.3333a	35.667ab	87.67bcd	2760.7ab	1661.7bc	60.044a
DGMH181021	215.53abc	27.5bc	9.053ab	2.167ab	1.6667ab	57.667a	101abcd	3050.3ab	1618bc	53.739ab
DGMH181027	211.47abc	26.177bc	9.167ab	2.833ab	1.6667ab	45.333ab	76.33cd	2676ab	1584.7bc	60.001a
DGMH181009	235.9a	25.89bc	8.61ab	9.167ab	1.3333ab	52a	92.67bcd	2682.3ab	1428.7bc	53.627ab
DGMH181018	229.67ab	28.557bc	9.003ab	4.167ab	1.3333ab	43ab	86.67bcd	2943ab	1650bc	54.722ab
DGMH181004	230.57ab	34.337ab	10ab	8ab	1.3333ab	52.333a	87bcd	3687.7ab	1986.7ab	53.621ab
DGMH181017	216.33abc	26.72bc	13.61a	4.167ab	1.6667ab	46.333ab	82bcd	1993.7b	901c	45.539b
DGMH181025	204.57abc	27.33bc	12.11ab	5ab	1b	52.667a	119.33a	4326.3a	2672.7a	61.592a
DGMH181006	220.33abc	24.89c	8.83b	6.167ab	1.33ab	55ab	116.67ab	2972.7abc	1705.3bc	57.39ab
DGMH181029	200.9bc	26.06bc	10.057ab	5.833ab	1.6667ab	54a	87.33bcd	2700.3ab	1686.7bc	62.315a
DGMH181030	220.43abc	37.22a	8.943ab	-1.167	1.3333ab	51.667a	72.33cd	2907.7ab	1635.3bc	57.238a

Panlrn - Panicle Length, NHarpan - Number of harvested panicles per plot, PanCIR - Panicle circumference, PanEx - Panicle exertion, AS - Panicle compression, PanWt - Panicle weight, NHarpan - Plant number at harvest, and GRWT - Grain weight

Comparative Analysis of Organic (Compost Tea) and Inorganic Foliar Fertilizer on the Growth and Yield of Cucumber (*Cucumis Sativa)*

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ABSTRACT

Organic foliar fertilizers are the valuable by-products of farming and allied industries derived from plant and animal resources. The introduction of compost tea (organic foliar fertilizer) will remove the barrier of dosage in application of organic fertilizer and bulkiness, which are considered as a drawback of natural manure. This innovation will also create employment in form of waste to wealth. The experiment was laid out in Randomized Complete Block Design (RCBD) with three treatments and four replicates. Growth parameters were recorded at 2, 4, 6 and 8 weeks after planting while yield parameters were taken at 8 weeks after planting respectively. Result shows that there were appreciable differences in the application of compost tea and synthetic foliar fertilizer in terms of number of leaves and size as well as vine length. The highest fresh fruit yield (6.75) was recorded in plots treated with compost tea as compared to synthetic foliar fertilizer (3.25) and control (2.75). There was increase in the average weight of harvested fruits in compost tea treated plot (1.26kg) as compared to synthetic foliar fertilizer (0.55kg) and control (0.72kg). The increase in yield may be attributed to the ability of the compost tea to promote vigorous growth, increase meristematic and physiological activities in plants due to the supply of plant nutrient and improvement in the soil properties thereby resulting in the synthesis of more photo-assimilate which is utilized in the production of fruits.
Keywords: compost tea, foliar fertilizer, fresh fruit, yield parameters

INTRODUCTION

Compost tea is the water-soluble extract obtained from the compost. This is a system to extract compost compounds that are soluble in water and additionally, microorganisms. Composting is a biological process that occurs under aerobic conditions (presence of oxygen) ranging from 4 hours to 2 weeks with or without a closed aeration and the addition of nutrients (molasses, casein etc.) (Pilar, María & Alberto, 2015). Likewise, it contains high concentration and variety of beneficial microorganisms such as bacteria, fungi and nematodes which, in agricultural systems, help preventing disease, increase the availability of nutritional elements and stimulate plant growth (Pilar *et. al.,* 2015).

The production of compost tea is intended to increase the microbial load of compost, so additives can be incorporated to the process which act as catalysts to induce microbial metabolism and thereby, increase populations more quickly and efficiently (Scheuerell, 2004; Angulo *et al.*, 2011).

Foliar application has been used as a means of supplying supplemental doses of minor and major nutrients, plant hormones, stimulant and other beneficial substances. It has been observed that the effects of foliar fertilization have included yield increases, resistance to diseases and insect pests, improved drought tolerance and enhanced crop quality (Kuepper, 2003)

Cucumber is a fruit crop belonging to *Cucurbitaceae* family. It does not tolerate frost. It must be well supplied with moisture and plant nutrient element throughout the growing season. Cucumber contain Vitamin A, Niacin, Vitamin C, Calcium, Iron, Phosphorus, Potassium, Carbohydrate, and Calories. These elements are very essential for body development. Cucumber reduce the risk of heart attack and help in digestion of food.

Increasing interest to food safety and environmental pollution has stimulated the attention for compost as valued alternative to the use of chemical fertilizers, beside the recovery of by-products from refuse. The development of the products derived from compost such as compost tea is increasing due to their positive effects on the crops (Loredana, *et. al.*, 2015*)*. Moreover, the declining soil fertility from continuous cultivation of small holder farms and escalating cost of imported fertilizers and the need to conserve and build natural resource base capital and biodiversity has led to renewed interest in the use of local nutrient resource for soil fertility management in Nigeria. However, the use of compost on a large farm requires huge amount of compost which are more expensive than using inorganic fertilizer. Farmers do not have the opportunity to know the right dosage of application that are needed to correct nutrient imbalance, amount of nutrients and exact elements that are included in an organic fertilizer. According to Paschalis, (2013) organic fertilizers release nutrient in slow manner. It is in view of this, that this research was conceived to produce Organic foliar fertilizer (Compost tea) that will solve the problems associated with the use of organic fertilizers.

The aim of this research work is the comparative analysis of organic (compost tea) and inorganic foliar fertilizer on the growth and yield of cucumber (*Cucumis sativa)*.

MATERIALS AND METHODS

Experimental Area: The research was carried out at the Teaching and Research Farm of Yaba College of Technology, Epe campus, Epe Local Government area of Lagos state. Epe lies between 6^0 35^I N 3^0 59^I E/ 6.583^0N 3.983^0E and 42m above mean sea level.

Experimental layout: The experiment was laid out in randomized complete block (RCBD) design with three treatments and four replications where; T1= Compost tea, T2= Foliar fertilizer, T3= Control (no application of foliar and compost tea).

Land preparation and sowing: Standard agronomic practices were carried out such as land clearing, marking out of land, bed preparation, staking, watering (morning and evening) as well as periodic weeding. Seeds were sown at 2 seeds per hole at a spacing 60cm by 60cm giving a plant population of 40 stands per bed (giving a plant population of 480)

Preparation of compost and compost tea: The compost is prepared from locally sourced fibrous materials such as hedge cuttings, maize stalks, fodder remains, weeds, livestock manure, topsoil and ash and prepared under shade as follows:

Two heaps were prepared with a height of 1m for a dry region after which the soil at the site was loosened. Fibrous materials were chopped to a length of about 5cm on the bottom layer of about 30cm thick and sprinkle with water. Drying of vegetable material such as grass, banana leaves, tree leaves; from the second layer of 10cm and were sprinkled with water. A stem of a layer of fresh or semi-decomposed animal dung and slurry from a biogas plant of thickness of 2cm. the function of this layer is to add nitrogen so as to enable micro-organisms to function well and to add phosphate and other plant nutrients. Wood ash was sprinkled to cover the materials. This contains calcium and potassium that helps in regulating pH. Addition of green vegetable such as green plants (preferably leguminous) and kitchen trash that decomposes easily to a thickness of 15 – 20cm were also added. Topsoil was sprinkled to a thickness of 2cm.This prevent ammonia produced from escaping, prevent loss of temperature and increased plant nutrients in the heap. Water was sprinkled on the whole pile adequately.

The procedures above was repeated until the pile was about 1m high. Final layer of topsoil was put to a thickness of about 5cm and the whole pile was covered with dry vegetation or banana leaves to avoid evaporation. Dry sharp stick of about 2m long was dipped into the pile at an angle. This stick assist in showing whether the pile is dry or wet and also act as a thermometer. Decomposition starts within 2 – 3 days. When the stick was removed, its feels warm and moist. This stick was removed every 7 days to monitor warmth and moisture. Depending on the weather conditions, the pile was watered every 3 – 5 days. Every 2 weeks, the pile was turfed in such a way that the different layers get mixed-up. The preparation of the compost was completed in 16weeks (4month).

In preparing the compost tea, the compost was placed into the mesh bag or porous bag in a ratio equivalent to 15% (weight and volume) to 150 litres of water. The mesh bag was hanged on the edge of the tank ensuring that the solid materials is in contact with water. This is similar to a tea bag in a cup. The water in the tank is stirred at several intervals for aeration process. When time is over, the mesh with damp compost was removed and this material return to a compound pile in its initial phase. The liquid turns caramel colour. A simple verification way to ensure that the process is carried out correctly was through the odour because unpleasant odour is produced when oxygen is insufficiently; an aerobic process should not produce offensive odours.

Application of Compost Tea and Inorganic Fertilizer: Inorganic fertilizer applied was maxi force, a multifunction standard formulation with equal nitrogen, phosphorus and potassium ratios (20-20-20) and Magnesium (14%). After 2-3 weeks, maxi force was applied in 13ml to 7liters of water as recommended by manufacturer while compost tea was applied at 8.3 litres of compost tea+16.7 litres of water (ratio of 1:2). After 4 weeks and above maxi force is applied in 200ml to 10liters of water while compost was applied at 12.5 litres of compost tea+12.5 litres of water (ratio of 1:1).

Determination of mineral composition of compost tea: Samples of compost tea were collected in a covered plastic bottle container for the determination of the macro and micro nutrient present in the compost tea. These analyses was carried out at the Department of crop production, Federal University of Agriculture, Abeokuta, Ogun State.

Soil analysis and determination of growth and yield components: The soil samples were analyzed prior to the experiment. Composite soil sample (0-30cm) was taken from the site, bagged, air dried and analyzed for routine nutrient property using standard laboratory procedure according to Association of Official Analytical Chemists (AOAC). Five (5) stands of cucumber were randomly selected and tagged per plot for determination of growth and yield performance. The parameters assessed were number of leaves, size and vine length (cm) at 2, 4, 6 and 10 weeks after planting. Numbers of leaves was determined by visual counting of the leaves; vine length was determined using meter rule at the distance from the node close to the soil level to the terminal bud. At harvest, number of harvested fruits were recorded per plot and weighed using weighing scale.

Data analysis: Data collected was subjected to analysis of variance, T-test and standard deviation and treatment means were compared using least significant difference at 5% probability level with SPSS version 22.

RESULTS AND DISCUSSION

From Table 1 it could be observed that the soil is slightly acidic(6.30), adequate in exchangeable magnesium (167.95mg/kg), iron (113.55mg/kg) while it is low in phosphorus (38.50mg/kg), nitrogen (32.32mg/kg) and manganese (20.22mg/kg), zinc (3.20mg/kg) and copper (0.62mg/kg) according to the critical levels of 3.0% organic matter, 0.2%nitrogen, 10.0mg/kg, available phosphorus 0.16 – 0.20cmol/kg, exchangeable potassium 2.0cmol/kg, exchangeable calcium and 0.40cmol/kg, exchangeable magnesium recommended for crop production in ecological zones of Nigeria (Akinrinde and Obigbesan, 2000).

Table 1: Soil analysis of the study area

Parameters	Values	Parameters	Values
Nitrogen (mg/kg)	32.32	Zinc Zn (mg/kg)	3.20
Phosphorus P (mg/kg)	38.50	%sand	78.75
Manganese Mn (mg/kg)	20.22	% silt	14.8
Magnesium mg (mg/kg)	167.95	% clay	6.7
Copper Cu (mg/kg)	0.62	Ph	6.30
Iron Fe (mg/kg)	113.55		

Compost analysis: After four months of preparation, the compost was subjected to laboratory analysis to determine its nutrient composition. The result is presented in table 2. The result reveals that compost tea is high in essential nutrients such as: Nitrogen 1846mg/kg, Phosphorus 1433 mg/kg, Potassium 922 mg/kg, Calcium 351 mg/kg, Magnesium 198 mg/kg required for the growth of *Cucumis sativa var*. The content also include micronutrient such as Iron (1872 mg/kg), Zinc (66.0 mg/kg), Copper (5.01 mg/kg), Nickel (16.2 mg/kg) and Manganese (155 mg/kg). The generally low ambient soil nutrient content, made the soil suitable for this study of response to compost tea and foliar fertilizer. The soil amendments thereby confirming previous report by Akande *et. al*., (2010) that fertilizer (organic manure and inorganic fertilizer) is one of the most important inputs contributing to crop production because it increases productivity and improves the quality and quantity.

Table 2: Nutritional composition of experimental compost tea

Parameters	Values	Parameters	Values
Nitrogen (mg/kg)	1846	Iron (mg/kg)	1872
Phosphorus (mg/kg)	1433	Zinc (mg/kg)	66.0
Potassium (mg/kg)	922	Copper (mg/kg)	5.01
Calcium (mg/kg)	351	Nickel (mg/kg)	16.2
Magnesium (mg/kg)	198	Manganese (mg/kg)	155
Available Nitrogen (mg/kg)	1592		

Source: Field work, 2019

Agronomic and yield parameters: The study revealed that there were appreciable differences in the application of compost tea and synthetic foliar fertilizer in terms of their number of leaves and vine length at 4, 6, 8 and 10weeks. (Table 3). The application of compost tea generally resulted in growth and yield which compared favourably with chemical foliar fertilizer.

This agrees with the previous report by Adeloju *et al*. (2010) and Dada and Fayinminu (2010) that nutrient from mineralization of organic matter promotes growth and yield of cucumber. Also, application of compost tea and inorganic foliar fertilizer enhances cucumber agronomic performance (vine length, number of leaves, etc.) and yield as compared to untreated control. The acidic nature of the soil and the generally low soil organic matter (<1%), as well as high percentage silt and clay below 25% made the soil suitable for the study of responses to compost tea and synthetic foliar fertilizer, thereby confirming work done by Akande *et. al.,* (2010) that fertilizer (organic manure and inorganic fertilizer) is one of the most important input contributing to crop production because it increases productivity and improves yield quality and quantity.

Fruit Yield: Highest fresh fruit yield (6.75) was recorded in plots treated with compost tea (Table 4) as compared to inorganic foliar fertilizer (3.25) and control (2.75). Similarly, there was increase in the average weight of harvested fresh fruits in compost tea treated plot (1.26kg) as compared to inorganic foliar fertilizer (0.55kg) and control (0.72kg). The increased number of fruits and average weight could be attributed to the ability of compost tea to promote vigorous growth, increase meristematic and physiological activities in the plant, due to supply of plant nutrients and improvement in the soil properties, thereby resulting in the synthesis of more photo-assimilate, which is used in producing fruits. This is in agreement with the findings of Sanni *et al.,* (2013).

Table 4: Mean of Fruit Weight

No. of harvested fresh fruit	**Mean**	**Standard error mean**	**T-value**	**Significant level (2-tailed)**
Inorganic fertilizer	3.2500	0.75000	4.333	0.023
Compost tea	6.7500	0.85391	7.905	0.004
Control	2.7500	0.6915	4.371	0.022
Weight of harvested fresh fruit (kg)				
Inorganic fertilizer	0.5500	0.28951	1.900	0.154
Compost tea	1.2625	0.10680	11.821	0.001
Control	0.7275	0.24033	3.027	0.056

CONCLUSION

Bunch (1996) in Sanni *et. al.,* (2013) reported that about 30% of increase in harvest by small scale farmers in the third world in the last three decades are due to the use of chemical fertilizers. However, use of chemical fertilizers can improve crop yield and soil pH, total nutrient content and nutrient availability but their escalating prices, scarcity, nutrient imbalance, soil acidity and mammalian toxicity places limitation for their use by poor resource farmers. (Sanni *et. al.,* 2013)**.** Thus, use of organic manure (such as compost tea) as a means of maintaining and increasing soil fertility has been advocated. (Oti-mbuba *et. al.*, 2016). As they enrich the soil with organic matter, supply minor and trace element, contain plant growth regulatory substances similar to hormones and vitamins in animal body, simple to prepare and inexpensive in terms of cash outlay. They are profitable way of disposing refuse so that the farmers holding and farm shade are left clean. It also ensures sustainable crop productivity by immobilizing nutrient that are susceptible to leaching, release nutrient more slowly and are stored for a longer time in the soil ensuring longer residual effects, improving root development and higher crop yield. (Sanni *et. al.*, 2013).

In all, due to the increasing attention about the use of natural substances (such as compost tea and by-products) to increase crop productivity, compost tea shows bioactivity on plants due its content in aromatic, hormone-like organic molecules and useful microorganisms. It also exerts protective effects against plant diseases occurrence and or stimulate an enhanced plant physiological status with improvements in quantity of crop productions (Loredana, *et. al.,* 2015). It is therefore recommended that farmers should make use of compost tea to fertilize their crops because it does not leave residual chemical in the crops unlike inorganic foliar fertilizer also because of its low cost of production and availability of materials.

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Table 3: Growth Parameters

		2 weeks after planting Fertilizer	Compost tea	Control	4 weeks after planting Fertilizer	Compost tea	Control	6 weeks after planting Fertilizer	Compost tea	Control	2 weeks after planting Fertilizer	Compost tea	Control
No of leaves	**Mean**	5.0000	4.9500	4.6000	11.7000	11.9500	8.6500	33.4500	32.2000	30.800	60.7000	58.3500	46.7500
	Standard error mean	0.21602	0.12583	0.14142	2.73435	2.23215	0.45735	0.66018	0.54772	0.86023	4.19563	2.25592	4.64713
	T-value	23.146	39.359	32.529	4.279	5.354	18.913	50.668	58.789	35.804	14.467	25.865	10.060
	Significant level	0.000	0.000	0.000	0.023	0.013	0.000	0.000	0.000	0.000	0.001	0.000	0.002
Size of leaves	**Mean**	85.2550	65.4725	58.3875	129.3490	169.3000	111.2900	209.6000	220.7000	172.3000	203.690	208.8425	193.1200
	Standard error mean	3.20164	18.21690	16.42249	4.34677	7.46016	9.56039	13.55802	7.59188	6.51217	8.91793	4.52732	4.24963
	T-value	26.629	3.594	3.555	29.757	22.694	11.641	15.459	29.071	26.458	22.841	46.129	45.444
	Significant level	0.000	0.037	0.038	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000
Vine length	**Mean**	10.5350	11.2000	9.3550	29.950	31.4850	13.2575	110.4500	105.9000	88.7500	144.2000	144.6000	123.7000
	Standard error mean	0.34335	0.36815	0.12500	2.09065	2.18706	0.23694	1.90679	1.17331	0.69940	7.05360	6.54879	10.60519
	T-value	30.683	30.423	74.840	14.326	14.396	55.953	57.925	90.257	126.894	20.443	22.080	11.664
	Significant level	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001

Effect of Integrating *Arbuscular Mycorrhizal* and N.P.K Fertilizer on the Soil Properties, Nutritional Composition and Performance of Sweet Potato Production

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ABSTRACT

Agricultural practices based on application of bio-fertilizers and inorganic fertilizers would produce vigor growth and more sustainable yield performance. The experimental trial was conducted to evaluate the effects of Glomale mycorrhizal fungal (AMF) inoculants and NPK fertilizer on the soil properties, nutritional composition, and yield performance of two orange fleshed sweetpotato (OFSP) varieties Tis 0087/87 and Tis 8164. The inocular at the rate of 250kg/ha were tested separately as NPK fertilizers at 200kg/ha. The results obtained showed that AMF and NPK significantly enhance and improve the soil chemical properties as well as increasing population of bacteria and fungi, when AM was introduced compared to NPK, which reduce the number of bacteria and fungi. The nutritional value of the two varieties of OFSP were significantly improved when mycohrrizal fungi and NPK were applied, showing that Tis 8164 has more nutritional value than Tis 0087/87. Inoculation plants with AM-fungi and NPK significantly increase the yield performance of Tis 0087/87 and 8164 to 7.94t/ha and 11.79t/ha respectively and improved root organic composition. In general, the results indicated that application of organic and inorganic fertilizers enhance the sustainable sweet potato production.

Keywords: Arbuscular Mycorrhizal; N.P.K Fertilizers; Soil properties; Nutritional composition; Sweet potato.

INTRODUCTION

Sweet potato (*Ipomoea batatas* (L). Lam) is an important secondary staple food and nutrition security root crop for great percentage of people whose staple diet is based on cereals, particularly maize (Gakonyo, 1993). They are rich in beta carotene, a natural precursor of vitamin A, and as such important in alleviating vitamin A deficiency nutritional disorders. The productivity of this crop is being hampered by many factors among which include declining soil fertility, which used to be solved through shifting cultivation to allow a particular soil fallow for a long time and resuscitate its fertility. In addition, for sustainable production of the root crop by farmers in Nigeria, soil fertility improvement package which inculcate the use of inorganic fertilizer (NPK), and integration of microorganisms as bio-fertilizers have to be developed.

Though the continuous application of inorganic fertilizers, especially phosphorus and nitrogen, improve crop yields but it has its limitation. It can directly or indirectly affect soil biological properties which, in the long run, can affect the quality and productivity of such soils. Soil microorganisms are important components of many agricultural ecosystems because of their role in organic matter decomposition, nutrient transformations and cycling (Cakmakci *et al*., 2006). The use of arbuscular mycorrhiza, (AM) fungi as biofertilizers to improve the soil prove important for sweet potato production. George *et al*, (1992) asserted that most agricultural crops are more productive when they are well colonized by AM Fungi inoculation of plant roots. AM fungi are particularly important in improving uptake of phosphorous, micro-nutrients, and also enhance phyto-accumulation of heavy metals (Al-agely *et al.,* 2005). To overcome these deficiencies in sweet potato cultivation, the use of Arbuscular mycorrhizae and N.P.K compound fertilizer were tested on the crop. Hence, the objective of this study was to evaluate the effect of the arbuscular mycorrhizae fungi and N.P.K fertilizer on the soil chemical and biological health, yield performance, and nutritional quality of sweet potato production.

MATERIALS AND METHODS

The research trial was executed at the experimental field of National Root Crop Research institute (NRCRI) Igbariam substation, Anambra State in 2018 cropping season. The field was ploughed, harrowed and ridged. Soil sample (0 – 30cm depth) was randomly collected and analysed for physicochemical parameters, and for soil biological parameters using standard procedure. The experiment was executed in randomize complete block design with three replications, comprising 12 treatments in each replicates with control plots. The sweet potato cultivars obtained were Tis 87/0087 and Tis 8164. Chemical fertilizer, N.P.K 20-10-10 at 200kg/ha were applied, a week after planting. Arbuscular mycorrhizal fungi (AMF), *Glomus mosseae*, at 250kg/ha was inoculated to the root zone, a week after planting with the exception of the control plots that were not treated with either fertilizer or AM. Data collected at 16 WAP include fresh weight of tuber roots (kg), marketable root yield (ton fed.$^{-1}$) and unmarketable root yield (ton fed.$^{-1}$). Nutritional contents of tuber roots, and mineral compositions were determined. All the data were subjected to statistical analysis of variance (ANOVA), using LSD at 0.05 probability level.

RESULTS AND DISCUSSION

The results of the selected soil chemical parameters were presented in table 1 and 2. The organic carbon, total nitrogen including available phosphorous, exchangeable bases such as Ca, Mg, Na, K, and exch. acids of the soil cultivated with Tis 87/0087 and Tis 8164 showed significant reduction with the application of AMF when compared to NPK. Lower values of available P. were observed in AMF treated soil relative to the N.P.K treatment and significantly higher than the value in control soil as well as soil treated with higher rate of NPK fertilizer. The increased phosphorous uptake by mycorrhiza plants can help to reduce the quantity of this nutrient to be added to the soil, and decrease the accumulated phosphorous soil and water (Smith and Read, 1997).

Tables 3, 4 and 5 indicated that there was significant increase of microbial organisms, and higher values of proximate and mineral content of sweet potato varieties when AMF and NPK were applied to the soil. AMF amendment increased the fungi characteristics of the soil whereas NPK reduced the microbial characteristics of the soil in both varieties of sweet potato. The proximate contents of orange-fleshed sweet potato were in the range of 1.91%–72%(Mohammad *et al*., 2016). The results showed that inorganic nutrient application have more proximate content when compared to AMF amendments. Beta carotene, a natural precursor for vitamin A, was high when AMF and NPK fertilizer were applied. Tomlins *et al.,*2012 reported that the highest range, 20–364μg/g db of the beta carotene in orange flesh sweet potato were observed from different varieties grown in different locations. The mineral contents range of 0.24-334mg/100mg were reported in orange fleshed sweet potato. These variations were attributed to varietal and agro-geological conditions (Ukom *et al,* 2009). Table 6 showed that there was significant increase in yield performance of sweet potato when AMF were inoculated to the soil than the application of NPK. Tis 87/0087 and 8164 recorded significantly the highest yield of 7.94t/ha and 11.79t/ha when treated with AMF compared to NPK.

CONCLUSION

The application of arbuscular mycohrrizal fungi and inorganic fertilizer improve greatly the soil health status as well as nutritional content and sustainable yield productivity. NPK has more significant effect on the sweet potato productivity when compared to AM, but AM has proved to be more sustainable in improving root organic composition and supporting soil biological characteristics. Hence, it is acceptable to use organic means and/or inorganic means for sweet potato productivity.

Table 1: The result of pre-planting soil analysis of sweet potato

Soil Parameters	**Pre-planting values**
Texture	Sandy Loam
$PH_{(water)}$	6.45
Org. Carbon (%)	2.56
Total N. (%)	0.13
Avail. P (mg/kg)	69.80
Exch. Bases(mol/kg)	
Ca	1.60
Mg	0.15
Na	2.57
K	0.34
Exch. Acids (mg/kg)	1.56

Table 2; The effects of AMF and NPK on the Soil Chemical Properties

Treatment/Chemical ppt		pH	O.C	TN	AP	Ca	Mg	Na	K	Exch. A
Tis 87/0087	AMF	6.15	2.51	0.25	71.18	2.57	0.28	2.55	0.39	1.52
	NPK	6.67	2.82	0.28	72.97	2.53	0.33	2.65	0.32	1.67
Tis 8164	AMF	6.13	2.63	0.17	70.00	2.45	0.18	2.72	0.37	2.01
	NPK	6.65	2.81	0.20	75.94	2.55	0.31	2.81	0.35	2.09

Organic carbon, pH, Total Nitrogen, Available phosphorus, Calcium, magnesium, Sodium, Potassium, Exchangeable Acids.

Table 3. AMF and NPK effect on Microbial populations

Treatment/soil microbial agent		Bacteria(x10^{6}) cfu	Fungi(x10^{6})cfu
Tis 87/0087	AMF	8.50	9.52
	NPK	6.24	7.40
Tis 8164	AMF	8.35	9.23
	NPK	6.05	7.00

Table 4. AMF and NPK effect on Nutritional content of sweet potato

Trt/ Nut. comp (%)		β-carotene(μg)	Cruder fiber	Sugars	Protein	Fats	Starch	Carbohydrate.
Tis 87/0087	AMF	150.25	3.10	68.02	3.67	0.39	60.62	90.15
	NPK	158.05	3.65	73.15	4.78	0.42	64.41	96.16
Tis 8164	AMF	155.10	2.95	69.68	4.05	0.39	62. 45	90.29
	NPK	160.00	3.35	76.21	5.15	0.53	67.53	96.85

Table 5. AMF and NPK effect on mineral composition

Trt/ Min. comp.(mg/100g)		Ca	Mg	k	P	Fe	Zn	Na
Tis 87/0087	AMF	32.50	30.05	40.08	138.00	10.65	0.35	35.90
	NPK	40.25	34.15	45.20	156.15	14.10	0.60	46.06
Tis 8164	AMF	32.54	31.10	40.12	138.45	12.10	0.38	36.10
	NPK	40.75	35.10	45.55	157.01	14.45	0.72	47.05

Table 6. AMF and NPK effect on yield performance of sweet potato

Treatment.		WTR(kg)	MRY(t/ha)	URY(t/ha)	T. Yield(t/ha)
Tis 87/0087	AMF	0.54	5.93	2.01	7.94
	NPK	0.41	4.13	2.17	6.30
Tis 8164	AMF	0.55	10.17	1.62	11.79
	NPK	0.49	4.98	1.43	6.41

* WTR - Weight of tuber roots; MRT - Marketable root yield; URT - Unmarketable root yield;TY -Total yield

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Evaluation of Some Exotic Sugarcane Varieties for Cane and Sugar Yield in Nigeria

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ABSTRACT

The field experiment was conducted at the sugarcane research field of National Cereals Research Institute Badeggi to evaluate the performance of some exotic sugarcane varieties. The field was laid out in Randomised Complete Block Design with three replications. Analysis of variance showed that significant differences occur among the evaluated genotypes for the measured traits. High significant difference was noted among the studied genotypes for sugar yield and SP-801816 gave the highest sugar yield (23.1%) which was significantly better than the sugar yield recorded for some clones (Sp71-618, B 96812, SP-791011, BD 98-001, RB-867515, M21-1988, CO-997 and B 47419). Significant differences were also observed for cane yield among the entries. B/245/B0197 had the highest cane yield (105.2 t/ha).

Keywords: exotic, genotypes, sugarcane, sugar yield

INTRODUCTION

Sugarcane (*Saccharum officinarum*) is one of the most important cash crops and is the first major sugar crop worldwide. In Nigeria both industrial cane and soft cane (chewing cane) are cultivated. Soft cane is usually more robust, softer stem, higher moisture with less sucrose content and the industrial cane type has relatively thin and hard stem, thick ring and less moisture with higher brix percent (Busari *et al*., 1995).

In tropical Africa, Mauritius, Kenya, Sudan, Zimbabwe, Madagascar, Cote d'Ivoire, Ethiopia, Malawi, Zambia, Tanzania, Nigeria, Cameroon and Zaire are the important sugar-producing countries in the continent (Girei, 2012). Nigeria possess important potential of sugarcane production with a land potential of over 500,000 hectares of suitable cane field capable of producing over 3.0 million metric tons of sugarcane (NSDC 2003). Sugarcane plays significant role in food and income security of Nigeria and attention should be directed towards the selection of high yielding cane varieties.

Mian, (2006) stated that variety plays a major role in both increasing and decreasing per unit area sugar yield, while using unapproved, inferior quality cane varieties affect sugarcane production negatively. Developing sugarcane seedlings from genetically diverse parents or breeding clones is important for producing high yielding, disease and insect resistant varieties with better ratoonability for cultivation. A good study of genetic variability in the different characters of sugarcane clones from diverse parents or environment will be a useful tool in the genetic improvement of the crop. These will aid in the identification of useful clones and their behaviour in hybridization programs. Identification and selection of high yielding clones and subsequent introduction to the existing local types will lead to increase in sugarcane production in Nigeria. It has been essential to substitute varieties regularly with new clones due to the facts that sugarcane varieties tend to decline in performance after some years in a specific area (Khan *et al*., 2009). The sugarcane varieties are clonally propagated and it is not expected to undergo any genetic changes as occur in a seed propagated crops, however the variety decline in sugarcane result due to disease and pest incidence (Poehlman,1959). The solution of low cane yield and sugar recovery problem lies in the planting of improved cane varieties (Chattha *et al.*, 2006). According to Khan *et al.*, (2017) evaluation of sugarcane varieties for their traits performance is paramount for the selection of promising high cane and sugar yielding non-flowering varieties adaptable to an area. Identification of proper variety to be grown in a particular agro-ecological zone is a primary requisite to explore its yield and sugar recovery potential (Getaneh et al., 2015). With the views above, this study was carried out to reveal the potentials of some exotic sugarcane varieties imported by National Sugar Development Council (NSDC), Nigeria.

MATERIALS AND METHODS

The evaluation study was conducted by sugarcane research program of the National Cereals Research Institute, Badeggi, Niger State, Nigeria. Sixteen sugarcane clones were collected from the sugarcane Biofactory, Zaria. The clones were grown on randomized complete block design (RCBD) and two standard varieties (B47419 and NCS 009) were used as check. Each clone was planted on a 5 m x 5 m plot and replicated three times. Ten setts (3 bedded) were planted per row and each plot comprised of six rows at inter row spacing of 1m. The evaluation trial was established on 15th April, 2019.

Data were collected on sprout percent at 21 days after planting (DAP) and establishment count at 42 DAP respectively, tiller count at 3 months after planting (MAP); stalk girth, stalk length, number of stool per plot, number of millable cane per plot and cane yield per plot at harvest. Brix (sugar yield) was measure with the use of refractometer at 12 MAP. The data collected was used for analysis of variance (ANOVA) using Crop Stat (version 7.2) package. Means were separated using standard error (SE$\pm$) where significant differences occur among the clones.

RESULTS AND DISCUSSION

The result of Table 1 shows the growth performance of the studied clones at NCRI Badeggi. SP-801816 and RB-867515 significantly gave the highest sprout (35 and 33.3%) which were at par with mean sprout percent recorded for some studied cones (RB-855536, B/245/B0197, IAA-873396, SP-791011, B1245, RB-801845 and NCS 009). Poor sprout percent was recorded in BD 98-001, B 96812 and SP-1816. The studied genotypes generally exhibit better tillering when compared to their sprout percent. BD 98-001 significantly produced more tillers than other tested clones except RB-855536, SP-813250, Co 6806, B/245/B0197, RB-867515 and B1245. RB-801845 had the tallest (225.3 cm) plants at 3 MAP, while the shortest (108.2 cm) plant height was recorded in BD 98-001. At 6 months after planting RB-801845 still maintain the tallest (318.8cm) plants, while M21-1988 and BD 98-001 gave the shortest (228.1 and 231.3cm) plant height. The differences recorded among the studied genotypes for cane height agrees with the report of Ali *et al*., 2017 that carried out assessment of sixteen sugarcane genotypes for cane yield at Haripur, Pakistan and recorded plant height of 164.1 to 273.3cm.

Table 2 reveals the differences among the studied sugarcane genotypes for yield attributes at NCRI Badeggi in 2019. The best stalk length (221.1cm) at 12 MAP was recorded for RB-801845 which showed better plant height at 3 and 6 months after planting. However, M21-1988 significantly gave the least (135.8cm) stalk length which is at par with stalk length recorded for some clones (SP-813250, BD 98-001, Co 6806, SP-1816 and the checks). The differences among the clones were not significant for milleable stalk per plot and number of cane stools per plot. However, there was reduction in the milleable canes per plot recorded for the studied genotypes when compared to the number of tillers and this confirms the report of other researchers (Getaneh *et al*., 2015, Worku and Chinawong 2006).

Table 1: Mean values for growth performance of sugarcane clones from Zaria evaluated in Preliminary yield trial 2019 at NCRI Badeggi

Genotypes	Sprout (%)	Tiller Count	Plant height 3 MAP (cm)	Plant height 6 MAP (cm)
RB-855536	26.3	113.3	164.4	283.0
Sp71-618	23.7	86.3	165.9	290.6
B 96812	13.7	78.0	156.4	295.0
SP-813250	22.3	119.0	148.7	263.8
Co 6806	23.0	116.7	157.1	277.3
B/245/B0197	26.7	102.0	188.0	275.2
IAA-873396	27.0	88.0	208.0	307.6
SP-791011	26.0	95.3	214.7	298.4
SP-801816	35.0	86.3	223.7	272.5
BD 98-001	11.7	132.3	108.2	231.3
RB-867515	33.3	102.0	194.3	305.5
M21-1988	19.3	66.0	133.7	228.1
B1245	25.7	114.0	171.0	295.2
CO-997	23.0	92.0	145.7	267.8
RB-801845	26.3	84.3	225.3	318.8
SP-1816	14.3	79.0	157.0	266.7
B47419 Check	19.3	84.0	132.3	254.3
NCS 009 Check	26.0	85.7	179.5	299.2
SE	3.4	11.1	12.7	16.7
CV	24.9	20.1	12.9	10.4

Means were separated using SE$\pm$ at P<5%.

Getaneh *et al.,* 2015 further revealed that reduction of stalk population (mortality of cane) could be attributed to the factors which induce competition for light, moisture, nutrient and the survival of the tillers after the competition is a character of a variety. High significant difference was noted among the studied genotypes for brix percent (sugar yield). The best brix (23.1%) was recorded in SP-801816 which was significantly better than the brix recorded for some clones (Sp71-618, B 96812, SP-791011, BD 98-001, RB-867515, M21-1988, CO-997 and B 47419). Maximum single stalk weight was recorded in IAA-873396, B1245 and RB-801845 (1.1kg) which did not differ significantly from those recorded for other accessions except SP-813250, B 96812, BD 98-001, M21-1988, SP-1816, B47419. The total sugarcane yield (t/ha) was significantly greater in B/245/B0197 (105.2 t/ha) than in 6 other accessions and BD 98-001 gave the poorest yield among the studied accessions. Most of the genotypes that showed better yield also possess good stalk length, more number of milleable canes and had heavier single stalk weight. This suggests that these traits are important in the selection of suitable varieties in any sugarcane varietal trial.

The variation in cane yield among the studied genotypes is in agreement with the result of other workers (Ali *et al.,* 2017 and Islam *et al*., 2011). Soomro *et al.* (2006) carried out studied among twelve promising sugarcane varieties for some quantitative and qualitative attributes under Thatta (Pakistan) and observed variation for cane yield (146.7 to 58.3 ton/ha). Increase in cane yield might be due to maximum plant height, weight per stool and cane girth according to Khan *et al,* (2003). Javed *et al*. (2001) reported that cane yield in tonnes per hectare depend upon number of stalks per hectare and weight per stalk. It had been stated that unless the genetic potentialities of a variety are high, mere provisions of growing conditions such as manuring, irrigation etc. will not lead to appreciable improvement in cane or sugar yield (Keerio *et al,,* 2003). Selection of high cane yield may not be necessarily give high sugar yield. A threshold is however important in achieving both high sugar and cane yield.

Table 2: Mean values for yield performance of sugarcane clones from Zaria evaluated in Preliminary yield trial 2019 at NCRI Badeggi

Genotypes	Stak length (cm)	Milleable/plot	Stool/plot	Brix (%) sugar yield	Single stalk weight (kg)	Yield (t/ha)
RB-855536	178.9	70.3	11.0	22.5	1.0	70.0
Sp71-618	199.0	60.0	14.0	18.9	1.0	65.1
B 96812	212.8	63.3	15.0	18.6	0.7	80.8
SP-813250	168.9	57.7	12.0	22.2	0.8	69.8
Co 6806	178.2	84.3	16.3	21.0	0.7	70.7
B/245/B0197	193.4	94.3	18.3	21.0	0.9	105.2
IAA-873396	205.9	73.3	15.0	22.4	1.1	102.0
SP-791011	200.6	74.3	14.3	20.0	1.0	83.8
SP-801816	208.2	76.0	12.3	23.1	1.0	80.4
BD 98-001	153.3	47.0	10.7	19.9	0.8	56.3
RB-867515	181.0	68.7	15.7	20.2	1.0	96.7
M21-1988	135.8	39.0	9.0	18.9	0.7	43.1
B1245	186.6	73.0	14.0	20.3	1.1	96.3
CO-997	180.0	70.3	12.3	17.5	1.0	65.7
RB-801845	221.1	63.3	10.0	21.4	1.1	61.0
SP-1816	163.1	65.7	8.3	21.4	0.7	87.5
B47419 Check	160.6	50.7	9.0	18.2	0.7	61.2
NCS 009 Check	161.9*	75.3	11.0	20.3**	0.9*	77.5*
CV	13.5	24.8	31.8	7.6	20.0	27.9
SE	14.3	9.6	2.3	0.9	0.1	12.3

Means were separated using SE$\pm$ at P<5%.

CONCLUSION

Some of the tested genotypes (B/245/B0197, 0535 and B1245) that exhibit better performance in this plant crop should be ratooned and selected for evaluation in more advance trials.

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Effect of shelling Methods and Packaging Materials on seed Germination and Vigour of Maize (*Zea mays* L.) After Short-Term Cold Storage

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ABSTRACT
Shelling operation is an important aspect of seed conditioning in the processing of maize seed. The objective of this study was to investigate the effect of locally fabricated maize sheller used during processing on seed quality of maize after short term cold storage using different packaging materials. Freshly harvested maize ears dried to about 12% moisture content were subjected to two shelling methods: machine-shelled and hand-shelled (control). A 500g of maize seeds was weighed from each part and each part was partitioned into three. The samples were packed separately using three packaging materials namely, plastic containers, aluminium cans and aluminium foil bags. Thereafter the samples were kept under short term conditions (18±3°C) for eight months. Samples were drawn and subjected to standard germination test. The results of analysis of variance (ANOVA) revealed that shelling method was highly significant (P< 0.01) for standard germination test. The mean germination values were 94.44 and 86.00% for hand-shelled and machine-shelled maize seeds respectively. From this study, result clearly shows that hand-shelled maize seeds would store longer in the storage environment compared to machine-shelled maize seeds
Keywords: Maize, shelling, germination, packaging materials

INTRODUCTION
Shelling operation is one of the steps of seed conditioning that influences maize seed quality. Wilson (1994) reported that among steps involved in seed conditioning of maize, shelling is the only operation that consistently damages the seed and thereby reduces standard germination in shrunken-2 sweet corn. Germination and vigor are crucial aspects of seed quality therefore germination tests are used worldwide to determine the maximum germination potential of a seed batch under optimum conditions while speed of emergence of seedlings is one of the oldest seed vigour concepts. The objective of this study therefore was to investigate the effect of the locally fabricated maize sheller on seed quality of maize variety.

MATERIALS AND METHODS
Seeds of maize variety, DMR ESR-Y sourced from Institute of Agricultural Research and Training (IAR&T), Ibadan were used for the study. The variety was regenerated in isolation at the experimental field of National Centre for Genetic Resources and Biotechnology (NACGRAB), Moor Plantation, Ibadan located on latitude 007^0 48' 11.3" N, longitude 003^0 50' 52.0"E and altitude of 183m above sea level. The seed regeneration was carried out during the early growing season of 2015. At maturity, 200 well filled ears were harvested and selected for further sun-drying to reduce seed moisture content to about 12%. Dried ears were divided into two parts, one part was shelled using locally fabricated maize sheller (Figure 1) and the second part was shelled manually with hands. Further cleaning of seeds was done and 500g of maize seeds was weighed from each part. The seed samples from each part were further sub-divided

into three and packed separately using plastic containers, aluminium cans and aluminium foil and thereafter kept in a short term storage conditions ($18 \pm 3^{o}C$) in January, 2016 for eight months.

Figure 1. Maize sheller

Laboratory standard germination test

The laboratory seed quality test (standard germination) was carried out at the Seed Testing Laboratory, NACGRAB, Ibadan, Nigeria. The test was conducted in August, 2016 using Complete Randomisation Design (CRD), replicated three times with 100 seeds per replication. The test was carried out on seed samples using sterilized riverbed sand as substratum. Seed germination was assayed by placing 100 seeds in sand inside plastic trays and covered with moist sand up to about 2cm level. These trays were kept at room temperature of about $25^{0}C$ for 7 days. Germination counts were carried out and percentages were calculated by expressing the number of seedlings in a replicate that emerged 7 days after planting as a percentage of the number of seeds planted according to ISTA (1993) rules. Germination Index (GI) was calculated by taking the germination counts at 5, 7 and 9 days after planting using the following formula:

$$GI = \frac{\text{No of germinated seed}}{\text{Days of first count}} + \ldots\ldots\ldots + \frac{\text{No of germinated seed}}{\text{Days of final count}}$$

Statistical Analysis

Data obtained from laboratory experiments and field emergence trials were subjected to analysis of variance (ANOVA), using Generalized Linear Model Procedure (PROC GLM) of Statistical Analysis System (SAS, 1990) package. Since data on percentages do not conform to normal distribution, hence the germination data were log-transformed before subjecting them to the ANOVA. However, ANOVA was not able to detect any significant difference between transformed and untransformed values, untransformed values are hereby presented in the study. Treatment means were thereafter separated by use of the least significant difference (LSD) at 0.05 level of probability.

RESULTS AND DISCUSSION

Effect of maize shelling machine was highly significant (P < 0.01) for standard germination test (Table1). The mean germination for hand-shelled maize seeds (94.44%) was significantly higher than that of machine-shelled maize seeds (86.00%) (Table 2). The significant difference between both shelling methods for standard germination suggests that the extent of damage caused by the machine during shelling operation. This results support the findings of Miah *et al.,* (1994) which stated that the percentage of grain damage was significantly affected by the threshing method used for rice. However, the effect of packaging materials was not significant on the germination of maize seeds which might be due short duration of storability. Maize being an orthodox species and a cereal, a longer period of investigation may give significant differences among the packaging materials used to store in cold environments.

Table 1. Mean squares from the analysis of variance for laboratory standard germination.

Source of variation	Degree of freedom	Germination (%)	Emergence index (days)
Replication	2	5.39ns	0.01ns
Threshing Method (T)	1	80.22*	0.11ns
Packaging materials (P)	2	16.72ns	0.56ns
TxP		4.39ns	0.22ns
Error		7.66	0.22
Total		12.34	0.23

*, **, Significant at probability level of 0.05 and 0.01, respectively; ns = Not Significant

Table 2. Effect of shelling methods and packaging materials on seed germination and vigour of maize seeds

Factors	Germination (%)	Emergence index (days)
Threshing Methods		
Hand-shelled	94.44	4.56
Machine-shelled	86.00	4.72
LSD	**2.91**	**0.49**
Packaging Materials		
Aluminium bag	87.66	4.95
Plastic container	94.00	4.62
Aluminium can	88.00	4.34
LSD	**3.56**	**0.60**

CONCLUSION

In conclusion, from this study, it seemed therefore that hand-shelled maize seeds would store longer in short term storage environment compared with machine-shelled maize seeds. Hence, for maize seed conservation in the genebanks, although hand-shelling is labour intensive it can be recommended that hand-shelling method should be employed in shelling of maize in order to enhance maize storability in genebanks.

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Infestation of Dodder (*Cuscuta Campestris* Yunck) In Cassava Field - A Review

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ABSTRACT

Dodder (Cuscuta spp) is an annual parasitic weeds infesting many crops such as cassava as well as some weeds. It reproduces both from seeds and vegetatively from pieces of the stem. Dodder seeds can remain viable in the soil for 10 to 20 years. Once it germinates, it attaches to a host and lives entirely on the photosynthates and water extracted from the host plant. The dodder seedling can survive several days without a host, but if it does not come in contact with any host within 5 to 10 days the seedling will die. This parasitic weed inflict serious damage to cassava crop, its infestation lowers the crop vigor resulting in yield reduction and death of the host plant. Dodder can serve as vector of pathogens such as African Cassava Mosaic and spread plant diseases from host to host. Cassava is highly susceptible to dodder, which attaches and wraps tightly on its stem, if left uncontrolled could destroyed the whole cassava field. Dodder in cassava field is difficult to control without damaging the above ground part of the cassava. Hand weeding is common to cassava field infested by this parasitic weed and this method is laborious, timing consuming and can only destroy part of the weed which can regenerate from the haustoria (suckers) left embedded in the cassava stem. The close attachment between cassava and dodder require a promising selective herbicide to destroy the parasite weed without damaging the crop.
Keywords: Dodder, cassava, host, parasite, weed and yield reduction

INTRODUCTION

Dodder (*Cuscuta campestris* Yunker) of family Cuscutaceae are annual, obligate and shoot/stem parasitic weeds with a genus of about 100 – 170 different species widely distributed through the world (Holm *et al*., 1997). Dodder is a common parasitic weed in Nigeria reportedly in Benin, Edo state (Aigbokhan and Nwokocha, 2013) and in Adamawa State, Nigeria (Gworgwor *et al*., 2001; Mustapha *et al*., 2016) and entire West Africa (Akobundu and Agyakwa, 2016). This weed infesting many crops and weeds, causing growth inhibition and yield losses in various crops worldwide (Mishra *et al*., 2006). Once the dodder (*Cuscuta spp*) seed bank is established, they can remain dormant, yet viable, in the soil for 10 to 30 or more years, depending on the species and environmental conditions (Lanini and Kogan, 2005). *Cuscuta spp* prefer dicotyledons as host but also parasitize monocotyledons (Gworgwor *et al*., 2001). *Cuscuta campestris* is most important *Cuscuta* (dodder) species, attacking and inflict serious damage to many crops and causing severe loses such as cassava (Melifowu, 2000; Mushagalusa *et al*., 2016), vegetables, fruits, ornamentals and woody plants (Tan *et al*., 2008). *Cuscuta spp* infestation can lower the crop vigor resulting in yield reduction (Lanini and kogan, 2005). It reported that cassava yield was reduced by 47% when the field infested by dodder (Mushagalusa *et al*., 2016). Therefore, there is high level of susceptibility of cassava to dodder and the rate of spreading of this invasive weed (Dodder) from one infected farm to another is great alarming which pose a threat to farmers interested in cassava cultivation due to the fact that cassava is vegetatively propagated, hence dodder is spread primarily via movement of cuttings from affected cassava. Consequently, the spread of dodder into new localities typically the patterns of cassava cuttings exchange among farmers. Once infected cuttings are planted, the dodder regenerates readily from the haustoria left embedded in cassava stem and continue multiply within fields. Cassava is more susceptible to dodder in south-eastern Nigeria. While soybean, cowpea, and tomatoes reported more susceptible to dodder (*Cuscuta competries)* in North-eastern Nigeria (Mustapha *et al*., 2016).

Dodder (*cuscuta spp*) parasitizing cassava

Dodder is a true oblige parasite, that is, neither chlorophyll to produce its own food but must have its host to survive thereby live by attaching to a host with houstorium extracting carbohydrates (Glenn *et al*., 2016), withdrawing photosynthates (Lanini and kogan, 2005), water and nutrient (Melifonwu, 2000) thus the vigor of the host is affected and crop production drastically reduced (Lanini and kogan, 2005). However, it was reported that cassava is one of the major root crops prone to dodder infestation (Melifowu, 2000; Mushagalusa, *et al*., 2016). This invasive weed (dodder) wraps tightly on cassava stem and within few days, if uncontrolled, choke cassava plant (Plate 1). Dodder reportedly serve as vector of pathogens (Roos and Aldrich, 1988) such as African Cassava Mosaic Virus and one of the important factors limiting cassava yields (Wisler and Norris, 2005). Mushagalusa, *et al*., (2016) reported that cassava root yield was reduced by 47 % six months after planting when the field was infested by dodder. Root diameter decreased from 15.9 cm to 15.1cm, root length changes from 17. 7 cm to 15.6 cm and dry weight of each root was reduced by 39% leading to an average yield loss of 47% (Table 1; Mushagalusa*, et al*., 2016).

Dodder is extremely difficult to control in cassava field since dodder seeds can remain viable in the soil for 10 to 20 years, and remain viable, continue germinates and emerges as far as environmental conditions is favorable (Mishra *et al*., 2006). Its reproduction may also be vegetative through segmentation of its thread-like stem. Such reproduction mode is frequent in cassava field while weeding by hoe (Melifowu, 1994). This enables its transfer from infested plots to non-infested fields (Parker, 1991). And once dodder germinates and attaches to cassava, it is difficult to control without affecting the crop (Nadler-Hassar and Rubin (2003); Melifonwu, (2000); Mushagalusa *et al*., (2016). Many cassava field infested by dodder is usually weeded by hand, thus this method is laborious and time consuming and can only destroy the belowground party of the weed while the aboveground continue growing on the stem and branches after destruction of basal organ. Also, breakage of cassava shoot/stem is common during hand weeding (Melifonwu *et al.,* 2000). Dodder fragments can be disseminated in the field during weeding and regrowth if they attached to the cassava stem (Dawson *et al*., 1994). Several different methods for dodder control in crops were reviewed by Parker and Riches (1993) and they suggested intercropping system as a control method but many other crops such as legumes (cowpea, ground nut, soya bean) unfortunately are also potential field dodder hosts (Mustapha *et al*.,2016). Pre-emergence applications of herbicide such as Kerb,® Treflan,® and Prowl® have been reported to suppress dodder germination (Mueller, 2006). Glyphosate and paraquat have been reported to control dodder POST and can be applied as a spot treatment but cassava is less tolerant. Mushagalusa *et al.*, (2016) reported that cassava leaves do not affect the development of dodder, which can thrive under the cassava canopy once infected, causing substantial yield losses and suggested that dodder control may be more effective if herbicide applications are made before the parasite attaches to the host such as cassava in order to reduce its seed production and further spread.

Plate 1; (a) Dodder (cuscuta spp) wrap tightly on cassava stem (b) Dodder parasitizing cassava plant

CONCLUSION

There is high level of susceptibility of cassava to dodder which suggested a potential threat to cassava production. Dodder is difficult to control because of its ability to produce large number of seeds, remain viable and continue to germinate throughout the warm season and its reproduction may also be vegetative through segmentation of its threadlike stem. In addition of attachment to the crops make it difficult to control. Therefore, there is need for post-attachment dodder control in order to reduce it seed production in cassava infested field. More also the close attachment between cassava and dodder require a promising selective herbicide to destroyed the parasite without damaging the crop.

Table 1. Effect of field dodder on cassava root yield

Parameter	Uninfected plants	Infected plants	LSD	CV	F-test	P-value
Root diameter (cm)	5.899±0.61a	5.088±0.90b	0.448	14.33	13.26	<0.001
Number of root	4.734±1.39a	4.224±2.00a	0.943	36.94	1.19	0.281
Root fresh weight (g)	299.49±94.25a	230.29±124.12b	62.580	41.45	4.96	0.031
Root dry weight (g)	199.86±59.4a	121.62±65.63b	36.059	39.36	19.1	<0.001
Root Length (cm)	17.677±2.63a	15.635±3.21b	2.006	21.14	4.2	0.046
Root fresh weight per plant (g)	1381.6±392.8a	916.8±309.4b	321.9	49.14	8.46	0.005
Root dry weight per plant (g)	922.88±209.5a	483.86±251.4b	191.707	47.82	21.27	<0.001

Source: Mushagalusa, *et al*., 2016

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Efficacy of Fertilizer Rates and Maize Population on the Growth and Yield of Cassava-Maize Intercrop

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ABSTRACT

Cassava is one of the common root crops intercropped with other crops such as maize, etc. This study was conducted in Otukpo (Benue State), and Igbariam (Anambra State), both in the Derived Savanna Agro-ecology of Nigeria during the 2018/2019 cropping season. The study tested increased planting densities of maize and fertilizer rate on the growth and yield of cassava-maize intercrop. The trials were laid out in a randomized complete block design in a factorial arrangement with four replications. Cassava (TME 419) was planted as 1m x 0.8 m (12,500 plants ha^{-1}) while maize (SAMMAZ 35) seeds were sowed at 1m x 0.5 m (20, 000 plants ha^{-1}) and 1m x 0.25 m (40, 000 plants ha^{-1}). Fertilizer was applied as 90 kg N,20 kg P, and 40 kg K ha^{-1} versus 75 kg N, 20 kg P and 90 kg K ha^{-1} A control did not receive fertilizer. Grain yield was taken at harvest per net plot, the cobs were threshed and grains were weighed and extrapolated to tonne ha^{-1} while cassava was uprooted at harvest, weighed and extrapolated to tonne ha^{-1}. All data were subjected to analysis of variance (ANOVA) using Genstat statistical package and significant separated using LSD at $p<0.05$. The result indicated that cassava intercropping with maize significantly influenced the yield of both crops across the trial sites. Intercropping cassava at 12,500 plants/ha and maize at 40,000 plants/ha with 90:20:40 kg/ha of NPK gave intercrop yield of 14.97-20.45 ton/ha.

Keywords: intercrop, maize, cassava, yield, fertilizer and plant population

INTRODUCTION

cassava is an important root crop for resource-limited farmers in the tropics because of its adaptation in intercropping system (Reddy, 2015). Cassava is usually intercropped with short duration crops. Many researchers have conducted a lot of work on intercropping cassava with one or more short season crops like maize (Adeniyan, 2014), okra (Salau *et al*., 2012), pepper (Olasantan *et al*., 2007), groundnut and cocoyam (Okeleye *et al.,* 2001), maize and melon (Ijoyah *et al*., 2012), cowpea (Njoku *et al*., 2010), cowpea and maize (Adeniyan *et al.,* 2011); soybean (Mbah and Ogidi 2012; Umeh *et al*., 2012) and some local varieties of cassava reportedly intercropped with sunflower in the moist savanna region of Nigeria (Adetunji and Amanze, 2001). Therefore, maximum yield was obtained without affecting each component crop. Negash and Mulualem, (2014) reported that cassava-maize intercrop has more advantage than sole cassava in the sense that sole crop of cassava does not efficiently use the available light, water and nutrients during its early growth stages due to its slow initial development. Intercropping short duration crops, like maize, which are often harvested before the cassava canopy closes during the early stage of development of cassava and utilize the light not intercepted by cassava and intercropping farmer achieves not only the full production of the base crop (cassava) but also an additional yield bonus associated with the second crop component such as maize. Therefore, the aim of this study was to determine the effect of fertilizer rates and increased planting densities of maize on the growth and yield of cassava-maize intercrop.

MATERIALS AND METHODS

This study was conducted in Otukpo (Benue State) of Nigeria (07°10'N, 08°39'E), and Igbariam (Anambra State) of Nigeria (06°15'N, 06°52'E), both in the Derived Savanna Agro-ecology of Nigeria during 2018/2019 cropping season. In Otukpo site, the annual average rainfall was about 1000mm -1723mm and the mean temperature range of 25.5 °C - 27.2 °C. The soil was loamy-sandy and the land had been under continuous cropping with maize from 2015 till commencement of this study. While in Igbariam site, the annual rainfall was about 1500-2000mm and the temperature was 28 °C - 37 °C. The soil was loamy soil and the land was under continuous cropping for cassava and yam until commencement of this trial.

The trials were laid out as randomized complete block design (RCBD) in a factorial arrangement with four (4) replications. The treatment combinations were:
(i) 12,500 plants/ha cassava + 40,000 plants/ha maize + 75:20:90 kg/ha NPK (CM1F1)
(ii) 12,500 plants/ha cassava + 20,000 plants/ha maize + 75:20:90 kg/ha NPK (CM2F1)
(iii) 12,500 plants/ha cassava + 75:20:90 kg/ha NPK (CF1)
(iv) 12,500 plants/ha cassava + 90:20:40 kg/ha NPK (CF2)
(v) 12,500 plants/ha cassava + 40,000 plants/ha maize + no fertilizer (CM1)
(vi) 40,000plants/ha maize + 90:20:40 kg/ha NPK (M1F2)
(vii) 12,500 plants/ha cassava + 40,000 plants/ha maize + 90:20:40 kg/ha NPK (CM1F2)
(viii) 12,500 plants/ha cassava + 20,000 plants/ha maize + no fertilizer (CM2)
(ix) 12,500 plants/ha cassava + 20,000plants/ha + 90:20:40 kg/ha NPK (CM2F2)
(x) 20,000 plants/ha maize + 90:20:40 kg/ha NPK (M2F2)
The land was ploughed, harrowed and ridged using a tractor. The total experimental field was 2276 m^2 (0.23 ha) while treatment plot was 7.2 m x 7 m (50.4 m^2) and 1m alley way.
Cassava (TME 419) stems were caught 20 – 25 cm stakes and planted on ridge crests 15 cm deep into the soil in a slanted position. The stakes were planted 1 m x 0.8 m (12,500 plants ha^{-1}) apart.

Maize (SAMMAZ 35) seeds were sowed using 2 different spacing 1m x 0.5 m and 1m x 0.25m which gave approximately plant population of 20,000 plants ha^{-1} and 40,000 plants ha^{-1} respectively. Cassava and maize were planted simultaneously on the same day. Application of fertilizer was applied in two phases. The first fertilizer regime was applied as 90 kg N, 20 kg P and 40 kg K ha^{-1} as a basal application of the compound fertilizer NPK15:15:15 followed by two split applications of urea at 3 and 5 weeks after planting. The second fertilizer regime comprised of 75 kg N, 20 kg P and 90 kg K ha^{-1} applied at 3 weeks after planting (WAP) using urea/TSP followed by top dressings of urea at 6 WAP, urea/Mop at 10 and 16WAP. Pre-emergence application of Premextra @ 2.5 kg ai ha^{-1} was applied to all plots a day after planting while a supplementary hand hoeing was carried at 6 -7 WAP. Grain yield was taken at harvest per net plot, the cobs were threshed and grains were weighed and extrapolated to tonne ha^{-1} while cassava was uprooted at harvest, weighed and extrapolated to tonne ha^{-1}

RESULTS AND DISCUSSION

The result indicated that the cassava intercropped with maize significantly influenced grains and root yield (Table 1) across trials. The higher grains yield was obtained in a plot with high maize population with fertilizer as compared to others. The maize component of intercropped plots had higher grain yield which ranged between 1.42 to 2.11 ton/ha with no fertilizer application, 2.95 – 4.25 ton/ha at 40,000 plants/ha with low fertilizer rate and 2.20 to 2.58 ton/ha at 20,000 plants/ha with high fertilizer rate in both sites this results supported by Adeniyan *et al.,* (2014) who reported that the higher yield obtained under 40,000 plants t ha^{-1} about 3.28-3.55 t ha^{-1} of grain yield. The yield of cassava component increased with a reduction in maize population at optimum fertilizer dose ranged between 15.82 - 22.34 t ha^{-1} was in line with Agbaje and Akinlosotu (2004), Issaka *et al. (*2007), Ojeniyi *et al*. (2012) and Ezui *et al*. (2016) reported significant increases in cassava yield when optimum fertilizer rates were applied. While higher root yield recorded in sole cassava as compare to cassava-maize intercrop agreed with Takim and Fadayomi (2010) findings who reported that the sole plots yielded better than their intercropped components, although the aggregate crop yield in the intercropped plots was significantly higher than sole crop plots.

CONCLUSION

This study concluded that intercropping cassava at optimum population of 12,500 plants/ha and maize at 40,000 plants/ha with 90:20:40 kg/ha of NPK gave intercrop yield of 14.97-20.45 ton/ha. Therefore, cassava-maize farmer should adopt this treatment combination for optimum yield of both component crops.

Table 1. Effect of cassava-maize intercrop and fertilizer rate on the yield of component crops

	Igbariam			Otukpo		
Treatment Combination	Root Yield (ton/ha)	Grain Yield (ton/ha)	Intercrop Yield (ton/ha)	Root Yield (on/ha)	Grain Yield (ton/ha)	Intercrop Yield (ton/ha)
CF1	24.74	-	24.74	24.16	-	24.16
CF2	21.85	-	21.85	25.10	-	25.10
CM1	11.41	1.42	12.83	10.57	1.69	12.26
CM2	15.94	2.11	18.05	11.53	1.49	13.02
M1F2	-	3.77	3.77	-	3.91	3.91
M2F2	-	2.79	2.79	-	3.15	3.15
CM1F1	20.30	2.95	23.25	11.76	2.95	14.71
CM2F1	22.34	2.20	24.54	15.82	2.40	18.22
CM1F2	16.75	3.69	20.45	10.72	4.25	14.97
CM2F2	19.52	2.43	21.95	16.27	2.58	18.85
Sed (0.05)	2.70*	0.54*	3.96*	1.95*	0.27*	3.05*

C= cassava @ 12,500 plant ha^{-1}, M_1 = Maize @ 40,000 plants ha^{-1}, M_2= Maize @ 20,000 plants ha^{-1}, F1=NPK @ 75:20:90 kg ha^{-1}, F2= NPK @ 90:20:40 kg ha^{-1} ,

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Complex Interaction and Synergistic Effect of Damage Caused by Spittle Bugs, *Locris rubens* (Erichson) and *Poophilus Costalis* (walker) and Witch Weed (*Striga hermonthica*) on Maize (*Zea mays*) in Kubwa, Abuja, Nigeria

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ABSTRACT

During the raining seasons of year 2006 and 2007, different maize varieties – hybrid, inbred lines, and open pollinated varieties were screened for Striga resistance using artificial infestation of 5000 germinable Striga hermonthica seeds per hill. At 8 and 10 weeks after planting, emerged striga plants were counted and likewise striga damage symptoms were rated using the scale of 1 to 9. It was however discovered that those maize that were susceptible to striga were more affected due to attack of spittle bugs (Locris rubens) and Poophilus costalis.
Keywords: artificial infestation, Locris rubens, Poophilus costalis, spittle bugs, Striga hermonthica

INTRODUCTION

The parasitic seed plant of most important in Africa is the genius Striga (of the family Scrophulariaceae) (Now Orobanchaceae). Members of this genus are obligate annual hemiparasites; they are chlorophyllus but require a host to complete their life cycle (Musselman, 1987). Although, there are about 41 species, only 5 are presently of economic importance in Africa (Ramaiah *et al*., 1983; Raynal-Roques, 1994). These are in approximate order of economic importance in Africa, *Striga hermonthica* (Del) Benth., *S. asiatica* (L.) *S. forbesii* Benth. All except *S. gesneriodes* are parasites of Africa's cereal crops-sorghum, millet, maize and rice. *S. gesnerioides* is a parasite on cowpea and other wild legumes.

Spittle bugs, *Locris rubens* (Erichson) (Cercopidae: Homoptera) and *Poophilus Costalis* (Walker) (Walker) (Aphrophoridae: Homoptera) are endemic pest of sorgum (*Sorghum bicolor* (L.) Moench) in Nigeria and some other countries in West and Central Africa. Spittle bugs feed on leaves and inside leaf whorls of Sorghum and Maize resulting in chlorotic spots and blotches on the leaves (NRI 1996). Major species found in Nigeria include *Poophilus costalis, P. adustus,* and *Locri rubens*. Hosts of spittle bugs are maize, pearl millet, rice, sugarcane, and grasses. On sorghum or maize, *L. rubens* lay eggs in the epidermis of the leaf sheath. There are five nymphal instars and development from egg to adult take about 33days. Both species of spittle bugs feed on all growth stages and all parts of maize and sorghum, including the panicle in sorghum and tassel in maize. Feeding symptoms include yellow leaf blotching. Severe infestations often kill young leaves and plants. Under artificial infestation in cages, the severity of the damage and associated symptoms as well as grain yield loss increased with an increase in the population density of spittle bugs (Ajayi and Oboite, 1999).

MATERIALS AND METHODS

Various varieties of maize - hybrid, inbred lines, open pollinated varieties and synthetics were screened for striga resistance under rain feed conditions in the year 2006 and 2007 at Kubwa, Abuja. The control was not infested, while the other were artificially infested. The artificial infestation of 5000 germinable striga seeds per hill was used. The maize infested and non-infested with striga were exposed to natural infestation by spittle bugs (*L. rubens* (Erichson) and *P. costalis* (Walker).

Insecticide was not used to control the spittle bugs. Both *S. hermonthica* and spittle bugs, *L. rubens* and *P. costalis* were allowed to cause damage to the maize infested with striga, whereas only spittle bugs were allowed to cause damage in non-infested with striga. The non-infested plots have been injected with Ethylene to kill striga seeds in the soil.

Fig 1: picture of spittle bugs

Fig 2: Picture of Nymph of spittle bug inside spittle

RESULTS AND DISCUSSION

Both at 8 and 10 weeks after planting (WAP), the striga numbers were counted in the infested plots. The purpose of counting striga numbers in breeding plots is to determine the mechanism of resistance, i.e., whether a better performing variety is tolerant (supports the same number of emerged striga as the susceptible check), resistant (fewer emerged striga than susceptible check), or immune (no emerged striga, as well as no attachment and no damaged symptoms). The susceptible variety have high number of striga counts and show severe damage symptoms – leaf blotching, leaf streaking, leaf wilting, leaf scorching, stems with shorter internodes, dwarfed plants, reduced stalk diameter, brittle stalks which collapse easily under the slightest strain. The symptoms are normally scored thus – 1 = Normal maize growth, no visible symptoms. 2 = scattered small and vague whitish leaf blotches visible. Otherwise, normal plant growth. 3 = Blotching and streaking easily noticeable. Mild witting. Only a trace of scorching, restricted to tips of leaves. 4 = Extensive blotching and streaking, wilting. Leaf scorching on a small portion of the leaf area. Moderate stunting; ear and tassel size reduction. 6 = Extensive streaking, now obscuring the blotches, turning scorching. Leaf scorching covering over a third of the leaf area. About one-third reduction in height. Reduced stem diameter, reduced ear, and tassel size. 7 = Extensive streaking/scorching, turning gray and necrotic. About half of the plant's surface is scorched. Severe stunting about 50% reduction in height, noticeable reduction in stem diameter and in ear and tassel size. Some stalks breaking. 8 = scorching on most of the leaf area. Stunting resulting in a 50% reduction in height. Stalks look thin and weak; many are broken. Husk leaves are noticeably short and open. 9 = virtually all leaf area scorched; two-thirds or more reduction in height; most stems collapsing; no useful ear formed; miniature or no tassel; no pollen production; plants dead or nearly dead.

A single score is given for each plot, based on the average of all plants in the plot. The leaves on which *L. rubens* fed developed yellow blotches of various shapes and sizes, but essentially resembled those described by Zummo (1984) for yellow blotch disease. It also resembles that of striga. In fact, the symptoms could easily be confused with a nutrient deficiency, particularly nitrogen (Ajayi and Oboite, 1999). This symptom is just like that of striga. However, the symptom of spittle bug damage is not systemic.

The damage caused by striga and that caused by spittle bugs produced the characteristic symptoms (synergistic effect) observed on the maize plants and leaves in the trials. This damage is a multiplier effect of damage by striga and spittle bugs. Ajayi and Oboite (1999) also found out that in each year, infestation by spittle bugs was observed on sorghum in farmers' fields and at research stations in all sorghum growing areas of northern Nigeria as well as the Federal Capital Territory of Abuja. The maize breeders normally select the maize with damage ratings of 1 to 5 while rejecting those with 6 to 9. However, in the screening because of the synergistic effect of damage caused by striga and spittle bugs those plants that would have been rated 5 became 6. It was also observed that those lines that were susceptible to striga suffered more from the damage of spittle bugs. Those maize varieties that were not infested with striga (control) but exposed to spittle bugs also suffered damage but recovered. NRI (1996) also stated that most infested plants recover from damage and natural enemies provide a measure of control. Those varieties that are resistant or tolerant with damage ratings of 1 to 4 in the infested plots recovered from spittle bug damage but still show characteristic yellow leaf blotches of spittle bugs at 8 and 10 weeks.

There is need to further assess the extent of damage by artificially infest the maize (that was infested with striga) with spittle bugs to empirically quantify the synergistic effect especially in term of yield.

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Effects of Planting Time and Manure Types on the Performance of Five Tomato Cultivars

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ABSTRACT
Field experiment was carried out to determine the effects of cultivars, planting time and manure types on the growth and yield of five cultivars of tomatoes. The research was conducted at Kabba College of Agriculture, Kogi state of Nigeria in the months of July, august and September 2018 and repeated the same time in 2019. Three manure types were used for the research. Seedlings were raised in the nursery from the selected cultivars for each month and transplanted to the field four weeks after planting. The experimental design was spit- split design laid in a randomized complete block design with each treatment replicated three times. Data obtained for growth and yield parameters were subjected to analysis of variance using FLSD at 5% probability level. The result showed that significant differences were observed across the cultivars, months of planting and manure types. Rio grande, Boomerang and cobra recorded significantly higher yield amongst the tested cultivars. The yield was higher in the month of July while poultry manure recorded the highest yield across the cultivars.
Keywords: Boomerang, Cobra, manure types, yield parameters

INTRODUCTION
Tomato, *Solanum lycopersicum* L. is a very important vegetable crop worldwide. Tomato gives a high yield and it is economically and nutritionally attractive. Tomato can grow under a wide range of temperature however; fruit set is limited in a narrow range. Relatively low or high temperature lead to poor fruit set. The critical factor in tomato fruit setting is the night temperature, the optimal range being 15-20°C (Abou-Shleel and El-Shirbeny, 2014).

The performance of tomato crop at any stage of its development is influenced by its hereditary make up and the prevailing weather condition. In Nigeria, commercial tomato production relies mostly on exotic introductions, the production of which is essentially restricted to the northern Guinea savanna and the Sudan ecologies due to favorable climatic conditions, particularly high insolation and low relative humidity (Olaoye *et al*., 2011).

Developing cultivars tolerant to heat, salinity stress and resistant to flood, change in the sowing date, use of efficient technologies like drip irrigation, soil and moisture conservations measures, fertilizers management through fertigation, use of grafting techniques, use of plant regulators, protected cultivation, improving pest management are the effective adaptations strategies for reducing the impact of climate change (Pena and Hughes, 2007). At present, a significant percentage of processed tomato products used in Nigeria are imported, resulting in unnecessary pressure on foreign exchange reserve. It is therefore necessary to increase the production of tomato. The need to explore more areas with potential for large scale production thereby expanding the scope of production necessitated the study with the following specific objectives:

1. evaluate the planting time that is most appropriate for growing tomato in study area to meet the urgent need of the country.
2. identify the best variety of tomato amongst the tested varieties suitable for the study area.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Research Site of Horticultural Section, College of Agriculture, Kabba. The site is located at latitude of 07° 35' N and longitude of 06° 08' E and is 1000 m above sea level, in Southern Guinea Savanna Agro Ecological Zone of Nigeria. Soil samples (0-15 cm) was randomly collected from fifteen different points on the experimental site in zig-zag pattern with soil auger; the soil samples were analyzed for physical and chemical composition. The organic carbon content of the soil was determined using dichromate wet oxidation method (Nelson and Sommer 1996); Nitogen N by the micro-Kjeldahl method (Bremner, 1996) and Phosphorus extract using Bray-1 solution and determined by molybdenum blue colometry (Frank *et al*., 1998). Exchangeable K, Ca, Mg were extracted using ammonium acetate, K level was determined using a flame photometer and Ca and Mg by the EDTA titration method (Herdershot and Lalande, 1993). Soil pH was determined by a soil-water medium at a ratio of 1:2 using the digital electronic pH meter (Ibitoye, 2006).

Five cultivars of tomato (Ishaze, Dan karufi, Cobra, Boomerang and Rio grande) were selected. Three manure types were used namely NPK fertilizer, poultry manure and organo mineral fertilizer. The poultry manure was applied 2 weeks before transplanting at 10 tonnes per hectare. The organo mineral and the NPK fertilizer were applied 2 weeks after transplanting at 2 tonnes per hectare and 150kg per hectare respectively. The experiment was conducted in three consecutive months namely July, August and September. Weeding and earthling-up were done at third and sixth weeks after transplanting. Plants were staked at three weeks after transplanting (WAT).

The experiment was laid out as a randomized complete block design (RCBD) in a split- split plot arrangement. Planting dates was assign to the main plot, cultivars in the sub-plot and manures in the sub - sub plot, replicated three times. The data collected was subjected to analysis of variance (ANOVA) and treatment means will be compared using the Fisher least significant difference (F-LSD) at 5% probability level as stipulated by (Obi, 2002). Statistical analysis was done using (GENSTAT, 2007) Discovery Edition

RESULTS AND DISCUSSION

Table 1: Physical and chemical properties of poultry manure, Organo mineral and soil

	Mg/kg Na	Mg/kg K	Mg/100g Ca	Mg/100g Mg	P(Ppm)	PH in H_2o	% OC	% OM	% N	% Particle size
OMF	3.85	13.10	12.20	4.48	68.21	6.40	2.21	3.82	0.61N	
Poultry	2.25	13.60	11.20	4.55	61.01	6.90	3.87	6.74	0.59N	
Soil	1.28	0.26	2.16	1.60	1.13	5.57	1.88	3.20	0.10N	

OMF: Organo mineral fertilizer, Na: Sodium, K: Potassium, Ca: Calcium, Mg: Magnesium, H_20, OC: Organic Carbon, OM: Organic matter, N: Nitrogen

Table 2: Effects of cultivars, manure and planting time on the plant height of tomato

Cultivars	**PH6**	**PH8**	**PH10**	**PH12**
CI Ishaze	12.28	24.97	33.45	44.97
C2Dan karufi	11.60	27.52	40.10	47.07
C3Cobra	12.68	28.35	40.12	49.30
C4Boomerang	11.56	27.36	40.02	49.17
C5Rio grande	9.95	22.15	30.72	40.72
LSD(0.05)	1.37	3.96	3.96	4.44
fertilizer 1poutry	12.64	27.84	38.23	48.41
2organo	11.54	26.64	37.97	46.66
3 NPK	10.67	23.73	34.50	43.67
LSD(0.05)	0.57	3.55	6.86	3.97
Month 1July	13.07	26.12	39.67	46.82
2August	11.54	20.91	29.96	44.51
	10.24	31.18	41.08	47.41
3September				
LSD(0.05)	0.63	3.07	3.07	3.54
Cultivars C	Ns	**	**	NS
Fertilizer F	*	*	NS	NS
Month M	**	**	**	NS
C x F	*	NS	NS	NS
C x M	NS	**	**	*
M x F	NS	NS	NS	NS
C x F x M	*	NS	NS	NS

PH: plant height

Table 3: Effect of cultivars, manure types and planting time on the number of leaves

	NL6	NL8	NL10	NL12
CI Ishaze	5.69	9.02	12.59	14.88
C2Dan karufi	5.34	9.24	12.99	15.21
C3Cobra	5.57	9.45	12.91	15.71
C4Boomerang	4.68	7.85	10.95	13.40
C5Rio grande	5.19	7.98	10.63	14.38
LSD (0.05)	0.70	1.16	1.43	1.93
fertilizer 1poutry	5.92	8.23	11.99	14.45
2organo	5.25	9.24	12.66	15.18
3 NPK	4.71	7.96	11.39	14.52
LSD (0.05)	0.63	1.04	1.28	1.73
Month 1July	5.69	9.02	12.59	14.88
2August	5.34	9.24	12.99	15.21
	5.57	9.45	12.91	15.71
3September				
LSD (0.05)	0.54	0.90	1.11	1.45
Cultivars C	NS	*	*	NS
Fertilizer F	**	*	NS	NS
Month M	NS	**	**	**
C x F	NS	NS	*	NS
C x M	NS	**	*	*
M x F	NS	NS	NS	NS
C x F x M	*	*	*	NS

Table 4: Effect of cultivars, manure types and planting time on the average Fruit length, fruit circumference, number of fruit per plant and fruits weight per plant

	AFRL	AFRC	ASFRW	AFRWP
CI Ishaze	7.45	10.24	34.08	530.89
C2Dan karufi	6.42	11.46	32.78	552.25
C3Cobra	6.94	12.98	33.28	785.56
C4Boomerang	6.46	11.61	32.80	774.47
C5Rio grande	6.66	11.58	38.38	809.42
FLSD(0.05)	0.12	0.07	5.76	191.20
fertilizer 1poutry	6.81	11.53	36.73	742.20
2organo	6.79	11.60	74.81	692.08
3 NPK	6.76	11.56	31.25	637.27
FLSD(0.05)	0.10	0.07	5.15	171.00
Month 1	7.36	12.17	38.25	1067.77
2	6.95	12.33	35.78	579.58
3	6.05	10.25	28.77	424.20
FLSD(0.05)	0.09	0.06	4.46	178.10
Cultivars C	**	**	Ns	**
Fertilizer F	NS	NS	*	NS
Month M	**	**	**	**
C x F	NS	NS	**	NS
C x M	**	**	**	*
M x F	NSS	NS	**	*
C x F x M	NS	NS	*	NS

AFRL: Average Fruit length, AFRC Average fruit circumference, ASFRW: Average single fruit weight, AFRWP: Average fruits weight per plant,

The physical and chemical properties of poultry manure, organo mineral and soil revealed that organo mineral is rich in Potassium (13.10g), Calcium (12.12g), Nitrogen (0.61N). The PH is almost slightly acidic (6.40). The soil texture is sandy loam with low Mg (1.28g), K (0.26g), and N (0.10N). The soil is acidic with a PH (5.57).

The effect of cultivars, manure and planting time on the plant height of tomato recorded a significance difference on cultivars from 6 – 8WAP. The highest height was recorded on cobra (49.30cm) and was statistically similar to the height recorded on boomerang (49.17 cm). Significant differences were recorded across the manure types; at 12 WAP poultry manure has the highest height (46.66cm). Significant difference was also observed on the time effects. The highest height was recorded in the month of September. Interaction between cultivars and manure types shows significant difference at 6 and 8 WAP. A highly significant difference was observed between cultivars and planting time from 8 – 10 WAP. There was no significant difference on the interaction between planting time and manure from 6 – 12 WAP.

The effect of cultivars, manure and planting time on the number of tomato leaves showed significant difference from 8 – 10 WAP. The cultivar cobra at 12 WAP had the highest number of leaves (15.71) while the manure types revealed a significant difference at 12WAP with organo mineral having the highest number of leaves (15.18). Interaction between manure types and cultivars show no significant difference.

The effect of cultivars, manures and planting time on the yield of tomato indicated a highly significant difference on the fruit length and fruit circumference in terms of cultivars. Cultivars effect revealed a significant difference on fruit length, fruit circumference and average fruit yield per plant. Ishaze cultivar had the longest average fruit length (7.45 cm). Cobra tomato fruit had the widest average fruit circumference (12.48cm). The highest average fruit weight per plant was observed on Rio grande cultivar (809.42g). Planting time showed a highly significant differences on fruit size and yield, the month of July had the highest average fruit yield per plant(1067.77g) The effect of manure types was significant on average number of fruit per planting. The interaction between cultivars and manure revealed a significant difference on fruit size and yield likewise the interactions of other factors.

The importance of the combinations of planting the appropriate cultivar of tomato at the right time and with manure cannot be overemphasized as it has direct effect on the growth and yield of tomato. The research by Hossain *et al*., (2013) revealed that the yield of tomato was significantly affected by different sowing dates and tomato genotypes. Increased productivity is attained only when tomato is grown adopting improved varieties and agro techniques. Isah *et al*. (2014) recorded significant differences in plant height by tomato cultivars (47.60-110.50 cm). The tallness, shortness and other morphological differences recorded are varietal characteristics, which are controlled and expressed by certain genes. Fayaz *et al*., (2007) discovered that days to first picking indicate significant differences among 11 tomato cultivars. They found that cultivar Rio grande gave the earliest days to first picking (82.40) after transplanting followed by Liger-87 and Roma with 83.07 and 85.33 days respectively, while cultivar Local round recorded maximum days to first picking (96.04) followed by Shalkot (95.25 days). This effect enhances crop health by increasing water and nutrient availability, as well as suppressing harmful levels of plant parasitic nematodes, fungi and bacteria (Abolusoro *et al*., 2012). The results from the study carried out by (Michael *et al*., 2018) indicated that effect of organic and inorganic fertilization on growth and fruit yield was significant, in turn gave value higher than the control. In other comparative studies no significant differences in fruit yield has been found between organic fertilization (Bocek *et al*., 2008; Asharfu *et al*., 2017 reported an increase in the growth and yield of tomato using both organic and inorganic fertilizer.

CONCLUSION

The yield of three cultivars of tomato (Boomerang, Cobra and Rio-grande) amongst the tested cultivars was significantly higher than that of other cultivars and are therefore recommended to farmers wishing to key into tomato production in the area while the month of July is recommended as the best period for growing tomato in the study areas.

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Fall Armyworm and Spittle Bugs; Prey-Predator Relationship?

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ABSTRACT
Different predators and natural enemies have been found to control Fall Armyworm. Among the popular ones are birds, rodents, ear wigs, lizards, several wasps, and beetles have been found to be natural enemies. However due to project sponsored by Korean African Cooperatives initiatives many more predators and natural enemies were identified. Some of them are known to be phytophagous insects. Therefore, the mechanisms of predating may not be conventional methods. One of such unique natural enemies are spittle bugs from genera such as Locris and Poophilus. However, their association with Fall Armyworm has not been ascertained.
Keywords: natural enemies, phytophagous, predators, spittle bugs

INTRODUCTION
Fall armyworm (*Spodoptera frugiperda*) belong to the family Noctuidea in the order lepidoptera. Fall armyworm was discovered in Nigeria in 2016 since then it has spread throughout Nigeria and to other 40 African counties. The pest can ravage maize fields if not controlled (Adegbite, 2016). Fall armyworm is voracious feeder and can cause considerable yield loss. Fall armyworm is currently threatening the production of maize especially in hot humid ecologies, the yield loss cause by fall armyworm is currently threatening maize industry and food security in Nigeria. Since 2016, green maize is no longer available for sale especially in southern Nigeria as it used to be due to fall armyworm. Chemical control is currently the most viable control option. However, chemicals can constitute environmental hazard, hence the need for all the control options in environmentally and ecologically balanced approach. Therefore, an important control option for Integrated Pest Management of fall armyworm is biological control.

Spittle bugs are also pest of maize. Though they are minor pest, but they have potential to become a major pest in the absence of biotic and abiotic limiting factors. The biotic limiting factors are both natural enemies, parasite and parasitoid that can reduce the population density in the agro-ecosystem. A spittle bugs found in Nigeria are majorly in two genera. The genera are *Locris* and *Poophilu*s. Those that belongs to *Poophilus* genera resemble *Cicadulina* species. Spittle bugs can reduce photosynthetic ability of maize, sorghum and pearl millet and rice and other cereals by causing chlorotic blotches on the leave of cereals due to spittle that spittle bugs put in the maize or cereal whorls to protect its eggs or nymphs. Hence, spittle bugs are also capable of reducing crop yield.

MATERIAL AND METHODS
Attempt was made to search for the natural enemies of fall armyworm including parasite and parasitoid that can be used for biological control of fall armyworm as part of Integrated Pest Management. Several maize fields were combed in other to find either predator, parasite and parasitoid in Oyo and Kwara State.

Figure 1: fall armyworm inside spittle of spittle bugs of maize plant

RESULTS AND DISCUSSIONS

One of the interesting results found was spittle bugs nymphs surrounded with spittle inside the whorl of maize where fall armyworm also resides in other to field. The fall armyworm was sub-merged in the spittle of spittle bugs. The fall armyworm was noticed to have been discolourised due to the spittle of fall armyworm. However, the fall armyworm was still alive. Since spittle of spittle bugs are capable of bleaching maize and cereal leaves leading to chlorotic blotches, spittle bugs are therefore a potential natural enemy of fall armyworm. However, their relationship may still need further investigation. If their relationship is symbiotic, that means they become pest complex of cereals to further reduce the yield, if their relationship is commensalism, i.e a relationship in which one partner benefited while the other is neither benefited nor harmed (Idodo-Umeh 2015), they will constitute pest complex to maize or cereals thereby reducing the yield. If their relationship is parasitism i.e, a relationship in which one obtain food and shelter and the other is harmed and those not receive any benefit (Idodo-Umeh 2015), this could be exploited for pest management. If the relationship is a predator-pre relationship its also a benefit to the farmer. However, if their association is neutralism, that is neither beneficial nor detrimental to either population (Idodo-Umeh 2015), then their association could also constitute pest complex to cereals. But if their association is inter-specific competition, that is, one reduces the availability of resources such as food (leave), water, sunlight, space to one of the computing species (either fall armyworm or spittle bugs) (Idodo-Umeh 2015), then their relationship can also benefit famers. This is because their competition may lead death of one or two them thereby serving as biological of pest control.

CONCLUSION

Spittle bugs is a potential natural enemy or predator of fall armyworm spittle bugs can be part of arrays of arsenals for biological control of fall armyworm they can be utilize has part of integrated pest management of fall armyworm if other control methods are combined in environmentally and ecologically balanced approach. However, this is achievable if the pesticide that is inorganic are not employed in the control option. The botanicals that are

environmentally safe and compatible to biological control can be used to complement spittle bugs and other predators, natural enemies, parasites and parasitoids for integrated pest management of fall armyworm. However, it means the population of spittle bugs have to build up in the agro-ecosystem provided other biotic and abiotic constraint and not contrary to spittle bugs during the session.
However, the relationship between fall armyworm (*Spodoptera frugiperda)* and spittle bugs need further investigation.

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Efficacy of Some Antibiotics and Fungicides on the Management of Rice Bacterial Leaf Blight (*Xanthomonas oryzae*)

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ABSTRACT
This study was carried out to determine the efficacy of some antibiotics, copper oxychloride and Bordeaux mixture in the management of bacterial leaf blight (BLB) of rice. Significantly low incidence (23.52%) of bacterial leaf blight was recorded on the plots where Bordeaux mixture was used. Streptomycin and copper oxychloride also showed a good level of effectiveness of management of the disease indicated by the incidence values of 44.11 and 42.36 respectively. The highest yield was obtained on the plots treated with bordeaux (3.10 tonnes/ha) followed by those treated with copper oxychoride (2.64 tonnes/ha) and streptomycin (2.35 tonnes/ha) which were all significantly higher than that of the check (1.62 tonnes/ha). The study concluded that Bordeaux mixture is the best among all the treatments imposed in controlling bacterial leaf blight.
Keywords: Rice, Bacterial leaf blight; Antibiotics

INTRODUCTION
Rice (*Oryza sativa* L.) plays a vital role in the Nigeria economy as an export item and also as a staple food. Rice disease especially bacterial leaf blight (BLB) is a limiting factor faced by the farmers in all rice fields of the middle belt zone, particularly areas of irrigated lowland. Bacterial leaf blight caused by bacterium (*Xanthomonas oryzae pv. Oryzae*) is a widely distributed and devastating disease of rice (Mohiuddin *et al*., 2007). Its symptoms are observed at the tillering and booting stages. The disease increase with plant growth and reaches its peak at the flowering stage. The severity and significance of damages caused by infection necessitated the development of strategies to control and manage the disease for minimizing yield loss, which is reported to be 50% or even more in severe cases (Maji and Imolehin 2003). Losses due to BLB in Tropical Asia vary from 2 to 74 percent depending on certain factors such as location, weather conditions, crop stage and cultivars (Chaudhary *et al*., 2009). Similarly, Maji and Imolehin (2003) reported that yield losses due to BLB disease range from 20 to 30 percent though in severely infected fields the losses may reach up to 80 percent.

A lot of work (Nyvall 1999 and Chaudhary *et al*., 2009) has been done in India to control the disease through copper-based chemicals and antibiotics. Bactericides, particularly antibiotics such as streptomycin satisfactorily control several important bacterial diseases of crops. Copper compounds have served as fungicides and also as bactericides (Khan *et al*. 2005). Also, Bordeaux mixture is the most widely known and economical among all the fungicides used against parasitic fungi as well as for bacteria (Devadath, 2003). The earlier studies in Nigeria, have identified some chemical and antibiotics with relative efficacy against the disease, however, effective control of the disease has not been recorded, hence this study was to evaluate the efficacy of some antibiotics and fungicides for the control of BLB in hot spot area of Badeggi, Bida Niger State, Nigeria.

MATERIALS AND METHODS

This study was conducted at National Cereals Research Institute Badeggi, Bida Niger State, Nigeria, as well as at farmer's field particularly in hot spot area of experimental rice field and on farmer's field during the wet season, 2015. The experiment was laid out in RCBD with three replications having a net plot size of 4×5 meter. The crop was fertilized with a heavy dose of nitrogen (145kg/ha) in three splits to make the crop more susceptible to the disease. All agronomic practices were kept uniform for each treatment. The detail of treatments is given in Table 1.

Table 1: list of the treatments

Treatments	Designation
Trt 1	Check
Trt 2	Copper oxy-chloride 50% @ 1.25 kg/ha
Trt 3	Oxy-tetracycline @ 0.75 1/ha
Trt 4	Streptomycin @ 0.50 kg/ha
Trt 5	Bordeaux mixture at 2.5:2.5:300/ha (2.5 kg copper sulphate +2.5kg quick lime + 300 l of water/ha)

The bacteria suspension was prepared from leaves with growing BLB lesions soaked in water (25 g/l) for 30 minutes according to Khan *et al*. (2005). Inoculation was applied at booting stage of the crop and the treatments applied after 24 hours of inoculation followed by two further sprays at weekly intervals (Chaudhary, *et al*., 2012). Data on the disease incidence were taken 15 days after completion of spray using standard evaluation system 2013. The crop was harvested at maturity after which the number of filled grains, unfilled grains and yield were recorded. Data collected were analyzed using Statistical tool for Agricultural Research (STAR) and means separated using Duncan Multible Range test.

RESULTS AND DISCUSSION

The attack of BLB was present in all the treatments under study. The data showed no significant difference in disease incidence between controls (57.34%) and oxy-tetracycline (56.00%). streptomycin and oxy-chloride were not significantly different from each other in terms of control of the disease with incidence level of 44.11% and 42.36% respectively which was supported in the findings of Maji and Imolehin (2003) and Khan *et al*. (2005) who reported that bactericides, particularly antibiotics such as streptomycin, satisfactorily controlled several important bacterial diseases of crops. This is because these antibiotics have powerful active site that engulfs these bacteria when they come in contact with them. The plots treated with Bordeaux mixture showed a significantly lower disease incidence (23.52%) in comparison with other treatments and this was supported by Devadath (2003) who reported that Bordeaux mixture is effective against parasitic fungi and bacteria.

Table 2: Means of the disease incidence and yield

treatments	Disease Incidence %	Yield (tonnes/ha)
1	57.34a	1.62c
2	42.36b	2.64b
3	56.00a	1.67c
4	44.11b	2.35b
5	23.52c	3.10a
CV%	5.53	6.81

Values with same alphabet shows no significant difference.

The highest yield was obtained from the plots treated with bordeaux mixture which was significantly higher than the other treatments. Also, it was observed that the yields obtained from plots treated with streptomycin and copper oxy-chloride were significantly hgher than the check and oxy-tetracyclin. This shows that yield loss was significantly reduced by the application of Bordeaux mixture, streptomycin and oxy-chloride which is in agreement with the report of Chaudhary *et al*. (2009) who reported yield losses due to BLB in Tropical Asia which could vary from 2 to 74 percent. Similarly, Maji and Imolehin (2003) reported that yield losses due to BLB disease range from 20 to 30 percent though in severely infected fields the losses may reach up to 80 percent.

CONCLUSION

Bordeaux mixture at (2.5 kg copper sulphate + 2.5 kg quick lime +300 l/ha water) proved more effective and economical in the control of BLB of rice. Two to three sprays of Bordeaux mixture on the leaves at booting stage as preventive measure at a week interval is recommended. Also, in event of disease outbreak Bordeaux mixture could be readily used as quick intervention to curb the virulence of the pathogen while attaining a good yield as well. Streptomycin and copper oxychloride are also relatively effective in the control of bacterial leaf blight.

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Effect of Different Level of Poultry Manure on the Performances and Insects' Population of Okra (*Abelmoschus esculentus* L. Moench)

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ABSTRACT
The study was carried out The study was conducted at Teaching and Research Farm of Rufus Giwa Polytechnic, Owo to evaluate the effect of different level of poultry manure on insect population of okra in a Randomized Complete Block Design (RCBD). The land was manually cultivated for seed bed preparation and the different levels of poultry manure (PM) were applied at a depth of 15cm one (1) weeks before sowing of okra seeds. Yield parameters such as number of fruits, fruits weight, plant height and diameter were determined at harvest and leaf area was determined at 2 weeks' interval after germination. Data collected were subjected to analysis of variance (ANOVA) and significant treatment means separated using Duncan Multiple Range Test (DMRT) at 5% probability level. The result shows that plant height increases with increase in PM level. Okra fruit weight decreases as the rates of application decreases at the end of 4 WAP. The results also show that insect populations of okra plant at 4 and 6 WAP were not significantly (P<0.05) different from the control. At the end of 8 WAP, the population was highest in 20 tons/ha of poultry manure and reduces as the rates decrease. Plant growth was markedly influenced by application of PM at different levels as observed from the better plant height, stem girth fruit length and diameter compared to the control. The best growth characteristics were recorded under 20t ha^{-1} of the manure at 4, 6 and 8 WAP and the least growth and development was recorded in the plot with no addition of manure. From the results obtained in this study, it can be recommended that application of 20tons/ha of poultry manure will sufficient to improve okra yield and production. Also, the use of poultry manure as substitution for inorganic fertilizer should be encouraged.
Keywords: Okra, Poultry manure, Insect, NPK fertilizer

INTRODUCTION
Okra (*Abelmoschus esculentus* L. Moench) is an important vegetable crop widely grown primarily for its soft immature fruits or pods and the third most important fruit vegetable crop after pepper and tomato in Nigeria. They are boiled or fried and eaten as vegetable. They can also be cut into pieces, dried and/or powdered and stored for use in soups during the dry season when fresh Okra fruits are scarce. Despite its nutritional value, its optimum yield (2-3t/ha) in the tropical countries is low partly because of continuous decline in soil fertility (Abdul-El-kader *et al.,* 2010). NPK fertilizer increases soil fertility and yield of okra. However, NPK fertilizer is very expensive; not environmentally friendly and therefore increases cost of

production. Alternative sources of fertilizer are therefore sought to increase yield of okra. Manure applied in correct proportion not just improves soil porosity but it also contributes to good plants growth, development and yield (Sanni, *et al*., 2015). According to Ewulo (2005) and Awodun (2007), poultry manure contains high amount of nutrients especially nitrogen that are easily taken up by plants for fast growth.

One of the major insect pests of okra is *Aphis gossypii*. Crop plants attacked by this pest include cotton, citrus, coffee, egg-plant, pepper and tomato. They infest seedlings of susceptible plants, but may also infest older plants and pods. The nymphs remove plant sap causing stunted growth, curling of leaves or may even kill young plants (Baidoo and Mochiah, 2011). *A. gossypii* is a vector of over 50 plant viruses. Other important pests of okra include the flea beetle, *Podagric auniformis*, *Nezera viridula* (L.), *Bemisia tabaci* (Genn.), *Spodoptera litoralis* (Boisd.), bollworm, *Earias* sp. and other insects, whose activities reduce drastically the photosynthetic capacity of the leaf, resulting in low-dry matter production and consequently the yield (Saskia *et al.,* 2004; Baidoo and Mochiah, 2011).

The control of insect pests by the application of animal manure involves the application of animal feaces in controlling and maintaining the population of insect pests below the economic injury level. Farmers can manipulate some production practices to minimize insect damage to plants. This is done by ensuring that plants have favorable growing conditions such as sufficient water and fertilizer. Higher doses of nitrogen fertilizer increases pest attack while potasium fertilizer makes plants more resistant. Plants suffering from mineral nutrient deficiency have lower tolerance to pathogens and pests (Saskia *et al.,* 2004). Baidoo and Mochiah (2011), explored the utilization of organic manure for managing the pests of okra. However, the interactions between fertilizer application and insect pest infestation in okra production have not been adequately addressed. The objective of this study was to determine the effect of different level of poultry manure on insect population of okra.

MATERIALS AND METHOD

The study was conducted at Teaching and Research Farm of Rufus Giwa Polytechnic, Owo (RUGIPO), Ondo State, Nigeria during 2019 late planting season. The land was manually cultivated after which the seed beds were prepared and different levels of poultry manure were applied at a depth of 15cm one (1) weeks before sowing of okra seeds. The treatments were laid out in a Randomized Complete Block Design (RCBD) with plots measuring 25m x 10m (250m^2). Four treatments levels of Poultry manure were used and replicated three times resulting in 12 experimental plots. NHAE-47-4 okra variety obtained from National Horticultural Research Institute, Ibadan, Nigeria was tested for seed viability using floatation method and the seeds were planted at two seeds per hole and later thinned to one plant per stand. The planting distances of okra were 60cm between rows and 50cm within rows with thirty-two (32) stands per plot and total plant population of 348 stands. All agronomic practices and insect pest control were carried out when necessary.

Poultry manure was obtained from the livestock unit of the Teaching and Research Farms of RUGIPO. The manure was air dried and allowed to decompose for four weeks. Four (4) treatments made up of 0t/ha^{-1}, 15t/ha^{-1}, 20t/ha^{-1} and 25t/ha^{-1} of the poultry manure was applied 2 weeks before planting in both trials, by integrating it into the seed beds making shallow groves about 5 cm as per varied treatments in the field trial. Weeding was carried out at 3 and 5 weeks after sowing in the field. Scouting for insect pest presence was done at 4, 6 and 8 weeks after germination between 6.00 am and 8.00 am when the insects were less active and easier to spot. Different insect species were sampled into sealed labeled bottles and taken into the laboratory, counted and their numbers recorded. Growth parameters, plant height, number of leaves were visually counted. Yield parameters such as number of fruits, fruits weight and diameter were determined at harvest and leaf area was determined at 2 weeks' interval after germination. Plant height was measured using a meter rule, 2 cm from the base of the plant to annul undulations on the farm. For leaf area, 10 leaves of the sampled plants were pressed onto graph sheets and the outline drawn, after which the boxes were counted; two half boxes were counted as 1. Data collected were subjected to analysis of variance (ANOVA) and significant treatment means separated using Duncan Multiple Range Test (DMRT) at 5% probability level.

RESULTS AND DISCUSSION

Table 1: Soil physical and chemical analytical data

Properties	Value
Sand (g/kg)	800
Silt (g/kg)	90
Clay (g/kg)	110
Textural class	Sandy loam
% Field moisture capacity	14
OM (g/kg)	22.87
Kjeldahl N (g/kg)	2
Available P ($mgkg^{-}$)	27
Exchangeable cation(cmol/kg)	
K^+	0.14
Na^+	0.05
Ca^{++}	3.75
Mg	1.75
pH (in 0.01 M $CaCl_2$)	6.31

Table 2: Effects of poultry manure on okra agronomic parameters

Parameters	**Trts tons/ha)**	**4 (WAP)**	**6 (WAP)**	**8 (WAP)**
Height (cm)	Control	16.58±0.22a	17.75±0.5b	18.25±0.86a
	5	23.00±3.91a	25.67±5.94b	28.67±6.30a
	10	21.73±7.09a	29.76±4.08a	33.00±3.30a
	15	29.00±1.04a	34.42±2.58b	48.25±5.87a
	20	30.00±0.75a	36.50±2.41ab	46.75±2.08a
No of Leaves	Control	4.25±0.14c	3.08±8.8 a	4.25±2.7a
	5	5.33±0.44bc	4.83±0.0a	5.33±0.0a
	10	5.58±0.46bc	6.17±9.6a	5.58±4.9a
	15	6.08±6.08ab	7.33±7.8a	7.58±4.2a
	20	6.67±0.16a	8.5±8.8 a	7.17±7.8a
Stem girth(cm)	Control	1.68±0.71 b	1.20±2.7a	1.21±0.0a
	5	1.73±0.33a	1.73±6.1a	1.73±2.2a
	10	13.45±7.55a	2.22±8.8 a	2.30±0.0a
	15	2.60±0.33a	3.20±7.8a	3.39±4.9a
	20	2.95±0.12a	3.51±6.1a	3.25±0.0a
No of fruit	Control	1.67±7.8a	1.33±6.1a	1.00±2.7b
	5	2.67±7.8a	2.00±2.2a	2.67±0.0a
	10	3.67±6.1a	4.00±2.7a	4.00±2.2ab
	15	4.00±6.1a	4.67±9.6a	7.00±4.9a
	20	7.33±4.2a	5.33±4.2a	6.33±4.2a

Table 2b: Effects of poultry manure on okra agronomic parameters

Parameters	Trts (tons/ha)	4	6 Week after planting(WAP)	8
Fruit diameter (cm)	Control	1.23±2.7a	1.60±7.8b	1.20±6.1a
	5	3.93±4.2a	3.96±7.8b	4.83±11.3a
	10	5.80±4.9a	5.33±4.9a	6.03±4.2a
	15	6.56±6.1a	5.53±6.1b	5.86±2.7a
	20	5.97±6.9a	6.00±0.0ab	6.03±4.2a
Fruit length (cm)	Control	0.97±7.8c	1.40±8.8 a	1.40±2.7a
	5	2.30±2.2bc	2.50±0.0a	2.63±0.0a
	10	3.83±2.7bc	3.17±9.6a	2.80±4.9a
	15	4.60±4.5ab	3.87±7.8a	2.63±4.2a
	20	3.77±9.3a	3.77±8.8 a	2.97±7.8a
Fruit weight (g)	Control	0.97±6.1b	1.96±2.7a	1.86±0.0a
	5	3.51±2.7a	5.03±6.1a	3.69±2.2a
	10	9.70±2.2a	7.04±8.8 a	9.30±0.0a
	15	14.22±4.9a	12.46±7.8a	12.49±4.9a
	20	19.58±2.2a	9.96±6.1a	11.60±0.0a

Table 3: Effects of poultry manure on insect population of okra

Trts (tons/ha)	4	6 Week after planting(WAP)	8
Control	0.58±6.1a	0.58±2.7a	0.00±0.0b
5	0.00±2.7a	0.50±6.1a	0.25±2.2ab
10	0.25±2.2a	0.75±8.8 a	0.42±0.0ab
15	0.42±4.9a	0.83±7.8a	0.58±4.9a
20	0.67±2.2a	0.83±6.1a	0.67±0.0a

The result obtained from the study shows that plant height was significantly affected by different levels of poultry manure (PM). The result shows that maximum plant height increases as with increase in PM level applied and the plant height decrease as the rates of application of the manure decreases as shown in Tables 1 and 2. The increase in plant height with PM was mainly due to the adequate organic matter with mineralized N, P and K content of the treated experimental plot which was made available to the growing okra seedlings, thus influence the growth of the plant. These results are in accordance with the findings of Adewale, *et al.* (2011) Adesina *et al.* (2014) that the plant height of pepper, garlic and tomato increased significantly with soil amended with organic manure.

Number of leaves, stem girth, fruit length and fruit diameter were significantly affected by different levels of poultry manure and the effect increase as the rates of application increases in each plot at the end of 4, 6 and 8 WAP. Plant growth was markedly influenced by application of poultry manure at different levels as observed from the better plant height, stem girth fruit length and diameter compared to the control. The best growth characteristics were recorded under 20.0t ha-1 of the manure at 4, 6 and 8 weeks after planting and the least growth and development was recorded in the plot with no addition of manure. The okra growth rate increased progressively with the age of the plant. This agrees with the submission of Frank (2000) that a general increase in vegetative growth was obtained when manures are applied to plants. Moreover, poultry manure is known to rich in N, P and K, which when mineralized add nutrients to the soil resulting in better vegetative growth and development.

The pod weight and number of fruits were significantly influenced with the application of poultry manure and were statistically higher than the control (Table 3). The yield increase with an increase in poultry manure rates suggest that PM supplies nutrients which enhances vigorous growth which are important indices that culminate in increase in fruit yield. This result is in concurrence with the findings of Adesina *et al*. (2014), who reported significant response in yield to different types of manure rate applications. Insect population were not significantly affected by different levels of poultry manure. However, the population increases at the end of 8 WAP and the highest was recorded in 20.0ton/ha with mean value 0.67 followed by 15ton/ha (0.58) and the effect decreases with decreases in the application rates, the lowest was observed in the control which could be due to lower nutrient status that could influenced the vegetative growth and development of the host plant.

CONCLUSION

The study has emphasized that poultry manure application influence vegetative growth and development and the best growth characteristics were recorded under 20.0t ha-1 of the manure at 4, 6 and 8 WAP. The insect population increased in plot treated with poultry manure at the end of 8 WAP. From the results obtained in this study, it can be recommended that application of 20tons/ha of poultry manure will be sufficient to improve okra yield and production. Increasing yield and production of okra can thus translate in an increase in the standard of living of farmers who engaged in the cultivation. Also, the use of poultry manure as substitution for inorganic fertilizer should be encouraged.

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Insecticidal of Anisaldehyde against Cowpea Bruchid, *Callosobruchus maculatus* (Fab.) [Coleoptera: Chrysomelidae]

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ABSTRACT
An insecticidal activity of anisaldehyde against cowpea bruchid (Callosobruchus maculatus) in stored cowpea seeds was carried in the laboratory at temperature and relative humidity of 30.2°C and 77.1%, respectively. The anisaldehyde was made into 2% concentration into a petri dish which was mixed separately to the grain at 10, 20, 30, 40, 50 µl per 20g of cowpea seed. The mortality of the insect was observed at 24, 48, 72, 96hour post treatment. The oviposition and adult emergence of the insect as well as seed weight loss were observed. The result obtained showed that only 20% concentration of the active compound above 50 µl mortality of the insect at 24hour post treatment and its effect was significantly different from other concentration and the controls. 93.33% of anisaldehyde was required to achieve 50µl mortality of the insect within 24 hour of application as reflected by the regression probit analysis. Likewise, the active compound significantly reduced adult emergence as well as seed weight loss. Based on high insecticidal potential displayed by the compound, it could be incorporated into the integrated pest management strategy for the control of adult C. maculatus.
Keywords: adult emergence, anisaldehyde, oviposition, strategy

INTRODUCTION
Cowpea (*Vigna unguiculata*) is a grain legume which plays a vital nutritional role globally, particularly in developing countries where it serves as an important source of protein, carbohydrate and vitamins. Nigeria is the largest cowpea producer in the world, followed by Niger (FAOSTAT, 2013). This crop's production is plagued by numerous issues, the most serious of which is insect pest infestation. Post-harvest losses to storage insect pests limit cowpea production in sub-Saharan Africa, which otherwise accounts for about 70% loss of this pertinent crop (IITA, 2010). In Nigeria, up to 10% of cowpea seeds may be damaged before they are stored (Yusuf, 2009). Bruchids, particularly those of the genus Callosobruchus, represent a serious threat to this legume. This genus contains several cosmopolitan, tropical and subtropical pests of grain legumes, of which *C. maculatus* is the most prominent. To combat this insect pest, a variety of methods have been employed.

The control of this insect pest and other related pest of stored products was heavily relied on the use of synthetic chemical insecticides. However, the use of organochlorines and organophosphorus chemicals has resulted in harmful impacts on the environment and humans. Synthetic pesticides are very difficult to come by for poor resource farmers, and when they are, they are prohibitively expensive. Botanicals have been found to have broad spectrum insecticidal properties with reduced persistence and toxicity in relation to organochlorines and organophosphorus compounds and therefore being suggested as alternative to synthetic chemical insecticides (Zibaee, 2011). Despite high success reported on the efficacy of most plant materials in controlling bruchids, there is dearth of information on their active compounds and mode of action (Oni, *et al*., 2019). In this work, the insecticidal of anisaledehye against cowpea bruchid, *C. maculatus* were evaluated under laboratory condition.

MATERIALS AND METHODS

Insect Culture

The insects (*C. maculatus*) used for the study was derived from the colony originating from the infected cowpea seeds obtained from Oja – Oba market in Akure, Ondo State, Nigeria. Fifty pairs of newly emerged adults of *C. maculatus* were introduced into the 1000g of cowpea seeds in kilner jar. The jar was then covered with muslin cloth secured in place with a rubber band to allow for easy air passage while keeping the insects in. To allow the insects to oviposit and reproduce, the insect culture was kept in the lab for 35 days. The newly emerged adults were then grown in the laboratory on clean, uninfested Ife brown variety, and served as the stock culture of the insects used throughout the experiment. The insects were raised in a laboratory setting with a temperature of 28+2°C and a relative humidity of 75+5%.

Collection of material and cowpea grain

The active compound used was obtained from the laboratory of Professor Isman Murray of the University of Columbia, Canada. The cowpea grain used for the research was obtained from Seed Research Institute, Ibadan and was sterilized at -7ºC for one month before use.

Insect Bioassay

Twenty grams (20g) of cowpea seeds was weighed into a petri dish and 2% concentration of the active compound (Anisaldehyde) was mixed separately to the grain at 10, 20 ,30 ,40 and 50 μl. While the cowpea grain treated with DMXO (dimethyl sulphoxide) was set as control. Each treatment was replicated three times and mortality was observed at 24, 48, 72 and 96 hours post treatment. Both life and dead insects was removed on the fifth day and the set up was left for 30 days to observe adult emergence. The experiment was set up using randomized design. The percentage Adult emergence and inhibition rate was calculated using the formula indicated below respectively.

$$\% \text{ Emergence} = \frac{\text{number of adult emergence}}{\text{total number of egg laid}} \text{x} \ \frac{100}{1}$$

$$\%\text{inhibition rate} = \frac{C_n - t_n}{C_n \text{ x } 100}$$

Where T_n is the number of adult and C_n is the number of insects that emerged in the control treatment.

The formula below was used to compute the weight loss of the stored grains:

$$\% \text{ Weight loss} = \frac{\text{difference in weight}}{\text{weight of undamaged seeds}} \text{x} \frac{100}{1}$$

Data Analysis

The data obtained in this work were subjected to the analysis of variance and means were separated using Tukey's Multiple Range Test. The data obtained on mortality were also subjected to Probit analysis to determine the lethal dosage of the active compound at 72 hours post treatment. Regression analysis was also run using linear regression analysis to determine the relationship between the adult emergence and weight loss of protected cowpea.

RESULTS AND DISCUSSION

Mortality of C. maculatus exposed to different dosages of anisaldehyde

This result shows that mean percentage mortality of *C. maculatus* within 24 and hours post treatment with anisaldehyde was significantly higher ($p < 0.05$) than mortality in the control, irrespective of the rate of application. At 24 hour post treatment, 50 μl recorded the highest mortality of the insect (93.33%) and its effect was significantly different from all other dosages. At 72 hour post treatment, only 50 μl dosage recorded 100% mortality of the insect but was significantly ($p < 0.05$) different from 40 μl. At all period of exposure, the treatment was significantly different from that of control.

Table 1. Mortality of *C. maculatus* exposed to different dosages of anisaldehyde

Treatments(μl)	% mortality in Hour			
	24	48	72	96
10	7.67. ±3.33^{a}	43.33±6.67^{b}	53.33±3.33^{b}	63.33±3.33^{b}
20	13.33 ±3.33^{a}	50.00±0.00^{b}	63.33±3.33^{b}	70.00±0.00^{b}
30	53.33±3.33^{b}	63.33±3.33^{c}	73.33±3.33^{c}	86.67±6.67^{c}
40	60.00±5.77^{b}	86.67±3.33^{d}	96.67±3.33^{d}	100.00±0.00^{c}
50	93.33±3.33^{c}	100.00±0.00^{d}	100.00±0.00^{d}	100.00±0.00^{c}
Control	0.000±0.000^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.667±0.33^{a}

Each value is the mean ±Standard error of three replicates. Values followed by the same alphabet are not significantly (p>0.05) different from each other using Tukey's Multiple Range Test

Lethal dosage of anisaldehyde required to cause 50 and 95% mortality of *C. maculatus* within 72 hour post treatment

The lethal dosage of anisaldehyde compound required to achieve 50 and 95% mortality of the insect within 72hour post treatment. The negative coefficient of the active compound indicated that the higher the concentration of the compound, the higher will be the mortality rate of the insect. Also, the chi square values that are greater than zero indicated the high level of relationship between the concentration of the active compound and the mortality of the insect. There was a great significant relationship between the mortality of the insect and the concentration of anisaldehyde as the p-value of the calculated chi square is lesser than 0.05. Only 0.13 and 16. 96% dosage of the active is required to achieve 50 and 95% mortality of *C. maculatus* within 72 hour post treatment.

Table 2. Dosage of anisaldehyde required to cause 50 and 95% mortality of *C. maculatus* within 72 hour post treatment

Slope± S. E	Intercept± S. E	X^2	LD_{50} (95% FL)	LD_{95} (95% FL)	Sig
1.57±0.14	-0.27±0.64	117.458	0.13(0.003-0.39)	16.96(7.98-196.14)	0.0001

S. E: Standard error; X^2: Chi-square; LD: lethal dosage, FL: Fiducial limit

Adult emergence and % oviposition of *C. maculatus* exposed to anisaldehyde and the % weight loss of the protected cowpea grain

The mean percentage adult emergence and percentage weight loss of *C. maculatus* was exposed to different dosages of anisaldehyde post treatment was significant higher ($p < 0.05$) than in other treatment . The active compound significantly reduced the rate of inhibition and adult emergence of the insect which prevented weight loss. Only control recorded the highest % adult emergence which is 66.92 compared to other treatment. At 40 and 50μl dosages of anisaldehyde were able to prevent the adult emergence, however the effect was not significantly different from that of 30 μl that recorded 3.28%.

Table 3: Adult emergence and % oviposition of *C. maculatus* exposed to anisaldehyde and the % weight loss of the protected cowpea grain

Treatment(μl)	Oviposition	% Adult emergence	Weight loss
10	47.00 ± 2.30^{b}	25.78 ± 3.45^{c}	7.98 ± 0.53^{b}
20	42.33 ± 1.86^{b}	17.32 ± 0.13^{b}	4.99 ± 0.06^{b}
30	36.33 ± 3.28^{b}	15.39 ± 1.09^{b}	2.91 ± 0.16^{a}
40	5.00 ± 1.53^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}
50	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}
Control	55.67 ± 6.66^{c}	66.92 ± 1.46^{d}	31.37 ± 3.53^{c}

Each value is the mean ±Standard error of three replicates. Values followed by the same alphabet are not significantly (p>0.05) different from each other using Tukey's Multiple Range Test

Relationship between adult emergence and seed weight loss

The result shows the relationship between adult emergence at 72 hour exposure and seed weight loss of the protected cowpea grain. The adult emergence of the insect and the seed weight loss of the shielded grains had a strong association, as evidenced by their R value (0.96), which tends to 1. The R2 value showed that 92% of the seed weight loss of the cowpea can be determined by the emergence of the adult beetle. After the adjustment of the R2 value only 92% on the seed weight loss was being explained by the emergence of the adult beetle. The t-value -1.82 showed that the correlation between the adult emergence of the beetle and the seed weight loss of the cowpea was statistically significant.

TABLE 4: Relationship between the adult emergence and the seed weight loss

Parameters	R	R^2	AD (R^2)	K±S.E	$(R_{C})\pm$S. E	(R_E)	t-value	Sig.
Adult emergence	0.96	0.92	0.917	-1.91±1.05	0.47±0.03	W =-1.91+0.47(A)+E	-1.825	0.000

Note: Where AD) = adjusted R square; K = constant; R_c = regression coefficient; R_E = regression equation; E = error; O = oviposition and W = weight loss

The result obtained in this work showed that anisaldehyde have insecticidal properties as it significantly affected the survival rate, oviposition and adult emergence of *C. maculatus* and as well affected the ability of the insect to cause seed weight loss of the protected cowpea seeds. The ability of the active compound to effect high mortality of the insect, low oviposition rate and low adult emergence varied with the dosages of anisaldehyde. The high mortality of *C. maculatus* recorded by the anisaldehyde of this plant could be due to in ability of the insect to feed on the protected cowpea seed.

Adult *C. maculatus* can live for longer periods of time if supplied with honey or sugary materials, despite the fact that they do not eat. Therefore, the mortality of the insect recorded by the compound indicated that the compound had no sugary substance that can serve as food for the insect and thereby lead to the starvation and suffocation of the insect. Furthermore, botanical-based insecticides have been shown to have a deleterious effect on insects' respiratory organs, causing hyperactivity, convulsions, and total knockdown (Schmutter e*t al*., 2014). As a result, the cowpea beetle mortality seen in this study could be attributed to the active compound's capacity to block the insect's spiracle, resulting in asphyxiation and death. However, it was noted that the active compound (anisaldehyde) was required in high concentration to achieve 50 and 95% death of the insect as reflected by the probity analysis. The findings of this study corroborated those of Ogungbite *et al*., (2014), who discovered that botanical oils cause high mortality of *Callosobruchus maculatus* as well as other stored product insect pests.

The result obtained on the effect of anisaldehyde on the oviposition of *C. maculatus* indicated that the compound had significant effect on the oviposition rate and adult emergence of the insect. In comparison to the controls, the insect had a low rate of oviposition and adult emergence. The insect's low oviposition rate suggested that the active chemical was responsible for poor mating communication between male and female C. maculatus. Also, the low oviposition rate could be due to the insect's high mortality, which resulted in a short mating period, which led to a low number of eggs laid (Yusuf et al., 2011), and Isman (2006) stated that botanical insecticides, in addition to having an antifeedant effect on insects, can cause incomplete ecdysis in young insects and sterility in adult female insects. As a result of the poor oviposition rate, the chemical must have rendered the mature female C. maculatus sterile. Furthermore, the low rate of adult emergence could be owing to the insect's failure to hatch its eggs into larvae. The few insect larvae that have emerged may be unable to shed their exoskeleton, which is still attached to the rear section of their abdomen (Oigiangbe *et al*., 2013). Furthermore, the insect's poor oviposition rate may have contributed to the low rate of adult emergence. Botanicals, according to Ogungbite (2015) and Obembe and Ogungbite (2016), impede the chorion of insect eggs, preventing the emergence of adult insects or causing insect larvae deformation. The findings of this study revealed that the insect's oviposition rate was influenced by its death rate, and the weight loss of the seed was influenced by the beetle's adult emergence. The result of this research acquiesced with the findings of Yusuf (2009), Ileke *et al* (2013), Oni *et al* (2016) in which botanical compound were found to significantly reduced or prevented the emergence of adult *C. maculatus*. Seed weight loss was recorded in this work. This suggests that the insect larvae had a low feeding behavior, which could have resulted in a high seed weight loss. This was in agreement with Akinneye *et al* (2016) report.

CONCLUSION

The active compound used in this work has proven insecticidal against cowpea beetle, *C. maculatus*. Nevertheless, the insecticidal potential of this active compound depended on the concentration of the period of application. The result showed that the compound had more effects on the oviposition and adult emergence of the insect as well as the ability of the insect to cause seed weight loss.

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Fertilizer Differential Response of Cucumber (*Cucumis sativus)* Genotypes to Different Levels of Application in Derived Savannah Zone

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ABSTRACT
The experiment was conducted at Landmark University Teaching and Research Farm, Omuaran, Nigeria, with three (3) varieties of cucumber (Poinsett'76, Marketmore, Marketer) to investigate the differential response of Cucumber genotypes to 0, 100 and 150kg/ha and 0g, 15g and 22.5g levels of NPK fertilizer for fruits yield and associated traits in derived savannah zone. Among the three Cucumber genotypes studied Poinsett'76 recorded the highest number of leaves per plant while Marketmore at the same level of application, had the lowest number of leaves per plant. However, Marketer at 150kg/ha NPK fertilizer application recorded the lowest fruit weight, while Poinsett'76 recorded the highest value under the same level of NPK application. Across all the studied parameters, variety Poinsett'76 at 150kg/ha NPK fertilizer application recorded the highest value of vegetative growth and fruit per hectare. The same variety recorded the highest values of both vegetative and fruit yield per hectare across different levels of fertilizer application. The study also revealed differential response of cucumber genotypes to various levels of fertilizer application. Poinsett'76 is a good candidate for the development of high yielding Cucumber fruits in derived savannah zone. Similarly, the result of the study indicated that different level of fertilizer application is required for different Cucumber varieties for optimal fruit yield.
Keywords: Cucumber, Fertilizer, varieties, differential, NPK Fertilizer

INTRODUCTION
Cucumber (*Cucumis sativa* L) is one of the monoecious annual crops in the Cucurbitaceae family that has been cultivated by man for over 3, 000 years (Adetula and Denton, 2003; Okonmah, 2011). The key constraints to sustainable production of vegetable in the tropics are low moisture content, low use and unbalanced use of fertilizers (Shaheen *et al*., 2010). Increase in cucumber production can be achieved either by bringing more area under its cultivation, or by adopting improved varieties and better cultural practices. The second approach is more often preferred and among various cultural practices, fertilizer application is one of the quickest and easiest ways of increasing the yield per unit area under cucumber (Jilani *et al*., 2009). Rubeiz (1990) observed in a study that response of cucumber plants to NPK at the rate of 200:85:150Kg/ha was substantially higher than the control. Similarly, Rehamn *et al*. (1995) observed that NPK at 140-60-150 kg/ha exhibited better results for highest germination percentage, more fruits per vine, maximum fruit diameter and weight, vine length and total yield. Naeem *et al* (2002) reported that different levels of NPK were significantly different for days to flowering and days to fruiting. Abdel-and Mawgoud *et al* (2005) reported that increasing the level of NPK resulted in a positive response in the vegetative growth and

increased in yield. Phu (1996) also reported that N and K fertilizer applications had significant effect on the yield of cucumber variety.

Farmers in the tropics are using low quantities of organic fertilizers due to their limited quantities despite the government exertion to implement more sustainable agricultural practices by utilizing locally available inputs that are less deleterious to the environment (Mostafa, 2020). However, organic manures cannot meet crop nutrients' demand over large areas because of the limited quantities available, their low nutrients content and the high labor demands for processing and application (Cheryl *et al*., 1997). In this case, many farmers have resorted to the use of subsidized inorganic fertilizers such as NPK, due to its immediate availability to the plant roots and hence high yields (Stephen *et al*., 2014). However, the use of excess nitrogenous fertilizers in production of vegetables leads to accumulation of nitrates beyond safe limits which have been shown to be detrimental to human health (Musa *et al*., 2010). In developing countries like Nigeria, the population growth rate is so high that improved technologies including rational use of fertilizers must be employed to meet the food requirement of the people (Hera, 1996). It is therefore important to investigate the level of fertilizer that are adequate for good performance of different cucumber varieties in a tested environment. Blanket application may be excess for a particular variety, while it may be exactly adequate for some. Identification of differential requirement of fertilizer level for cucumber genotypes is essential for maximum yield and at the same time for the avoidance of detrimental effects on human health that results from excess application.

The study was conducted to investigate the differential response of cucumber genotypes to different levels of fertilizer application in derived savannah; and therefore recommended future study for determining the level of NPK fertilizer that can be recommended for optimal production of different carrot varieties in derived savannah zone of Nigeria.

MATERIALS AND METHODS

The research was conducted during the 2015/2016 cropping season at the Teaching and Research Farms of College Agriculture of landmark university Omu-aran, Kwara state, Nigeria. The experimental design for the experiment was Randomized Complete Block Design (RCBD) comprising of (3) treatments and each treatment was replicated three (3) times. The varieties selected for the study were Marketer, Marketmore'76, and Poinsett'76. The seeds were planted directly into a soil that was ploughed, harrowed and made into fifteen (15) beds sized 3m by 1.5m each. Planting space of 1m by 1m and sowing depth of 2cm were adopted for the study. Three varieties of cucumber were used for this experiment. Three different levels of fertilizer application used for the study were, 0, 100 and 150kg/ha and 0g, 15g and 22.5g were applied to each plant.

Data collected includes: number of leaves, number of vines and Plant length at 6, 7, 8 and 9 (WAP) and, number of fruit and girth at harvest. All data collected were subjected to analysis of variance using SPSS (version 21) package. Differences between the means were partitioned using Duncan Multiple Range at 5% probability level. (p=0.

RESULTS AND DISCUSSION

Table 1: Means for the number of branches per plant of Cucumber plant under three different levels of Inorganic fertilizer application (NPK)

Treatment	6wks (WAP) (cm)	7wks (WAP) (cm)	8wks (WAP) (cm)	9wks (WAP) (cm)
Marketer+0g NPK	2.6667b	3.7767b	5.3900b	6.5567b
Marketmore+0g NPK	2.0000b	3.6667b	5.1667b	6.3333b
Marketer+15g NPK	3.3333b	4.5567b	7.2767b	8.6667b
Marketmore+15gNPK	4.0000b	5.8333b	7.1667b	8.6667b
Poinsett'76+15g NPK	4.4433b	6.1667b	8.7233b	9.6667b
Marketer+22.5g NPK	2.0000b	2.8900b	3.4433b	4.6667b
Marketmore+22.5gNPK	2.5567b	4.6667b	5.6667b	6.3333b
Poinseet'76+22.5gNPK	12.5000a	16.5000a	19.3333a	22.3333a

Means followed by the same letter(s) along the same column are not statistically different at p≤0.05.

Highest and significant number of branches per plant were recorded by variety Poinsett'76 under application 0kg/ha of NPK fertilizer at 6, 7 and 8 weeks after planting (Table 1). However, there were no significant differences between varieties Marketer and Marketmore under similar condition. Least number of branches were obtained by Marketer with the application 0kg/ha of NPK fertilizer across the three weeks. However, highest but non-significant numbers of branches were again recorded across the three weeks by Poinsett'76 under the application of 100kg/ha of NPK fertilizer. Marketer had the least number of leaves per plant at 6 and 7 weeks after planting. Similar to the two earlier conditions of fertilizer application, Poinsett'76 had the highest number of branches per plant under the application of 150kg of NPK fertilizer per hectare.

Table 2: Means for the plant height of Cucumber plant under three different levels of Inorganic fertilizer application (NPK)

Treatment	6wks	7wks	8wks	9wks
Marketmore+0g NPK	7.3333b	12.0000cb	14.6667b	16.6667b
Marketer+15g NPK	7.9433b	13.6667cb	20.4433b	24.8900b
Marketmore+15gNPK	9.5000b	15.0233cb	20.1667b	23.8333b
Poinsett'76+15g NPK	11.6650b	16.5567cb	21.1667b	24.7233b
Marketer+22.5g NPK	6.16b	7.77c	11.11b	18.11b
Marketmore+22.5gNPK	17.66b	22.9150cb	26.0000b	35.5000ab
Poinseet'76+22.5gNPK	41.6400a	51.1667a	58.1667a	61.9333a

Means followed by the same letter(s) along the same column are not statistically different at p≤0.0

Significant differences were observed among the three Cucumber varieties for plant length under 0kg/ha application of NPK fertilizer across 6, 7 and 8 weeks after planting (Table 2). On the basis of plant length under 0kg/ha of NPK fertilizer, Poinsett'76 ranked first, followed by Marketmore, while the Marketer recorded the shortest plant length among the three varieties of the cucumber plants. With the application of 100kg/ha of NPK fertilizer. Poinsett'76 had the longest and but non significantly different plant length at 6 and 8 weeks after planting, however, it was significantly different from other two varieties at 8 weeks after planting. Poinsett'76 was significantly different from other two Cucumber varieties for plant length with the application of 150kg of NPK per hectare at 6, 7 and 8 weeks after planting, however, Marketer and Marketmore were only significantly different at 7 weeks after planting.

Table 3: Means for yield and related traits of the three Cucumber varieties under three different levels of inorganic fertilizer application (NPK)

Treatment	Weight (kg/ha)	Girth (cm)	Length (cm)
Marketer+0g NPK	16.000[ab]	2.0667[cb]	5.2333[ab]
Marketmore+0g NPK	6.667[b]	1.6667[c]	2.3333[b]
Poinsett'76+0g NPK	20.444[ab]	4.4000[ab]	13.9000[a]
Marketer+15g NPK	18.000[ab]	1.7333[cb]	4.6667[ab]
Marketmore+15gNPK	10.	2.8667[abc]	9.4667[ab]
Poinsett'76+15g NPK	667[ab]	2.6000[abc]	7.8333[ab]
Marketer+22.5g NPK	9.778[b]	2.1667[abc]	5.8000[ab]
Marketmore+22.5gNPK	19.333[ab]	2.9667[abc]	8.6667[ab]
Poinseet'76+22.5gNPK	22.667[ab]	5.4333[a]	13.6667[a]

Table 3 showed the means for yield and related traits of the three Cucumber varieties under the three different levels of inorganic fertilizer application (NPK). Highest and significantly different fresh weight of Cucumber was obtained by POINSETT'76 with application of 0kg/ha and 150kg/ha of NPK fertilizer, the same variety however had the least value of fresh weight of Cucumber fruit with 100kg of NPK per hectare. Marketer recorded the highest value of fresh weight of Cucumber fruits with the application 100kg/ha of NPK of fertilizer. Highest fresh fruit girth was recorded by variety Poinsett'76 with the application of 0kg/ha of NPK fertilizer, followed by MARKETER. With the application of 100kg/ha of NPK fertilizer, Marketmore had the highest value of fresh fruit girth, followed by Poinsett'76, while the least value was observed in Marketer

The result of the experiment indicated that there were significant differences among the various treatments and each variety of cucumber responded differently to the tested levels of NPK fertilizer application. Poinsett'76 performed significantly above other tested varieties at 150kg/ha application of NPK fertilizer for fresh fruit weight compared to the 0kg/ha and 100kg/ha NPK fertilizer application of the same variety. Moreover, Marketmore and Marketer varieties also recorded their highest yield at 150kg/ha of NPK fertilizer application but recorded the lowest fruit yield at 0kg/ha NPK fertilizer application which is agreement with El-Badawi (1994) who also reported significant increase in cucumber growth and yield with increasing fertilizer levels up to 75 kgN/ha in Samaru Zaria. Poinsett'76 at 0kg of NPK fertilizer application also showed a considerable performance in terms of yield. However, Poinsett'76 at 0kg/ha NPK fertilizer application recorded the highest fruit length and Marketmore at 0kg/ha NPK application recorded the lowest. Similarly, Ibrahim *et al* (1997) reported increase in vegetative growth in watermelon treated with inorganic fertilizer. According to Lawal (2000), the cucumber vegetative characters such as vine length, number of leaves, number of branches and leaf area responded significantly to applied inorganic fertilizer up to the 400 kg/ha. Poinsett'76 at 150kg/ha NPK fertilizer expressed better vegetative growth couple with higher root yield across all the tested level of fertilizer application. Indicated differential response of cucumber varieties to fertilizer application. Thus different levels of fertilizer application are required for optimal production of each cucumber variety.

CONCLUSION

Varieties differed in their response to fertilizer application. Variety Poinsett'76 recorded the highest cucumber fruit yield among all the three tested varieties at all levels. This variety is a good candidate for the development of high carrot root yield in derived savannah zone.

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Effect of Halosulfuron Herbicide on Growth and Yield of three Varieties of Cowpea (*Vigna unguiculata* L. Walp) in Lafia, Nasarawa State

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ABSTRACT

An experiments was conducted at the teaching and research farm of Faculty of Agriculture Shabu-Lafia campus (08^0,33^IN and 08^0, 32^IE), Nasarawa State Unversity Keffi, during the wet seasons of 2018 and 2019 to study the influence of halosulfuron herbicide on the growth and yield of three varieties of cowpea. The experiment consisted of two improved varieties (Fuampea1, Fuampea2) and one local (40days) variety and halosulfuron herbicide (applying once and zero application). The six treatment combinations with three replications were laid in a Complete Randomized Block Design. Data were collected on growth parameters such as plant height and number of branches and yield parameters such as 100 seeds weight, grain yield, total biological yield, haulms weight, and harvest index. Analysis was carried out using Genstat statistical package. The results obtained showed that cowpea Fuampea2 produced significantly (P<0.05) higher growth and yield values than cowpea Fuampea1 and the local variety evaluated. The results also indicated that plots treated with halosulfuron herbicide recorded significantly (P<0.05) higher values in all the growth and yield parameters measured than the zero herbicide application in both cropping seasons respectively. This study therefore recommended Fuampea2 variety and the use of post-emergence herlosulfuron herbicide to cowpea growers in Lafia, Nasarawa State for maximum productivity.

Keywords: Cowpea, halosulfuron herbicide, variety, weeds

INTRODUCTION

The cheapest alternative source of plant protein in the diet of rural people in the semi-arid regions across Africa is cowpea (*Vigna unguiculata* L. Walp) which is described as one of the most important food grain legume cultivated and consumed by both humans and animals is an herbaceous annual leguminous grain crop, from the family Fabaceae, in the genus *Vigna* and from species known as *unguiculata* (Timko and Singh, 2008). Various cowpea varieties have been reported to vary much in leaf size and shapes and this gives them an important classifying and distinguishing features (Pottorff *et al*., 2012). Cowpea is one of the most ancient human food sources and has probably been used as a crop plant since Neolithic times (Boukar *et al*., 2013). It is an important legume in many developing countries (Baidoo and Adam, 2008) and is regarded as the poor man's meat on account of its high quality protein and it is used as a substitute for animal protein (Dugje *et al*., 2009; Allen, 2013). It has been reported that out of 7.7 million hectares devoted to cowpea production worldwide, 6.1 million hectares (80%) of these are in the West Africa sub-region; and Nigeria accounts for 4 million hectares (Gerei *et* *al*., 2018). Nigeria is regarded as the largest producer and consumer of cowpea in the world with an estimated 45% share of the global cowpea production and over 55% of the production is in Africa (Alene *et al*., 2015).

Halosulfuron has the same mode of action as imazethapyr, however, its strength lies in its high activity on nutsedges (*Cyperus spp*.) and it is safe for use on many vegetable and leguminous crops grown (Brandenberger *et al*., 2005). Parasitic weeds such as *Alectra spp. and Striga gesnerioides* are the principal weeds attacking cowpeas, particularly in the semiarid regions (DPP and ARC (2011). When left un-weeded, cowpea can be completely smothered by weeds resulting in total yield losses, Ngalamu *et al*. (2015) also suggested that weeds compete with crop, during growth, for light, water and nutrients, can as well cause greater yield reduction than arthropods, bacteria, viruses, fungi and diseases and lowers the quality of the produce. The production of cowpea in the study area is affected by many constraints such as insect pests, weeds and poor variety used by the cowpea growers. Hence, the need of this study. This study therefore aims at evaluating the effect of halosulfuron herbicide on the growth and yield of three varieties of cowpea in Lafia, Nasarawa State, Nigeria.

MATERIALS AND METHODS

The experiment was conducted at the Teaching and Research Farm of Faculty of Agriculture, Shabu-Lafia Campus, Nasarawa State University, Keffi, which is situated on Latitude 08^0, 33^iN and Longitude 08^0, 32^iE and at altitude of 160m above sea level (Jayeoba, 2013). The experiment consisted of two improved varieties (Fuampea1, Fuampea2) and one local (40days) cowpea variety and halosulfuron herbicide (applying once and zero application). The six treatment combinations with three replications were laid in a Complete Randomized Block Design. The experimental site was cleared, harrowed and cultivated into ridges, plots measured at 3m x 4m each using manual implements. Seeds were sown at the spacing of 40cm x 70cm. Three seeds/hole were planted at the depth of 2-3cm and then covered thinly. Thinning was carried out at two weeks after sowing (WAS) in order to maintain 2 plants/stand. Five plants were randomly tagged in each of the net plots. Data was collected at 4, 6, 8 and 10 weeks after sowing (WAS) and the following parameters were used for data collection; growth parameters measured were; plant height and number of branches and yield parameters measured were; 100 seeds weight, grain yield, total biological weight, haulms weight and harvest index. All data collected were subjected to analysis of variance (ANOVA) using Genstat statistical package and treatment means were separated using Fisher's least significant difference (F-LSD) at 5 % probability level.

RESULTS AND DISCUSSION

In both years, at all sampling periods, Fuampea2 variety of cowpea significantly ($P<0.05$) produced the tallest plant height of cowpea plant followed by Faumpea1 while the local variety recorded significantly ($P<0.05$) the shortest plants (Table 1). The difference observed in these varieties could be attributed to the genetic makeup of the crop as suggested by Hall *et al.*, (2003). Plots treated with halosulfuron herbicide produced significantly higher plant height at all sampling periods, while the control plot produced lower plant height.

Table 2 shows that at all sampling periods, in both years, Fuampea2 variety of cowpea produced significantly ($P<0.05$) higher number of branches compared to other varieties evaluated. Application of halosulfuron herbicide recorded significantly ($P<0.05$) more number of branches more than the control plot at all the growing stages, in both the years. This result concurs with the discovery of Brandedberger *et al*., (2005) who suggested that application of halosulfuron herbicide is used on many vegetable, cowpea crops including dry beans which controls broadleaf weeds and nudseges and thereby improves the growth of weed-free crops.

Table 3 shows the effects of variety and herbicide on 100 seeds weight, grain yield, haulms weight, total biological yield and harvest index of cowpea during 2018 and 2019 wet seasons.

The result obtained showed that in both years, Fuampea1 and Fuampea2 varieties of cowpea recorded similar 100 seeds weight but significantly ($P<0.05$) higher compared to local variety. Plots treated with halosulfuron herbicide produced significantly ($P<0.05$) higher 100 seeds weight than the control plot in all the cropping years. The result also revealed that Fuampea2 variety of cowpea produced significantly ($P<0.05$) higher grain yield, haulms weight, total biological yield and harvest index compared to Fuampea1 and local varieties in 2018 and 2019 respectively. The outstanding performance in growth and yield of these varieties are signals of some possessive gene traits that are more tolerant and resistant to; weeds suppression, competition, drought and insect pest infestation. This idea agrees with Hall *et al*. (2003) and Ehlers *et al*. (2002) who suggested that substantial genetic diversity exist with growth habit characteristics in some leguminous crops and this poses an excellent opportunity to develop varieties with high weed suppressive ability and incorporation of insect resistance. Application of halosulfuron herbicide produced significantly ($P<0.05$) higher grain yield, haulms weight, total biological yield and harvest index more than the control plot (Table 3). This result is in line with Akobundu, (1980) who stated that, quantity and quality of grain yield can be increased when herbicide were applied for treated weeds competition for essential elements.

Table 1. Effect of Variety and Herbicide on Plant Height of Cowpea, 2018 and 2019 Wet Seasons

Treatment	Plant Height (cm)							
	2018 WAS				2019 WAS			
	4	6	8	10	4	6	8	10
Variety (V)								
Fuampea1 (V2)	13.93^{b}	27.43^{b}	34.91^{b}	43.13^{b}	11.95^{b}	27.99^{b}	42.43^{b}	45.08^{b}
Fuampea2 (V3)	16.80^{a}	28.51^{a}	36.90^{a}	53.73^{a}	12.25^{a}	28.74^{a}	44.52^{a}	52.90^{a}
Local (V1)	13.70^{b}	24.80^{c}	31.80c	27.11^{c}	10.85^{c}	26.93^{c}	37.50^{c}	50.03^{b}
F-LSD$_{0.05}$	0.79	1.54	0.69	1.01	1.05	0.83	1.35	1.71
Herbicides								
Halosulfuron(H$_1$)	15.14^{a}	27.56^{a}	37.76^{a}	43.51^{a}	11.55^{a}	28.19^{a}	44.60^{a}	57.85^{a}
Control(H$_0$)	13.48^{b}	25.72^{b}	29.98^{b}	39.13^{a}	11.16^{b}	26.24^{b}	38.36^{b}	46.83^{b}
F-LSD$_{0.05}$	0.35	0.66	3.01	0.40	1.11	1.12	4.07	2.30
Interaction								
V x H	NS	NS	NS	NS	NS	NS	NS	NS

Means of the same letter(s) in each columns of treatment group are not significant at 5% level of probability. NS= Not significant.

Table 2. Effect of Variety and Herbicide on Number of Branches of Cowpea, 2018 and 2019 Wet Seasons

Treatment	Number of Branches							
	2018 WAS				2019 WAS			
	4	6	8	10	4	6	8	10
Variety (V)								
Fuampea1 (V2)	3.58^{b}	3.36^{b}	2.37^{b}	1.90^{c}	2.00^{b}	3.75^{ab}	3.49^{b}	2.52^{b}
Fuampea2 (V3)	4.63^{a}	3.57^{a}	2.86^{a}	2.41^{a}	3.20^{a}	3.97^{a}	3.89^{a}	2.76^{a}
Local (V1)	3.06^{c}	3.22^{c}	2.00^{c}	2.31^{ab}	1.98^{c}	3..54^{c}	3.19^{c}	2.34^{b}
F-LSD$_{0.05}$	0.45	0.33	0.47	0.38	2,44	0.54	0.48	0.52
Herbicides								
Halosulfuron (H$_1$)	2.94^{a}	3.67^{a}	3.33^{a}	2.46^{a}	2.85^{a}	3.97^{a}	3.72^{a}	2.63^{a}
Control(H$_0$)	2.57^{b}	3.16^{b}	2.67^{b}	2.25^{b}	1.94^{b}	3.77^{b}	3.37^{b}	2.47^{b}
F-LSD$_{0.05}$	0.41	0.36	0.15	0.49	3.56	0.63	0.79	0.46
Interaction								
V × H	NS	NS	NS	NS	NS	NS	NS	NS

Means of the same letter(s) in each column of treatment group are not significant at 5% level of probability. NS= Not significant.

Table 3. Effects of Variety and Herbicide on 100 Seeds Weight, Grain Yield, Haulms Weight, Total Biological Yield and Harvest Index of Cowpea, 2018 and 2019 Wet Seasons

Treatment	2018					2019				
	Yield Parameters									
	100 Seeds Weight (g)	Grain yield (Kg ha^{-1})	Haulms Weight (g)	Total Biol. Yield (kg)	Harvest Index (%)	100 Seeds Weight (g)	Grain yield (Kg ha^{-1})	Haulms Weight (g)	Total Biol. Yield (kg)	Harvest Index (%)
Variety (V)										
Fuampea1(V_2)	16.51^{a}	921.4^{b}	134.8^{b}	1.7^{b}	30.4^{b}	20.42^{a}	983.9^{b}	148.8^{b}	1.8^{b}	30.6^{b}
Fuampea2 (V_3)	17.69^{a}	1121^{a}	155.7^{a}	2.0^{a}	31.4^{a}	23.00^{a}	1192.9^{a}	165.3^{a}	2.1^{a}	31.8^{a}
Local Var. (V_1)	14.60^{b}	450.0^{b}	127.7^{b}	1.0^{b}	25.2^{c}	17.00^{b}	523.2^{bc}	138.5^{c}	1.2^{b}	24.4^{c}
F-LSD$_{0.05}$	0.45	58.34	4.51	1.60	1.08	6.90	59.72	2.80	2.73	1.01
Herbicide (H)										
H_1	12.95^{a}	1124.4^{a}	152.8^{a}	2.2^{a}	31.4^{a}	24.5^{a}	1108.9^{a}	158.2^{a}	1.9^{a}	32.7^{a}
Control (H_0)	10.63^{b}	358.9^{b}	126.8^{b}	0.9^{b}	22.3^{b}	18.92^{b}	401.8^{b}	149.9^{b}	1.0^{b}	22.5^{b}
F-LSD$_{0.05}$	0.36	48.07	26.66	1.19	7.26	10.93	61.19	61.19	1.06	8.75
Interaction										
V x H	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means of the same letter(s) in each columns of treatment group are not significant at 5% level of probability.
NS= Not significant.

CONCLUSION

The results of this study revealed that growth and yield performance of cowpea Fuampea2 variety significantly (P<0.05) outperformed fuampea1 and the local varieties in both years. The results also indicated that plots treated with halosulfuron herbicide produced significantly (P<0.05) higher values in all the growth and yield parameters measured than the zero herbicide application in both years. This study therefore recommended Fuampea2 variety and the use of post-emergence herlosulfuron herbicide to cowpea growers in Lafia, Nasarawa State for maximum productivity.

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Agro-morphological Studies of Soybean Genotypes in Badeggi, Southern Guinea Savanna of Nigeria

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ABSTRACT
The presence of genetic variability is important in cultivar development as it provides material for effective selection. The aim of the study was to estimate genetic variability for grain yield and its component traits, and to assess morphological diversity among elite soybean lines. Sixteen genotypes were evaluated in the trial field of National Cereal Research Institute (NCRI), Badeggi, Niger State of Nigeria during the 2019 season using a 4 x 4 alpha lattice design with three replications. Data were collected on number of days to 50% flowering, first pod height, plant height at maturity, days to maturity, pod number per plant, hundred seed weight and grain yield. Means for both individual and combine years were obtained and separated using the Tukeys's Honest Significant Difference (HSD) Test. The result indicated that, yield correlation was derived from the analyzed data where correlation coefficient of yield was significant and positive with number of days to maturity, plant height at maturity, number of pods per plants and fodder weight. Selection and improvement of these traits will result to an increase in yield.

Keywords: fodder weight, improvement, seed weight, selection

INTRODUCTION
Soybean is native to China and it is one of the oldest world crops. However, soybean is now widely grown in both tropical and temperate regions of the world. The importance of this crop cannot be over emphasized as it plays a highly significant role in the nutritional and economic development of most households and industries in Nigeria. Mohammed *et al*. (2018) reported that, the protein sourced from just one kilogram (kg) of soybeans is equivalent to 45 cups of cow milk or 2kg meat or 5 dozens of egg. This protein-rich grain contains 22.8% edible vegetable oil, 33% carbohydrate and a good balance of amino acids. Its oil is 85% unsaturated and cholesterol free when compared with other legumes and other animal sources (Agada, 2014). The soybean breeding program of the International Institute Tropical Agriculture (IITA) has generated a large number of improved lines designated as TGx which stand for Tropical Glycine cross (Tefera *et al*., 2009). These lines of soybean were developed to curb most of the challenges (which include; diseases, poor nodulation and low seed viability) faced by farmers and also obtain substantive yield at the end. Soybean cultivars in Nigeria are naturally low yielding with an average yield of 1.2-2.2tha^{-1}(Tefera, 2011). Singh (2017) declared that, the genetic base (number of ancestral varieties that contributed to the modern commercial varieties) and diversity were narrow for public soybean cultivars grown worldwide. This assertion could be much typical to the existing cultivars in Nigeria as soybean breeders might had been confined to the use of few parents in the selection and hybridization processes. A continuous hybridization and crossing system will further reduce the genetic variation in

cropping programmes thus, causing reduction in the utilization of a novel cultivar with exploitable traits (Aremu, 2011). Existence of genetic variability is important in cultivar development as it provides material for effective selection. Therefore the objective of this study was to estimate genetic variability for grain yield and its component traits, and to assess morphological diversity among elite soybean line.

MATERIALS AND METHODS

The experiment was conducted at the soybean experimental field of the National Cereal Research Institute, Badeggi (Lat 9o 3' 0"N, Long 6o 9' 0"E and 70.5m above sea level). The site is of the Southern Guinea Savanna and bears an average annual rainfall of 1124mm (Gana and Adagba, 2013). A total of sixteen (16) genotypes were sourced from the National Cereal Research Institute germplasm. These include eight (8) local accessions [NCRI Soy; 32, 36, 38, 41, 47, 49, 58 and 16], three (3) others denoted as; Dina, Signal and JG of exotic pedigree and five National Released Varieties [TGx; 1987-10f, 1987-62f, 1835-10e, 1904-6f and 1448-2e] were used.

The experimental design was a randomized complete block design (RCBD) replicated 3 times. Each plot measured 2m x 3m with a total of four rows per treatment at 0.5m inter row spacing. Alleys of 1m separated each replication. Each experimental layout measured 26m x 13.5m, covering an area of 351m2 (0.0351ha) with a total of 48 plots (entries). This designed and layout was maintained for the two seasons the experiment was conducted. The study was conducted during the 2019 and 2020 rainy season. The field was cleared, ploughed and harrowed before planting. Seeds were planted using drilling method which was later thinned to 30 stands per roll at three weeks after emergence. Manual weeding was adopted and carried out at three (3) and six (6) weeks after planting.

Mixture of; 75g of NPK (15:15:15) and 90g of SSP were applied to each treatment in a block. Drilling method of application was adopted and the application took place immediately after the first weeding. Data was collected on the following traits; Days to 50% flowering, Plant height (cm) at maturity, Days to 95% maturity, Number of pods per plot, First pod height, Seed yield per plot, Fodder weight and 100seed weight. Data collected were subjected to Analysis of Variance (ANOVA). Correlation coefficient also determined. All analysis were done with Statistical Analysis for Agricultural Research (STAR) software version 7.2 (2002) and Means were separated using Tukeys's Honest Significant Difference (HSD) Test.

RESULTS AND DISCUSSION

The mean performance of the 16 soybean genotypes are shown in the table (1 and 2) below. The result revealed that, days to 50 % flowering in year one were significantly different among the genotypes. The earliest (33days) among them were, genotype; (3, 8, 11 and 13) while genotype (1 and 4) both took 44 days to attain 50% flowering. In the following year, a delay was observed for this trait, as genotype; 1, 4, 5, 6, 7, 9, 10, 12, 14, 15 and 16 varied from their initial days to 50% flowering. Futunless *et. al*., (2011) observed similar trends in their findings which was ascribed to environmental influence on the physiological process of the plants. However, genotype 3, 8, 11 and 13 maintained the least number of days to 50 % flowering across both years.

In the same vein, significant variation was observed in the Days to maturity (DTM) of the genotypes for the two years. This variation showed genotypes matured earlier in the second year. Mochizuki *et al* (2005) suggested that, under severe environmental stress, soybean plant reproductive stage may appear earlier than normal in an effort to produce seeds before premature death. However, genotype 13 and 15 expressed stability for this trait (DTM) in both years. The mean ranges for year 1 and 2 were (92-128 DTM) and (89.67-105DTM) respectively. Genotypes 1 and 4 were observed with the tallest statures for experiments (1 and 2), recording a mean value of 55.53cm and 54.30cm respectively in (2019) and also, 44.80cm and 46.40cm in

(2020) seasons. While, genotypes 2 and 12 recorded the least plant height of 38.47cm and 38.67cm respectively in (2019). However, genotype 13 had the least mean height of 34.70cm in the second year. These plant statures were similar to those observed by Jandong *et al*., 2020. Maximum and minimum height of the first pod (FPH) ranged from 8cm-12cm for genotype 5 and genotype 14 respectively across the two experiments. This is similar to the findings of (Malik *et. al*., 2006) who reported a range of 7-13cm for this trait. Highest number of pods were recorded for genotype 9 in both years (59.20 and 59.10 pod/plant) while genotype 1, 14 and 15 had the least number of pods. In the first experiment (table 1), highest grain yield was also obtained from genotype 9 with a mean value of 666g per plot (equivalent of 2.2tha^{-1}). While genotype 3 recorded the highest grain yield per plot (1.4tha^{-1} equivalent) in the next experiment (table 2). However, genotypes 11 and 16 had the least yield for both experiment with the best performance (equivalents of 0.71tha^{-1} and 0.67tha^{-1} respectively) in year two. Fodder weight for both years showed that, genotype 2 and 16 had the least mean weight. In the first experiment (table 1), the duo recorded a mean weight of (190g and 92.67g) respectively and also, (180g and 95g) in the second experiment. Genotype 13 had heaviest fodder of 530g in the first year against the 443.33g of fodder observed by genotype 15 in the second year.

Genotype with heaviest 100 grain weight included; 2, 3, 8, 10,11and 14 recording an individual weight of (15.67g, 15.67g, 15.67g, 16.33g and 15.33g respectively) in the first year. While, only genotype 11 grains weigh heaviest (17.33g) in the second year. Lightest grain weight (10.33g and 11.33g) was recorded against genotype 9 in year one and two respectively

Correlation Studies

Estimation of simple correlation was made among 8 important yield components with seed yield of sixteen (16) soybean genotype in table (3). Grain yield per plot showed positive correlation with Days to maturity (0.2465*), Plant height (0.2381*) Fodder weight (0.3863*) and number of pods per plant (0.2386*). Similar observation was reported by Sileshi (2019). This implies that, improvement of these traits will result to an increase in final yield. There was also a positive and highly significant (0.3629*) correlation between plant height and days to maturity. This was similar to the observation made by Ali *et al*., (2013). They also suggested that, taller plant took longer duration to maturity, therefore much time to produce more biomass as revealed in this study. Positive correlation was observed between days to maturity and fodder weight. This implies that, vegetative growth were more pronounced in leaves, branches, pods and roots as insignificant contribution were made from the stems (plant height). The negative correlation between grain weight and fodder weight (-0.2278*) suggest environmental influence had favored vegetative growth ahead of pod filling which is the critical stage in grain formation.

CONCLUSION

The heavy seeded character exhibited by genotype; JG, DINA and NCRISOY 16 should be a keen target for soybean breeders. Large number of pods produced by SIGNAL is also a desirable character for parent synthesis. Selection and improvement on the basis of these components will further increase the yield of such genotype. Further analysis of the obtained data is required to determine the amount variation contributed by each trait and also describe /categorize these variations on the basis of genetic or environmental effects. However, these results from the mean tables are sufficient to describe the performances of each genotype which will aid selection of superior lines for improvement and/or hybridization.

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Table1. Mean performance of 16 genotypes at Badeggi for the year 2019

GENOTYPE	code	50% FL	DTM	PHAM	FPH	NPPP	YPP	FWPP	100 SW
NCRISOYAC32	G1	44.00a	123.33a	54.30a	11.67ab	29.87de	335.00f	300.33cde	13.17ab
NCRISOYAC36	G2	34.00bc	124.00a	38.47b	10.57ab	38.93abcde	414.67def	190.00f	15.67a
NCRISOYAC38	G3	33.67c	94.00 c	51.83ab	10.53ab	53.07abcd	518.33bc	204.67ef	15.67a
NCRISOYAC41	G4	43.00a	124.00a	55.53a	10.97ab	47.73abcde	228.00g	381.67bcd	14.00ab
NCRISOYAC47	G5	42.33ab	125.33a	50.43ab	8.40b	45.27abcde	415.67def	380.00bcd	12.67ab
NCRISOYAC49	G6	42.33ab	127.33a	50.50ab	9.37ab	31.87cde	578.00ab	490.00ab	11.67ab
NCRISOYAC58	G7	40.67abc	125.33a	48.67ab	12.20a	54.10abc	385.67ef	490.00ab	12.67ab
NCRISOY16	G8	33.67c	125.33a	47.50ab	11.27ab	33.00bcde	405.00def	456.00ab	14.67ab
SIGNAL	G9	39.67abc	114.67ab	49.67ab	9.60ab	59.20a	666.00a	485.33ab	10.33b
DINA	G10	39.33abc	100.00bc	52.73ab	11.53ab	46.73abcde	540.00bc	392.00bcd	15.67a
JG	G11	33.33c	128.33a	48.47ab	10.33ab	38.80abcde	243.00g	269.00de	16.33a
TGX 1987-10F	G12	39.67abc	94.00 c	38.67b	11.07ab	32.27cde	403.67def	303.67cde	13.67ab
TGX 1987-62F	G13	33.67c	104.67bc	41.97ab	12.47a	56.53ab	476.67cd	530.67a	13.67ab
TGX 1835-10E	G14	42.67a	94.00 c	49.47ab	12.20a	27.67e	474.67cde	230.33e	15.33 a
TGX 1904-6F	G15	40.00abc	92.67 c	48.43ab	12.40a	27.53e	334.00f	421.00abc	13.67ab
TGX 1448-2E	G16	41.33abc	105.00bc	47.17ab	11.33ab	45.07abcde	230.00g	92.67f	14.33ab
CV		**7.3**	**5.27**	**10.45**	**10.05**	**18.85**	**7.15**	**12.21**	**9.90**
SE		**2.32**	**4.85**	**4.13**	**0.9020**	**6.42**	**24.26**	**35.01**	**1.11**

50%FL=days to 50% flowering, DTM=days to maturity, PHAM=plant height at maturity, FHP=first pod height, NPPP=number of pods per plant, YPP=yield per plot(g), FWPP=fodder weight per plot, 100SW=100 seed weight. **Means with the same letter are not significantly different at 5% level of probability**

Table2. Mean performance of 16 genotypes at Badeggi for the year 2020

GENOTYPE	code	50% FL	DTM	PHAM	FPH	NPPP	YPP	FWPP	100 SW
NCRISOYAC32	G1	44.67a	89.67b	44.80a	11.00ab	28.55bc	288.00de	282.67bcd	14.00ab
NCRISOYAC36	G2	33.33b	89.67b	39.57abc	10.67ab	33.10bc	224.33fgh	180.00de	13.00ab
NCRISOYAC38	G3	33.33b	94.00b	40.03ab	10.23ab	41.23abc	445.00a	189.33de	13.00ab
NCRISOYAC41	G4	42.00a	95.33b	46.40a	10.23ab	39.30abc	202.00gh	287.33bcd	15.67ab
NCRISOYAC47	G5	43.33a	96.00ab	41.00ab	8.13b	46.58ab	221.00fgh	344.33abc	13.00ab
NCRISOYAC49	G6	44.67a	96.67ab	41.80ab	9.73ab	37.00abc	362.33bc	407.33ab	13.67ab
NCRISOYAC58	G7	42.00a	93.00b	43.50ab	11.60a	44.53abc	244.67efg	417.33ab	15.33ab
NCRISOY16	G8	37.00b	98.33ab	39.87abc	10.87ab	36.13abc	295.00de	394.33ab	15.67ab
SIGNAL	G9	44.67a	105.33a	40.77ab	9.67ab	59.10a	419.33ab	362.00ab	11.33b
DINA	G10	44.67a	99.00ab	41.20ab	11.27a	33.13bc	394.33ab	352.00ab	15.00ab
JG	G11	37.33b	97.67ab	38.33abc	9.50ab	31.20bc	181.33h	206.33cde	17.33a
TGX 1987-10F	G12	42.67a	97.67ab	39.20abc	10.60ab	30.50bc	269.33def	360.67ab	14.33ab
TGX 1987-62F	G13	37.33b	92.00b	34.70bc	11.50a	40.33abc	325.67cd	359.33ab	11.00b
TGX 1835-10E	G14	44.67a	96.67ab	42.80ab	11.83a	21.80c	363.00bc	210.67cde	13.33ab
TGX 1904-6F	G15	45.00a	90.00b	38.80abc	11.50a	31.27bc	246.00efg	443.33a	11.00b
TGX 1448-2E	G16	45.00a	98.33ab	37.13bc	11.07ab	40.00abc	172.67h	95.67e	12.00ab
CV		3.22	3.32	7.84	9.45	**20.50**	**6.90**	**15.18**	**13.85**
SE		1.09	2.59	2.64	0.8165	**6.21**	**16.38**	**37.91**	**1.55**

50%FL=days to 50% flowering, DTM=days to maturity, PHAM=plant height at maturity, FHP=first pod height, NPPP=number of pods per plant, YPP=yield per plot(g), FWPP=fodder weight per plot, 100SW=100 seed weight. Means with the same letter are not significantly different at 5% level of probability.

Table 3: correlation coefficient of characters among 16 genotypes of soybean

	X50..FL	DTM	PHAM	FPH	NPPP	YPP (g)	FWPP(g)	100.SW(g)
X50..FL	1.0000							
DTM	-0.1013	1.0000						
PHAM	0.0176	**0.3629****	1.0000					
FPH	-0.0368	-0.1246	0.1089	1.0000				
NPPP	-0.1825	0.1854	0.1624	-0.0775	1.0000			
YPP(g)	-0.1710	**0.2465***	**0.2381***	-0.0143	**0.2386***	1.0000		
FWPP(g)	0.0536	**0.2696***	0.1192	0.0581	**0.2277***	**0.3632****	1.0000	
100.SW(g)	**-0.1990***	-0.0795	-0.0791	-0.0513	-0.1395	-0.1348	**-0.2278***	1.0000

*, ** indicate significant differences from zero at p=0.05 and p= 0.01, respectively

50%FL=days to 50% flowering, DTM=days to maturity, PHAM=plant height at maturity, FHP=first pod height, NPPP=number of pods per plant, YPP=yield per plot(g), FWPP=fodder weight per plot, 100SW=100 seed weight.

Effects of Pretreatment On Germination of the Seeds of *Plukenetia conophora*

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ABSTRACT
Nursery experiments were conducted to evaluate the effects of pre-germination treatment on Plukenetia conophora seeds with the aim of determining the most appropriate method of obtaining optimum and uniform germination of seeds of this species. The factors considered included seed treatments with hot water at 90°C for three minutes, soaking in cold water for three hours, soaking in diluted H_2SO_4 at 70% concentration for 3 minutes and mechanical scarification. Seeds subjected to mechanical scarification recorded the highest germination percentage. At 3 weeksafter planting (WAP), AC3 subjected to mechanical scarification had the highest number of germination (80.0%). No germination was recorded on seeds treated with hot water for 3 minutes. Analysis of variance(ANOVA) showed that there was significant difference among the treatment at 5% probability level.
Keywords: mechanical scarification, Plukenetia conophora, pre-germination

INTRODUCTION
*Plukenetia conophora (*African Walnut) *(*Müll. Arg.) Hutch. and Dalziel) belong to the family Euphorbiaceae (GRIN, 2010) and is a perennial climber found in the moist forest zones of sub-Sahara Africa (Oke, 1995). It is cultivated principally for its nuts that are cooked and consumed as snacks, along with boiled corn (Oke, 1995; Victor, 2003; Edem *et al*., 2009). *Plukenetia conophora* has been described as a semi-wild plant found naturally in the wild and may be extensively encountered in rural dwellings and on farm lands where they are protected (Okigbo, 1991). The seeds are available in June-September when other fruits are scarce, and people cherished eating the succulent seeds (Egharevba *et al*., 2005). The plant normally flowers between 1½ to 2 years after planting. The importance of *Plukenetia conophora* as an indigenous fruit climber is enormous as it is a multi-purpose crop. Its habitat is usually under large trees, the fruits are greenish with four round seeds in each fruit. The seed testa is hard, and the cotyledons are white in colour. (Ehiagbanare, 2007).

In West Africa, especially in Nigeria and Sierra-leone, the fruit is a source of income to the rural dwellers thereby improving their economy (Okafor, 1991; Udeala *et.al,*1984). The leaves, bark, and fruit of *P. conophora* are used medicinally, and their uses include masticatory, giddiness, thrush, antihelminthic, toothache, syphilis, dysentery, and as an antidote to snakebite (Odugbemi and Akinsulire, 2008). In the Southern Nigeria ethnomedicine, African walnut is used as a male fertility agent and in the treatment of dysentery (Ajaiyeoba and Fadar, 2006). The methanolic and ethylacetate extracts of *P. conophora* leaves have been shown to possess good antibacterial activities (Ajaiyeoba and Fadar, 2006). Oke and Fafunso (1995) reported on the high nutrient potentials of the nut. The fruit yields fats and oils (Conophor oil) which is of domestic and industrial importance for soap making, vanish and paints. Investigations by Okafor and Okorie (1990) revealed that the macerated leaves and roots are used for medicinal preparations for asthma and hypertension traditionally. Conophora nut contains 48-50% dry weight of oil, which in liquid form is golden yellow in colour, with taste and odour resembling those of linseed oil.

Proximate fruit composition of conophor nuts shows that it contains: water – 52%, protein – 29.09%, lipid (fat) – 48.9%, carbohydrate – 12.58%, fibre – 6.34%, ash – 3.09%. mineral composition: calcium – 42.06%, iron – 1.55%, magnesium – 57.27%, phosphorus – 465.95%. (Enujiugha and Ayodele-Oni, 2003). There have been reports on the high nutrient potentials of conophora nuts/seeds (Ogunsua and Adebona, 1983) and also on the impact of traditional processing on the nutrient and sensory qualities of the nut (Adesioye, 1991). However, a bitter taste is usually observed upon drinking water immediately after eating conophora nut. This has been attributed to the presence of alkaloids and some other anti -nutritional factors (Adesioye, 1991). The existence of these anti-nutritional factors affects the nutritional value and digestibility, and has been a major limitation in the utilization of many of these unconventional protein-rich and high caloric seeds.

MATERIALS AND METHODS

Eight accessions of *Plukenetia conophora* was collected across from five States in Nigeria. The states are Enugu, Imo, Abia, Kogi and Edo. The seeds were subjected to different pre - germination treatments made up of Mechanical scarification. Soaking in cold water for 3 hours, soaking in Acid (diluted H_2SO_4) for 3minutes, Soaking in hot water for 3 minutes and control. The control and treatments were replicated three times with 9 seeds per treatment. For acid scarification, the seeds were immersed in diluted H_2SO_4 for 3 minutes, they were stirred and thereafter washed with several distilled water before being sown. Mechanical scarification was carried out by sand papering (at the micropyle end and round the circumference) after which scarified seeds were sown. For hot water treatment, the seeds were immersed in hot water (100^0 C) and left for 3 minutes. Treated seeds were allowed to cool at room temperature before they were sown for germination. Cold water treatment was done by soaking the seed in cold water for 3hours.All seeds were sown in perforated plastic germination trays for germination. The experiment was carried out as a 5x 8 factorial in a completely randomized design (CRD), replicated three (3) times. The factor A was the treatment types while factor B was *P. conophora* accessions.

Data Analysis

Data collected were subjected to analysis of variance (ANOVA) using the GenStat Discovery Edition 3 (GenStat, 2007).

RESULTS AND DISCUSSION

Response of Plukenetia conophora to seed treatment

Table 1 showed the percentage germination of *P. conophora* accessions to different seed treatment. The result showed that at 2WAP, the accession was not significant but treatment effect and the interaction was significant ($P< 0.01$). The result showed that control was significantly different from other treatments and thus had better germination percentage at 2 WAP. AC5 6, 7, and 8 had 60% germination in this treatment at 2WAP but AC5 had 6.7% germination at the same time. Soaking in hot water for 3 minutes result in zero germination, an indication that it may be a good treatment.

At 3WAP, accession, treatment and their interaction effect was significant. AC3 had the best germination at 3WAP (53%) while AC8 had the lowest (25.3%). Soaking the seed of *P. conophora* in cold water for 3 hours had (50%) percentage germination while soaking in hot water for 3 minutes only resulted in zero germination of the seeds. The result also showed that mechanically scarifying AC3 results in 80% of the seed germinating.

Table1: Seedling emergence of *Plukenetia conophora* seeds as affected by different treatments.

	2WAP Treatment										3WAP Treatment	
Accessions	1	2	3	4	5	Mean	1	2	3	4	5	6
AC1	20.0	20.0	40.0	0.0	26.7	21.3	46.7	66.7	33.3	0.0	46.7	38.7
AC2	6.7	40.0	20.0	0.0	26.7	18.7	60.0	60.0	60.0	0.0	20.0	40.0
AC3	6.7	6.7	6.7	0.0	40.0	12.0	80.0	73.3	66.7	0.0	53.3	52.0
AC4	6.7	6.7	13.3	0.0	26.7	10.7	46.7	46.7	46.7	0.0	53.3	45.3
AC5	20.0	0.0	26.6	0.0	6.7	10.7	73.7	60.0	20.0	0.0	40.0	33.3
AC6	6.7	20.0	6.7	0.0	60.0	18.7	53.3	6.7	53.3	0.0	6.7	28.0
AC7	46.7	0.0	20.0	0.0	60.0	25.3	26.7	40.0	73.3	0.0	6.7	34.7
AC8	20.0	3.0	6.7	0.0	60.0	24.0	24.0	20.0	46.0	0.0	3.3	25.3
Mean	16.7	15.8	17.5	0.0	60.0		46.7	50.0	50.0	0.0	32.5	
LSD 0.005 accession=12.00ns								12.98*				
treatment=9.47***								10.26***				
Accession and treatment =26.83 ***								29.02***				

Key:1 = Mechanical scarification, 2= Soaking in cold water for 3hour ,3= soaking in 70% H_2SO_4 for 3 minutes,4= Soaking in hot water for 3 minutes, 5= Control (top soil)

CONCLUSION

Plukenetia conophora is one of the major perennial climber that are fast becoming extinct in our local forest, because they are difficult to propagate. This is particularly due to lack of adequate knowledge on their seed handling and nursery techniques as some of them bear seeds that peculiarly dominant, thus requiring pre-treatment to break dominancy. This paper investigated the effects of seed treatment on germination of *P. conophora*. The result indicated that there were significant differences in the treatments applied for this study. The percentage germination can be increased by pre-treating the seeds before planting, thereby reducing the germination time. However, to enhance and ensure optimum and uniform germination of *P. conophora* seeds, mechanical scarification will yield desirable germination within a period of 8days. Farmer should subject their seeds to mechanical scarification before planting to hasten the germination rate and produce satisfactory results.

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Suitability Assessment of Land Resources for Cassava and Yam Cultivation in Khana LGA, Rivers State, Southern Nigeria

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ABSTRACT

This study was conducted in Khana Local Government Area of Rivers State, Southern Nigeria to investigate the suitability of agricultural land resources at semi detailed level of soil survey using the nonparametric approach. Eight soil mapping units were established and suitable guidelines specific for each pedons was followed in establishing the suitability of the land for cassava and yam cultivation. Data from the eight pedons covering 49,631.54 hectares of land were used for the assessment. The results show that 40,681.54 hectares representing 81.97%, of the total land in Khana LGA were moderately suitable (S2) for cassava production; while 8,950 hectares representing 18.04 % of the total land area were also marginally suitable (S3) for cassava production. 30,582 hectares representing 61.82% were moderately (S2) suitable for yam production in the area and 4,750 hectares representing 8.57 % were marginally suitable (S3); while 12,450 hectares representing 25.08% were currently not suitable (N) for yam production in the area. Furthermore, the study shows that cassava and yam can adapt to similar environment in terms of climate, soil physical characteristics and fertility. Thus, the suitability map produced from this study will guide the choice of site to increase and sustain cassava and yam production in Khana.

Keywords: Suitability assessment, land resources, cassava and yam cultivation, Khana, Rivers State

INTRODUCTION

Suitability assessment of land resources for the cultivation of certain community crops is a key to sustainable crop production vis a vis land use planning and policy making as related to agricultural crop production (Peter and Umweni, 2020). Suitability assessment of land resource studies, aimed at assessing better and poor qualities of agricultural land and suggest the best management practice to ameliorate some of the inherent poor qualities as well as sustaining some of the better land qualities (Peter, *et al* 2019). It was also aimed at increasing the production of cassava and yam in the area to enhance national food security, rural empowerment and high standard of living. Cassava and yam are some of the arable crops produced by small scale farmers in Khana Local Government Area for decades now (Peter, *et al* 2019). It is of growing importance for both human as food, animal feed and raw materials to industries. These crops are supply to neighbouring local government area of Port Harcourt and Obio/Akpor where their agricultural land has metamorphosed into residential area as the expense of crop production due to urbanisation and population explosion in the area (Peter, *et al* 2019). According to Raji (2016), cassava is cultivated in all parts of Nigeria where rainfall is above 1000mm per annum, adding that cassava account for 70% of total tuber crops cultivated in Africa. Cassava play a very vital role as cash crop earner for growers and, low food cost for both urban and rural dwellers as well as house hold food security (Raji, 2016). It is of growing importance for both human as food, animal feed and raw materials to industries. Common community crops such as yam is an agro-staple food crops in Nigeria which grows mainly on well drained soils (Peter and Awaji, 2019). Yam is mainly used for human food either boiled, roasted, baked, fried pounded or in so many processed forms (Raji, 2016). Cassava and yam peels are also used to feed livestock such as goat, sheep, cattle and pig and as organic source of fertilizers (Peter and Onweremadu, 2015). Irrespective of the economic contribution of these two community crops (cassava and yam) in Khana and huge contributions of Khana Local government area in both the production and the distributions of cassava and yam to neighbouring local governments and state, suitability assessment studies of the land resources of the area has not been conducted and documented in existing literature (Peter, *et al* 2019). Thus, this study will help to fill the big gap in information on soil suitability evaluation of Khana Local Government Area of Rivers State for cassava and yam production on sustainable basis. Again, knowledge of the potentials and limitations of land resources for cassava and yam production in Khana Local Government Area, will enable cassava and yam farmers in the area to make adequate land use initiative to improve and maintain high yield of their crops on sustainable basis and at the same time improve their standard of living. Therefore, in specific terms, the foremost objective of this study was to evaluate the suitability of Khana soils for cassava and yam cultivation

MATERIALS AND METHODS

Study area

Khana local government is one of the four local governments that made up of Ogoni kingdom. It lies between 4.67172N and longitude 7.34398 Peter and Umweni (2020)**.** It also covers 49,631.54 hectares of land located in the southern part of Nigeria. The local government experience early rain from February to December with little dry season from December to late February with a distribution that ranged between 2000 - 2500mm/annum in a bimodal form with two peaks in June and September and a period of low precipitation popularly known as August break (Oyegun and Olosunorisa 2002 and Raji 2016). Mean temperature of the area varies annually and seasonally between 25oC and 28oC; and relative humidity also varies between 81-87% depending on the season of the year (Ayolagha and Peter, 2013, Peter and Anthony, 2017 and Peter and Umweni, (2020). The vegetation of Khana is the tropical rainforest dominated by tropical forest trees species such as *Delinox regia, Chrotaria exelsa, Mahogany, Iroko, Cieba petandra* among others and some area are grown with secondary vegetation and fallow with grasses such as Guinea grass (*Panicum maximum*) and Elephant grass (*Penisetum purpureum*) among others Peter and Umweni (2020). Anthropogenic activities such deforestation, crude oil pollution, bush burning and continuous cropping have altered the naturally occurring vegetation in the area Peter *et al* (2019). The major type of land use in the area, is the small scale agriculture and some of the grown community crops are cassava, yam, maize fluted pumpkin, cocoyam, okro etc. According to Peter and Umweni, (2020), four soil types, largely Inceptisols/Cambisols, Entisols/Arenosols, Ultisols/Acrisols and Alfisol/Lixisol are commonly identified in Khana. The soils are well drained coastal plain sand underlying alluvium of marine deltaic deposits commonly called Ogoni sands (Peter and Ayolagha, 2013, Peter and Onweremadu 2015, Peter and Anthony, 2017 and Peter and Umweni, 2020).

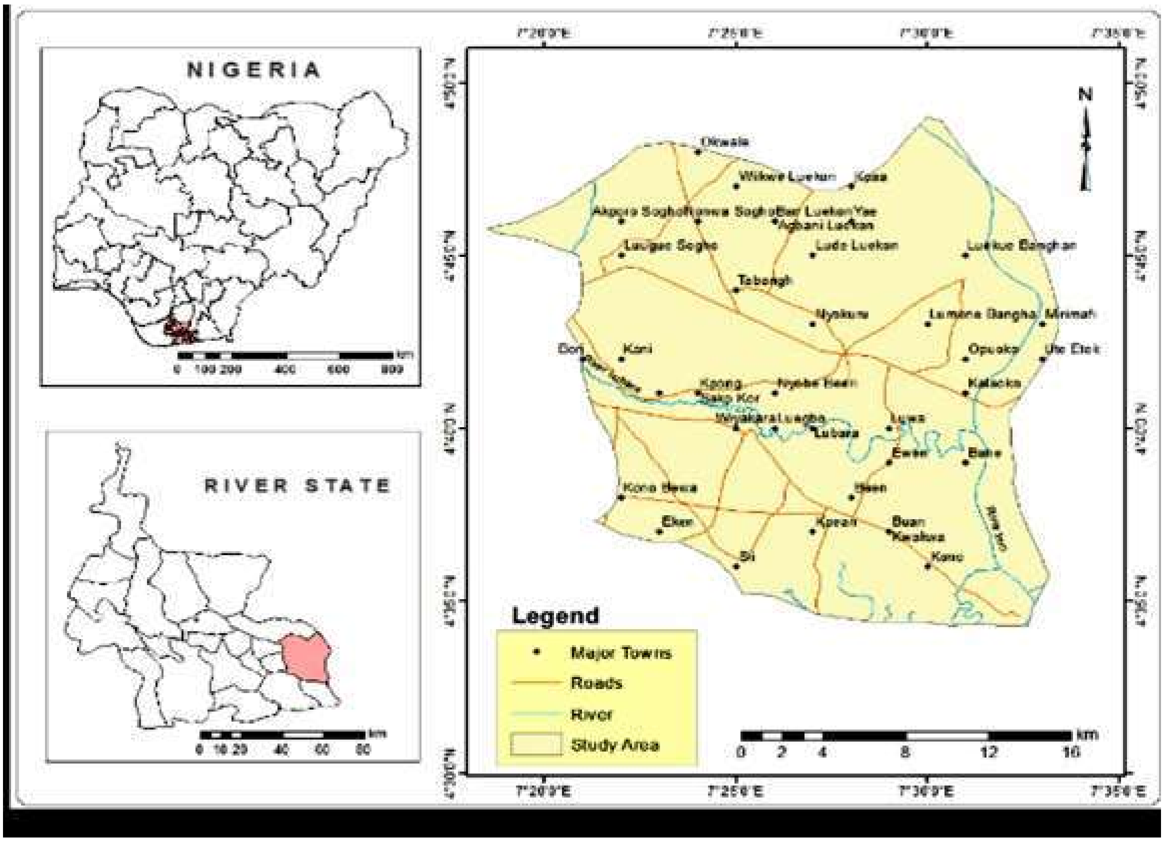


Fig. 1. Map of Khana Local Government Area (Project Site). Sources: Government of Rivers State, Office of Surveyor General (2014)

Field studies

A semi detailed soil survey was carry out on the 49.631.54 hectares of land in Khana. The entire land area of Khana LGA was gridded using 1000 m x 500 m measurement (50ha per auger boring points) at semi detailed level of soil survey. A total of nine hundred and nine three (993) auger sampling points were identified. Eight mapping units were also identified and delineated at semi detailed level of soil survey. One soil profile pit each of 2m x 2m x 2m was sited in each of the mapping unit and was described using FAO guidelines (1990).

Laboratory studies

Soil samples collected from each pedon was air-dried and crushed to pass through a 2mm sieve and analysis was carried out using standard laboratory procedures most appropriate at the Soil Science Laboratory, Federal University Technology, Owerri, Imo State. Particle size analysis was determined by the hydrometer method (Juo 979). Soil textural classes were determined using textural triangle (Soil Survey Staff, 2003). Bulk density was determined by core method as described by Blake and Hartge (1965). Soil Reaction (pH) was determined in H_2O and I N KCl solution respectively. Organic carbon was determined by dichromate wet oxidation method of Walkey and Black, (1934) as described in methods of soil analysis (Juo, 1979). Available Phosphorus (P) was determined by Bray and Kurtz No 2 (1945) method as described by Jou (1979) and Loganathan *et al.* (1984). Total nitrogen was determined by the Macro Kjedahl digestion method as described by Juo (1979) and Loganathan *et al.* (1984). Basic cations (Ca, Mg, K and Na) were determined by extracting with neutral ammonium acetate (I M NH4OAc) buffered at pH 7.0. Exchangeable cations: Ca, Mg, K and Na were leached from the soil with NH40Ac solution. Na and K were determined with a flame photometry. ECEC was determined as the sum of total exchangeable bases plus exchangeable acidity. Base Saturation was calculated using total exchangeable bases divided by CEC and multiplies by 100.

Land suitability evaluation

The suitability of soils was assessed for cassava and yam using non parametric method of land suitability evaluation system (FAO, 1976). Each pedon was placed in their respective suitability classes by matching them with the already established land qualities requirements for the two crops of interest. According to Peter, *et al* (2019) and Peter and Umweni, (2020), the potentials and limitations of five land qualities/characteristics (climate, topography, wetness, soil physical properties and soil fertility) in determining the suitability of the soils identified in Khana for the cultivation of cassava and yam. This was done using Senjobi and Ogunkunle, (2010) suitability guidelines for cassava and Eze (2014) modified from Sye *et al*. (1985) suitability guidelines was use for yam. Land suitability classes were obtained by matching some of the land qualities with the land use requirements for the two crop of interest produced in the study area. Aggregate suitability class of each pedon for both cassava and yam, were obtained in line with the law of minimum which states that "performance is always determined by the least favourable characteristic or plant nutrients in the lowest supply" (FAO, 1984). Land suitability classifications of the selected community crops were expressed in relevant land suitability maps.

Data Analysis

Spearman rho ranking correlations were used to compare the effective guidelines for the different crops.

Table 1: Land requirements for the Cultivation of Cassava *(Manihot Spp)* Production

Land use requirement	S_1	S_12	S_2	S_3	N_1	N_2
Climate (c) Annual rainfall (mm)	1400-1800	1000-1400 1800-2400	750-600 >2400	600-500	550-500	<500
Length of growing season (months)	3-4	4-5 1-3	5-6 <1			
Mean temperature (°C)	26-20	26-30 20-18	>30 18-16	16-14	14-12	<12
Topography (t)						
Slope (%)	0-4	4-8	8-16	16-30	30-50	>50
Wetness (w) Drainage	Good	Good	moderate	Somewhat poorly drained	Poor drainage	Poor, very poor, not drainable
Soil physical characteristics (s) Texture	L,SCL	SC,SiCi,SiCL, CL, SCL, SC	Cs, Lfs, LS, LSC Fs	Cs,S,CS	SC,Cm	Cm,Si
Soil depth (cm)	>125	>100	>75	>55	>50	>50
Fertility (f)						
CEC (cmol/kg)	>16	Any	<10	<10	<5	<5
Base saturation (%)	35	35-20	20-15	15-10	<10	<10
Organic matter (g/kg O.C 0-15cm	>15	8-15	<8	<5	<3	<2

Symbols used for soil texture and structure are defined as follows; Sc: structure clay, Cm: massive clay, SiCi: Silty clay, SiCL: Silty clay loam, CL: Clay loam, Si: silt, SIL: Silty loam, SC: sandy clay, L: loam, SCL: sandy clay loam, Lfs: loamy fine sand, LS: loam sand, LSC: loamy coarse sand, Fs: fine sand, S: sand, CS: coarse sand. Source: Senjobi and Ogunkunle, (2010)

Table 2: Land requirements for the Cultivation of Yam (*Dioscorea* spp)

Land requirement/ Land characteristics	Land Suitability Class (s)			
	S1	S2	S3	N1
Climate (c)				
Annual rainfall (mm)	≥2000	1300 – 1999	1000 – 1299	600 - 500
Moisture Availability (m)	≥5	4	3	<3
Length of growing season (Days	≥200	130 – 200	100 - 150	<100
Mean temperature (°C)	21- 28	25 – 30	30 - 35	>35
Topography (t)				
Slope (%)	0 - 4	4 – 8	8 - 16	16 – 30
Wetness (w)				
Flood hazard	F0	F1	F2	>F2
Drainage	Well drained	Moderate	Moderate	Poorly drain
Soil physical characteristics (s)				
Texture (surface)	LS, SCL	SC, SiC & SiCL	Cs, Lfs, LS, LSC & Fs	Cs, S & CS
Soil depth (cm)	Deep (>200)	>100	>75	>55
Fertility (f)				
Total N g/kg^{-1}	>1.5	<1.2	0.6	<0.6
pH (H_2O)	>5 – 6.5	4.5 – 5	4. 44	<4.0
ECEC (cmol/kg	>12	Any	8 – 5	<5
Base saturation (%)	>60	>40 – 60	20 -39	<20
Exchangeable K (cmol/kg	>2.0	1.5	1.0	<1.0
Organic matter (g/kg O.C	>15	8 – 15	<8	<5

Symbols used for soil texture and structure are defined as follows; Sc: structure clay, Cm: massive clay, SiCi: Silty clay, blocky clay, SiCL: Silty clay loam, CL: Clay loam, Si: silt, SIL: Silty loam, SC: sandy clay, L: loam, SCL: sandy clay loam, Lfs: loamy fine sand, LS: loam sand, LSC: loamy coarse sand, Fs: fine sand, S: sand, CS: coarse sand. Source: Eze (2014) Modified from Sye *et al*. (1985)

RESULTS AND DISCUSSION

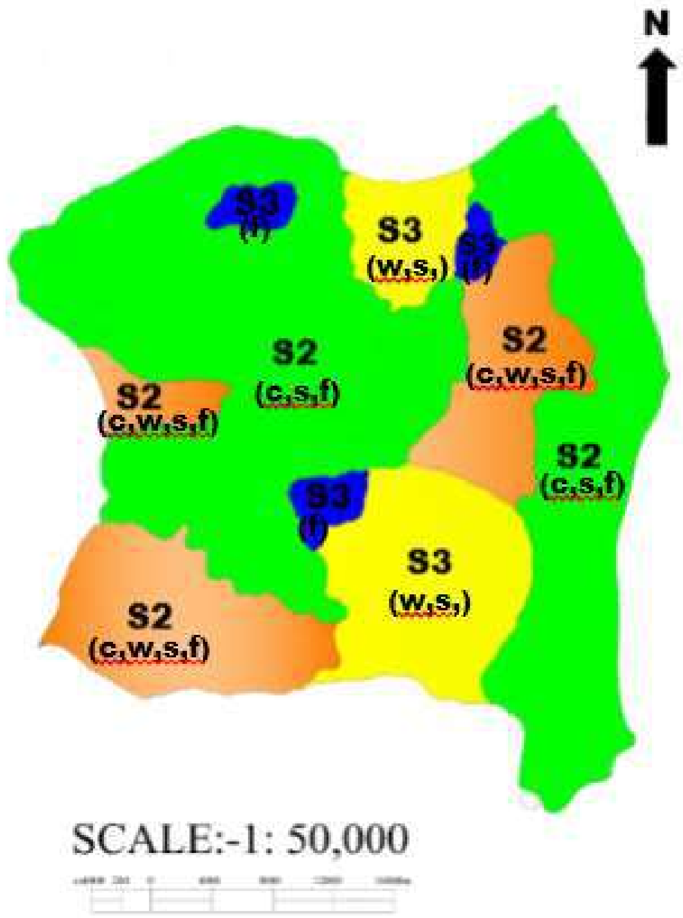
Land suitability classification for cassava

From Table 3, results of land suitability classes of the various pedons in the study area for cassava cultivation showed that Pedons 1 and 5 were moderately suitable (S2) for cassava cultivation with reasonable defects in climate, wetness and fertility. This contradicts the finding of Raji (2016) who revealed that the soils of Kwara were marginally suitable for cassava cultivation due to limitations in soil physical properties and fertility. The total land coverage for both pedons (1 and 5) is 10,700 hectares, that is, 21.55% of the study area. Pedons 2, 3, 6, and 7 are also moderately suitable (S2) for cassava cultivation with moderate constraints in climate and fertility. The four pedons covered a land area of 29982 hectares representing 60.41% of the total study area. Pedon 4 was marginally suitable (S3) for cassava cultivation with major defects in wetness and soils. Pedon 4 covered a land area of 7700 hectares representing 15.52 % of the study area. Pedon 8 was marginally suitable (S3) for cassava cultivation with major defects in fertility. This is in tandem with the report of Raji (2016), adding that the soils would become moderately suitable, if the fertility problems was addressed through fertilizer applications. Marginal suitability (S3) of pedon 8 for cassava cultivation due to defects in fertility was also in line with findings of Kinche and Vanlauwe (2017) who reported that most cassava yield lost to farmers was mainly as a result of poor soil fertility leading to poor growth and development. This is also in tandem with the observations of Ande, 2011), that CEC and organic carbon has very high effects on almost all soils properties especially when their levels are beyond critical limit for crop growth. Pedon 4 had specific defects in soil depth and surface drainage. Pedons 1, 2, 3, 5, 6 and 7 was moderately (S2) suitable for cassava cultivation covering 40,682 hectares representing (81.96%) of the study area; while pedons 4 and 8 were marginally suitable for cassava cultivation, covering 8,950 hectares representing 18.04 % of the study area. This is similar to the findings of Ande (2011), in his studies on soil suitability evaluation and management for Cassava cultivation in the Derived Savanna Area of Southwestern Nigeria.

Table 3: Summary Table for Suitability Evaluation for Cassava (*Manihot Spp*) Cultivation for Pedons 1 - 8

Land Requirements/Land Suitability	Pedons and their Suitability Class (s)							
	P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**
Climate (e)								
Annual rainfall (mm)	2000-2500 (S2)	2000 - 2500 (S2)	2000 - 2500 (S2)	2000 - 2500 (S2)	2000 - 2500 (S2)	2000 - 2500 (S2)	2000- 2500 (S2)	2000- 2500 (S2)
Length of growing Season (months)	5 months (S2)	5 months (S2)	5 months (S2)	5 months (S2)	5 months (S2)	5 months (S2)	5 months (S2)	5 months (S2)
Mean Annual temp (°C)	25 - 28 (S2)	25 28 (S2)	25 - 28 (S2)	25 28 (S2)	25 - 28 (S2)	25 - 28 (S2)	25 28 (S2)	25- 28 (S2)
Topography (t)								
Slope (%)	0 – 4 (S1)	0 – 4 (S1)	0 – 4 (S1)	0 – 4 (S1)	0 – 4 (S1)	0 – 4 (S1)	0 – 4 (S1)	0 – 4 (S1)
Wetness (W)								
Drainage (surface)	MD (S2)	WD (S1)	PD (S1)	MD (S3)	MD (S2)	WD (S1)	WD (S1)	WD (S1)
Soil Physical Characteristics (s)								
Texture (surface)	SL (S2)	LS (S2)	SL (S2)	LS (S2)	LS (S2)	LS (S2)	SL(S2)	SL (S2)
Soil depth (cm)	131 (S1)	200 (S1)	200 (S1)	50 (S3)	120 (S2)	200 (S1)	200 (S1)	200 (S1)
Fertility (f)								
CEC (mol-Kg^{-1}) clay	2.68 – 5.7 (S2)	2.01– 3.41 (S2)	4.52– 6.3 (S2)	3.75–3. 92 (S2)	3.05 – 6.5 (S2)	2.04 – 3.72 (S2)	3.64 – 5.0 (S2)	1.76 – 3.34 (S2)
Base Saturation (%)	34.9 56.34 (S1)	37.91 50.4 (S1)	21.22- 47 (S1)	34.06 - 44.95 (S1)	24.84 - 55.23 (S1)	59.35 - 90 (S1)	30.37 -61.62 (S1)	37.9 – 57.3 (S1)
Organic carbon (g/kg^{-1}) 0-15cm	1.48 (S2)	1.06 (S2)	1.02 (S2)	1.08(S2)	1.11 (S2)	0.82 (S2)	1.001(S2)	0.35 (S3)
Aggregate Suitability Class	S2 (c, w, s, f)	S2 (c, s , f)	S2 (c, s, f)	S3 (w , s)	S2 (c, w, s, f)	S2 (c s, f)	S2 (c s, f)	S3 (f)
Size (Hectare)	4750	1400	19882	7700	5950	5350	3350	1250
% Coverage	9.57	2.82	40.06	15.52	11.98	10.78	6.75	2.52

Source: Senjobi and Ogunkunle, (2010). Pedons 1, 2, 3, 5, 6, 7 (40,682 ha) were moderately suitable (S2) for cassava cultivation with limitations in climate (rainfall, length of growing season and mean annual temperature), soil physical properties (texture) and fertility (low CEC and organic carbon). Pedon 4 (7700 ha) was marginally suitable (S3) for cassava cultivation with limitations in wetness (drainage) and soils physical characteristic (eg depth to water table). Pedon 8 (1250 ha) was also marginally suitable (S3) for cassava cultivation but with constrain in fertility (low organic carbon).



LEGEND

SYMBOL	LIMITATION	SIZE (ha)
S2 (c,w,s,f)	Moderately suitable (S2) class for cassava cultivation with limitation in climate (rainfall, growing season, temperature) wetness (Drainage, textures) soil physical characteristics (texture) and fertility (Low CEC, organic carbon)	10,800ha^{-1} (21.55%)
S2 (c,s,f)	Moderately suitable (S2) class for cassava cultivation with limitations in climate (rainfall, growing season, temperature), soil physical characteristics (texture), fertility (Low CEC, organic carbon)	29,982ha^{-1} (60.4%)
S3 (w,s)	Marginally suitable (S3) class for cassava cultivation with limitations in climate (rainfall, growing season, temperature) wetness (drainage) soil physical characteristics) (soil depth),	7700ha^{-1} (15.52%)
S3 (f)	Marginally suitable (S3) class for cassava cultivation with limitation in fertility (low organic carbon)	1250ha^{-1} (2.52%)

Fig. 2. Land Suitability Map for Cassava in Khana LGA

Land suitability classification for Yam

Table 4 shows the results of suitability rating or classes for the cultivation of yam across the eight pedons in the area. It shows that Pedons 1, 3 and 5 were moderately suitable (S2) for yam cultivation in the study area with limitations in climate, wetness, soil and fertility. This observation is in line with the findings of Asadu and Ezike (2017) and Ali *et al.,* (2011), who reported that low fertility status of soils especially, nitrogen, magnesium and calcium, affects leaf and tendril growth and tuber formation in yam adding that yam tuber yield correlated to the maximum leaf index and for sustainable yam production, there was need to improve on some of the cultural practices as a mean of conserving soils fertility status. The three pedons (1, 3 and 5) covered a land area of 30,000 hectares, representing 61.62 % of the total land in the study area. Pedons 2 and 7 were also moderately suitable (S3) for yam cultivation in the study area with limitations in climate, soil physical properties and fertility. These covered 4,750 hectares, representing 9.57 % of the total land in the study area. Pedon 4 was permanently not suitable (N) for yam cultivation with severe defects in soil depth. It covered an area of 7,700 hectares, representing13.52 % of the land. Pedons 6 and 8 were currently not suitable (N) for the cultivation of yam in the study area with severe defect in fertility. They covered 6,600 hectares of land, representing 13.29 % of the total land in the study area. When looking at specific fertility limitations, total nitrogen was moderate in all the eight pedons. Total N and Organic carbon were very low in pedons 6 and 8. However, this limitation can be ameliorated by the application of organic and inorganic manure to soils in the study area, thereby changing them to become moderately suitable (S2). This is also in line with the findings of Raji (2016) who posited that, soils with low fertility status can be easily corrected by addition of organic or inorganic amendments at recommended rates

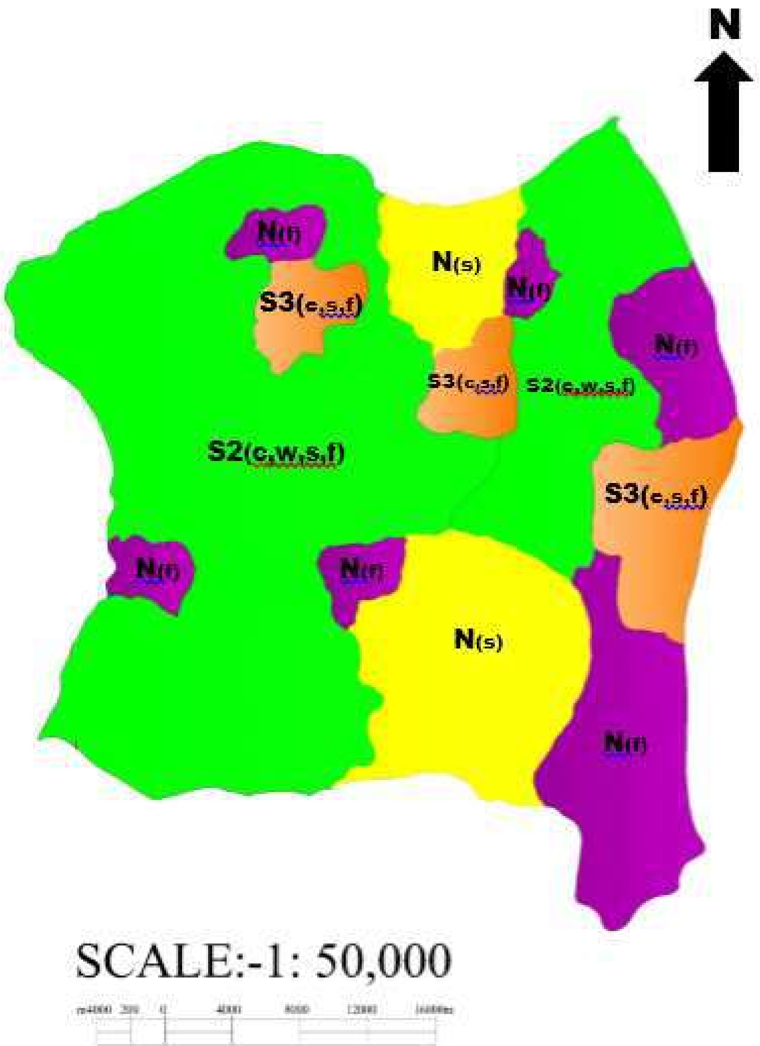
Table 4: Summary Table for Suitability Evaluation for Yam (*Dioscorea Spp*) cultivation in Pedons 1-8

Land Requirements/Land Suitability	P1	P2	P3	P4	P5	P6	P7	P8
Climate (c)								
Annual rainfall (mm)	2000 – 2500 (S1)	2000 – 2500 (S1)	2000 – 2500 (S1)	2000 – 2500 (S1)	2000 – 2500 (S1)	2000 – 2500 (S1)	2000 – 2500 (S1)	2000 – 2500 (S1)
Moisture Availability (m)	8 Months (S1)	8 Months (S1)	8Months (S1)	8 Months (S1)	8 Months (S1)	8 Months (S1)	8 Months (S1)	8 Months (S1)
Length of growing season (Days	180 (S2)	180 (S2)	180 (S2)	180 (S2)	180 (S2)	180 (S2)	180 (S2)	180 (S2)
Mean temperature (°C)	22 - 28 (S1)	22 - 28 (S1)	22 - 28 (S1)	22 - 28 (S1)	22 - 28 (S1)	22 - 28 (S1)	22 - 28 (S1)	22 - 28 (S1)
Topography (t)								
Slope (%)	0 – 4 (S1)	0 – 4 (S1)	0 – 4 (S1)	0 – 4 (S1)	0 – 4 (S1)	0 – 4 (S1)	0 – 4 (S1)	0 – 4 (S1)
Wetness (w)								
Flood hazard	F1 (S2)	F0 (S1)	F1 (S1)	F2 (S3)	F1 (S2)	F0 (S1)	F0 (S1)	F0 (S1)
Drainage	M (S2)	WD (S1)	WD (S2)	P-M (S3)	PM (S2)	WD (S1)	WD (S1)	WD (S1)
Soil physical characteristics (s)								
Texture (surface)	SL (S1)	SL (S2)	SL (S2)	LS (S2)	LS (S1)	SL (S2)	SL (S2)	SL (S1)
Soil depth (cm)	131 (S2)	200 (S1)	200 (S2)	50 (N1)	120 (S2)	200 (S1)	200 (S1)	200 (S1)
Fertility (f)								
Total N g/kg^{-1}	1.39 (S2)	1.09 (S2)	0.90(S2)	1.07 (S2)	0.41 (S2)	0.45 (N1)	1.12 (S2)	0.70 (S2)
pH (H_2O)	>5 .5 – 6.13 (S1)	5 .60 – 6.16 (S1)	5.14 – 6.11 (S1)	5.43 – 6.08 (S1)	4.50 – 5.71 (S1)	4.31 – 4.81 (S3)	4.70 – 5.90 (S1)	5 .67 – 5.83 (S1)
ECEC (cmol/kg	2.68 – 5.65 (S2)	2.01 – 3.41 (S2)	4.52 – 6.27(S2)	3.75 – 3.92(S2)	3.05 – 6.49 (S2)	2.76 – 4.02 (S3)	3.64 – 4.99 (S2)	1.758 – 3.439 (S2)
Base saturation (%)	34.87 – 56.36 (S2)	37.91 – 54.1 (S1)	21.22 – 47 (S2)	34.06 – 44.96 (S3)	24.84 – 55.23 (S2)	34.87 – 56.36 (S2)	30.37 – 61.62 (S2)	37.85 – 57.26 (S2)
Organic matter (g/kg O.C	1.48 (S2)	1.06 (S2)	1.02 S2	1.083 S2	0.82 (S2)	1.11 S2	1.001 (S2)	0.35 (N1)
Aggregate Suitability class	S2 (c, w, s, f)	S2 (c, s, f)	S2 (c, w, s, f)	N1 (s)	S2 (c, w, s, f)	N1 (f)	S2 (c, s, f)	N1 (f)
Size (Hectare)	4750	1400	19882	7700	5950	5350	3350	1250
% Coverage	9.57	2.82	40.06	15.52	11.98	10.78	6.75	2.52

Source: Eze (2014) Modified from Sys (1985). Pedons 1, 3, and 5 (30582) were moderately suitable (S2) for yam cultivation but with limitations in climate (length of growing season), wetness (flood hazard and drainage), soil physical properties (soil texture and depth) and fertility (low total nitrogen, base saturation, ECEC and organic carbon). Pedons 2 and 7 (4750 ha) were also moderately suitable for yam cultivation but with defects in climate length of growing season), soil physical properties (soil texture) and fertility (low nitrogen, ECEC and organic carbon).

Pedon 4 (7700 ha) was not suitable (N) for yam cultivation due to defect in soil physical characteristics (soil depth to water table).

Pedon 6 and 8 (6600 ha) were current not suitable (N) for yam cultivation due to limitation in fertility (low nitrogen and organic matter).



LEGEND

SYMBOL	LIMITATION	SIZE (ha)
S2 (c,w,s,f)	Moderately suitable for yam cultivation with limitation in climate (length of growing season) wetness (flood hazard) soil physical characteristics (texture, soil depth) fertility (ECEC, base saturation, organic matter)	30582 ha^{-1} (61.82%)
S3 (c,s,f)	Moderately suitable for yam cultivation with limitation in climate (length of growing season), soil physical characteristics (texture) fertility (ECEC, base saturation, organic carbon)	4750 ha^{-1} (9.57%)
N (s)	Not suitable for yam p cultivation due to limitation in (soil physical characteristics) (soil depth),	5850 ha^{-1} (11.79%)
N (f)	Currently not suitable for yam cultivation due to limitation in fertility (organic carbon)	6600 ha^{-1} (13.29%)

Fig. 3 Land Suitability Map for yam in Khana LGA

CONCLUSION

It is concluded that 75% of the total land sites in Khana LGA were moderately suitable (S2) for cassava and yam production. That is, 40,681.54 hectares representing 81.97%, of the total land resources in Khana LGA were moderately suitable (S2) for cassava production with some limitations; while 8,950 hectares representing 18.04 % of the total land area were also marginally suitable (S3) for cassava production. Again, 30,582 hectares (61.82%) were moderately (S2) suitable for yam production in the area and 4,750 hectares (8.57 %) were marginally suitable (S3); while 12,450 hectares (25.08%) were currently not suitable (N) for yam production in the area. It is therefore, recommended that, the land suitability map produced from this study for cassava and yam production in the area should be employed as a basis for land site selection to increase output for cassava and yam production to in Khana Local Government Area of Rivers State.

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Assessment of Genetic Components and Inter-Trait Associations of Okra (*Abelmoschus esculentus* L. Moench) genotypes

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ABSTRACT
Evaluation of inherent variability is a requisite for selection among germplasm lines. Information on relationship among desirable traits ensures reliable selection in a breeding programme. Fifteen okra genotypes were grown using randomized complete block design with three replications in the late season of 2020. The study assessed the components of genetic variability among the genotypes and investigated the extent and pattern of relationship among ten agronomic and yield-related traits of okra. . Genotype mean squares were significant for DTF, NOB, PDL, PDW, NOR, and PDWT showing the possibility of selection among the okra genotypes. Broad-sense heritability estimates (%) were high for PDL (74.20), DTF (70.50), NOR (68.80), PDWT (54.00), and PDW (42.30), and these traits could easily be selected in early generations. Step-wise regression analysis revealed significant influence of NOR, NOB, and NOP on PDWT with R^2 values of 19.50, 25.50, and 32.40 respectively, suggesting the possibility of simultaneous improvement of these traits with PDWT. Biplot analysis revealed different trait profiles of the okra genotypes and associated Iwo Nla, NH47-45, NHIK 103, NHIK 177, NHMB-1, and NHP 68 with NOR and PDWT. The significant correlation between NOR and PDWT can be exploited for simultaneous improvement of the two traits using associated accessions.
Keywords: biplot; genetic; heritability; okra; regression; variability

INTRODUCTION
Cultivated okra (*Abelmoschus esculentus* L. Moench) is an important fruit vegetable belonging to family Malvaceae. It is popular as a source of nutrition, industrial raw materials, and substances of medicinal value against fever, catarrh, and genito-urinary disorders among others (Des et al., 2012). The crop has been found adapted to a wide range of environmental conditions especially in the tropics and warm temperate zones (Walling et al., 2020). According to Walling et al. (2020), cultivated okra can yield up to 10-15 ton/ha under good management. However, the production observed is much less due to identified constraints, the chief of which is related to genetic materials (i.e. use of genetically-poor planting materials). Thus, it is essential that research efforts are directed towards improving the productivity of existing cultivars to meet the growing demand for the crop.

Yield is a polygenic trait that is directly or indirectly dependent on many other traits. Information on the extent of variability for yield and related traits, and the inter-relationship among key agronomic traits are essential to formulating effective strategies for breeding high-yielding genotypes of the crop. Therefore, this study assessed the components of genetic variability among, and investigated the extent and pattern of relationship among ten agronomic and yield-related traits of okra with a view to providing information for future improvement of cultivated okra.

MATERIALS AND METHOD

Location of the experiment

The research was conducted at the Teaching and Research Farm of the Department of Crop Production and Horticulture, School of Agriculture, Lagos State Polytechnic, Ikorodu.

Okra genotypes evaluated and their sources

Fifteen genotypes of okra were used for the study. Seeds were obtained from National Horticulture Research Institute, NIHORT, Ibadan. The names of the genotypes were Benue local, 12u1, IWO, MHK199, NHCaPi145, NHIK103, NHIK177, NHIK7, NHLP3, NHP68, NH47-4, NH47-45, NHCaP2/44, and NHCaP2/51.

Land preparation and plot layout

The land was tilled manually using hoes, since the land has been under cultivation. Planting was done on the flat land. The genotypes were laid out in randomized complete block design with three replications.

Field establishment and maintenance

A single-row plot method was used. Each row was 2.5 m long and rows were spaced 0.6 m apart. Seeds were soaked in water prior to planting, to hasten germination and emergence. Two seeds were sown per hole at inter- and intra-row spacing of 0.6 m and 0.5 m respectively. Seedlings were thinned to one plant per stand at two weeks after sowing (WAS), to give a plant population density of 33,333 plants per hectare. At three WAS, NPK 15:15:15 was applied at the rate of 333kg/ha at the base of the plants. Weeds were controlled manually as and when due. Insecticides were not used throughout the experiment to prevent scorching of the plants, due to the prevalent harsh weather condition.

Data collection and analysis

Data were taken on number of days to 50% flowering, plant height (cm), stem girth (mm), number of leaves per plant**,** number of branches per plant, number of pods per plant, pod length (cm)**,** pod width (cm), number of ridges per pod, and pod weight (kg). Data obtained were subjected to analysis of variance using 'proc glm' and genetic components were estimated via 'proc varcomp' (SAS Inst., 2011). The relationship among traits was investigated through simple correlation (Pearson) analysis while genotype association with traits was investigated using the multidimensional preference analysis in SAS (SAS Inst., 2011). Stepwise regression analysis was performed using the 'olsrr' package in R (R Core Team, 2021).

RESULTS AND DISCUSSION

The summary of analysis of variance among okra genotypes for the measured traits is shown in Table 1. Genotype mean squares were significant ($p \leq 0.05$ or $p \leq 0.01$) for number of days to 50% flowering, number of branches per plant, pod length, pod width, number of ridges per pod, and pod weight. This is an indication of the existence of adequate genetic variability for effective selection to improvement the traits. Agboruwo et al. (2019), Oyetunde and Ariyo (2017), and Das et al. (2012) reported significant genotype mean squares for various traits of okra including number of days to flowering, plant height, numbers of leaves and branches per plant, pod length and width, number of fruits per plant, number of ridges per pod, and pod weight.

Estimates of genotypic and environmental variances were obtained for all the measured traits providing sufficient evidence that all the traits were influenced by both genotype and environment, though at different levels (Table 2). Genotypic variance ranged from 0.003 for pod weight to 689.986 for pod length while phenotypic variance was lowest (0.006) and highest (930.474) for the same traits, respectively. There was close correspondence between genotypic and phenotypic variances for DTF (244.119 and 346.476 respectively), PDL (689.986 and 930.474 respectively), NOR (4.099 and 5.959 respectively), and PDWT (0.003 and 0.006) indicating superior influence of genotype over environment in the expression of the traits.

Phenotypic co-efficient of variation (PCV) was consistently higher than the genotypic counterparts (GCVs). However, GCV values were close to PCV values for the DTF, PDL, PDW, NOR, and PDWT which emphasizes the important role of the genotype in phenotypic expression of the traits (Oyetunde and Ariyo 2015; Guddadamath et al., 2011).

Broad-sense heritability estimates ranged from 0.30% for number of leaves per plant to 74.20% for pod length. The higher the heritability estimate for a trait, the closer the estimate phenotypic expression is to the genetic potential. Thus, pod length, number of days to 50% flowering and number of ridges per plant ranked top in reflecting the genotypic potential of genotypes for the traits. The moderately high heritability estimates (68.80-74.20%) for number of days to 50% flowering, pod length, and number of ridges per plant coupled with the moderate and closely-associated GCV and PCV estimates suggest that these traits could be the focus of selection for advancement of the genotypes (Walling et al. 2020).

Useful levels of association were observed among the measured traits as presented in Table 3. Number of days to 50% flowering had positive and significant ($P \leq 0.01$) with pod length ($r = 0.891$), pod width ($r = 0.837$), and number of ridges per pod ($r = 0.889$). Also, positive and significant ($P \leq 0.01$) correlation was observed in the relationship of pod length with pod width ($r = 0.770$) and number of ridges per pod ($r = 0.808$). Additionally, pod width shared positive and significant ($P \leq 0.05/0.01$) correlation with number of ridges per pod ($r = 0.902$) and pod weight (0.570) while number of ridges per pod had positive and significant ($P \leq 0.05$) association with pod weight ($r = 0.556$). Significant level of association between paired traits is an indication of possible simultaneous improvement of such traits, and can also serve as selection criteria for improvement of target traits. Thus, there is possibility of simultaneous improvement of flowering time with pod characters such as length, width, and number of ridges. There is also possibility of improving number of ridges per pod with pod length, pod width, and pod weight. Walling et al. (2020), Oyetunde and Ariyo (2017), and Nwangburuka et al. (2012) reported comparable observations for important traits of okra.

Stepwise regression analysis of variability in pod weight revealed number of ridges per pod and numbers of branches and pods per plant as the major contributors, with a joint contribution of 32.4% (Table 4). Number of ridges per pod, number of branched per plant and number of pods per plant accounted for 19.6, 5.9, and 6.9% of the observed variation in that order. This explains that number of ridges per pod is the major factor determining pod weight in okra. The high variation in pod weight that is due to number of ridges per pod is in tandem with the significant association between the two traits. Number of ridges per pod thus have an important role in breeding for pod weight of okra. Adeniji and Aremu (2007) observed similar relationship between number of ridges per pod and seed yield of okra.

The biplot (Figure 1) analysis reliably (with efficiency of 84.09%) profiled the evaluated okra genotypes for measured traits. Genotypes a, b, d, e, l, and m were associated with A, G, and E while c, f, j, k , n, and o were associated with H, I, and J. Furthermore, i was associated with D and F while genotypes g and h were associated with B and C. The different trait profiles of the genotypes suggest the possibility of developing superior hybrids with broad genetic base from planned selection of parents. The significant correlation between NOR and PDWT can be exploited for simultaneous improvement of the two traits using associated accessions.

Table 1: Mean squares from analysis of variance of 15 okra accessions evaluated for measured traits

SOV	DF	DTF	PHT	STG	NOL	NOB	NOP	PDL	PDW	NOR	PDWT
Block	2	245.000	409.110	2.907	46.200*	2.703	0.047	1482.990**	39.860	0.667	0.001
Accession	14	834.710**	457.320	18.649	7.000	5.270*	0.766	2310.450**	242.560**	14.160**	0.013**
Residual	28	102.360	316.440	15.637	6.945	1.969	0.727	240.490	75.794	1.8599	0.003

*, ** - significant at 5 and 1 % probability respectively; SOV – source of variation; DF – degrees of freedom; DTF – number of days to 50% flowering; PHT – plant height; STG – stem girth; NOL – number of leaves per plant; NOB – number of branches per plant; NOP – number of pods per plant; PDL – pod length; PDW – pod width; NOR – number of ridges per oid; PDWT – pod weight

Table 2: Genetic components of selected traits of okra

Component	DTF	PHT	STG	NOL	NOB	NOP	PDL	PDW	NOR	PDWT
σ^2e	102.357	316.440	15.637	6.945	1.969	0.727	240.488	75.794	1.860	0.003
σ^2g	244.119	46.960	1.004	0.018	1.099	0.013	689.986	55.589	4.099	0.003
σ^2p	346.476	363.400	16.641	6.963	3.068	0.740	930.474	131.383	5.959	0.006
ECV	23.899	44.462	42.466	32.637	57.322	43.641	23.681	39.110	24.790	100.961
GCV	36.908	17.128	10.760	1.680	42.818	5.814	40.111	33.493	36.802	109.696
PCV	43.970	47.647	43.808	32.680	71.548	44.025	46.580	51.491	44.372	149.321
H_B (%)	70.50	12.90	6.00	0.30	35.80	1.70	74.20	42.30	68.80	54.00
GA	27.017	5.075	0.507	0.014	1.292	0.031	46.597	9.991	3.459	0.088
GA as % of mean	63.819	12.684	5.445	0.178	52.785	1.582	71.154	44.880	62.876	165.928

σ^2e, σ^2g and σ^2p – environmental, genotypic and phenotypic variances respectively; ECV, GCV, and PCV – environmental, genotypic and phenotypic coefficients of variation respectively; H_B – broad-sense heritability; GA – genetic advance;

Table 3: Correlation coefficients among paired traits of okra

Trait	PHT	STG	NOL	NOB	NOP	PDL	PDW	NOR	PDWT
Number of days to 5o% flowering (DTF)	-0.271	-0.023	-0.262	0.027	-0.115	0.891**	0.837**	0.889**	0.334
Plant height (PHT)		0.114	0.201	0.014	-0.06	-0.111	-0.22	-0.094	-0.26
Stem girth (STG)			0.071	0.471	-0.375	0.076	0.19	0.029	0.26
Number of leaves per plant (NOL)				-0.099	0.15	-0.168	0.075	-0.006	0.306
Number of branches per plant (NOB)					-0.372	0.206	0.279	0.159	0.307
Number of pods per plant (NOP)						-0.235	0.053	0.032	0.356
Pod length (PDL)							0.770**	0.808**	0.357
Pod width (PDW)								0.902**	0.570*
Number of ridges per pod (NOR)									0.556*

*, ** - significant at 5 and 1% probability respectively

Table 4: Summary of stepwise regression analysis of other measured traits on pod weight of okra

Step	Variable	Estimate	Standard error	Partial R^2	Model R^2	P value
	Intercept	-0.113	0.041	-	-	0.009
1	Number of ridges/pod†	0.015	0.006	0.196	0.196	0.001
2	Number of branches/plant	0.015	0.012	0.059	0.255	0.019
3	Number of pods/plant	0.025	0.004	0.069	0.324	0.048

Prediction equation: $y = 0.015X_1 + 0.015X_2 + 0.025X_3 - 0.113$ where y = pod weight and X_1, X_2 and X_3 = number of ridges per pod, number of branches per plant, and number of pods per plant respectively; † selected in the forward selection.

Key

Genotypes	**Traits**
a - Benue Local	A – Number of days to flowering
b - I2U1	B – Plant height
c - IWO	C – Stem girth
d - MHK199	D – Number of leaves per plant
e - NH47-4	E – Number of branches per plant
f - NH47-45	F – Number of pods per plant
g - NHCaP2/44	G – Pod length
h - NHCaP2/51	H – Pod width
i - NHCaPi145	I – Number of ridges per plant
j - NHIK103	J – Pod weight
k - NHIK177	
l - NHIK7	
m - NHLP3	
n - NHNB-1	
o - NHP68	

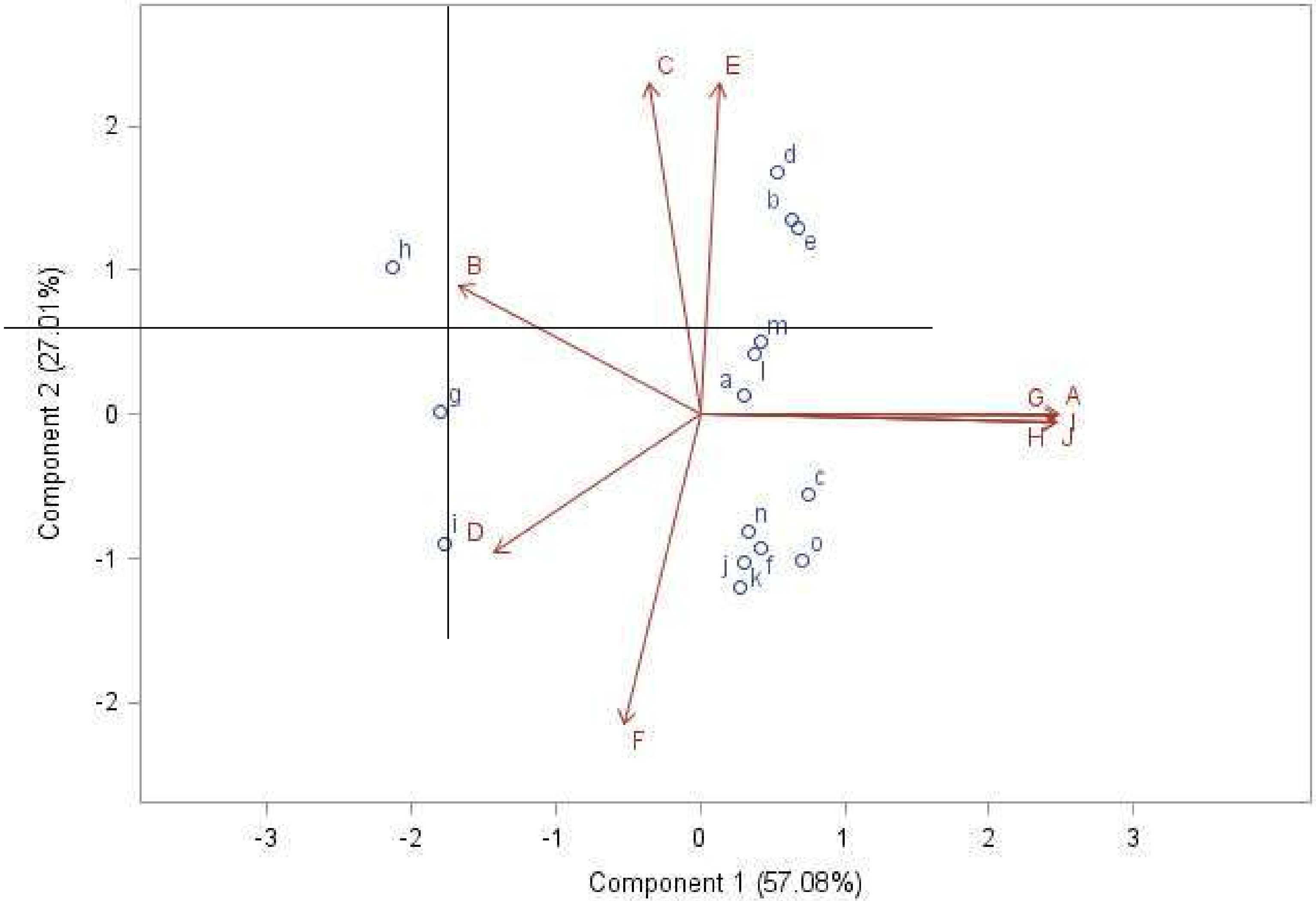

Figure 1: Biplot of the association of okra genotypes with measured traits. A, B, C, D, E, F, G, H, I, and J as well as a, b, c, d, e, f, g, h, i, j, k, l, m, n, and o are defined in the accompanying Key.

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Performance of Maize (*Zea mays* l.) Varieties as Influenced by Nitrogen Rates in Samaru, Zaria

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ABSTRACT
A field trial was conducted during the 2015 rainy season at the Research farm of the Institute for Agricultural Research, Samaru in the Northern Guinea Savanna to determine the performance of maize (Zea mays L.) varieties under varying nitrogen rates. The treatments consisted of two maize varieties (SAMMAZ 16 and OBA 98) and 5 nitrogen rates (0, 30, 60, 90 and 120N kg ha^{-1}) which were laid in a Randomized Complete Block design (RCBD) and replicated three times. Plant height, number of leaves, leaf area index, chlorophyll content, intercepted photosynthetic active radiation and grain yield ha^{-1} were the parameters assessed. The result from this study showed that there was no significant difference between the two varieties used and the application of 60N ha^{-1}produced the highest values of all the parameters taken.
Keywords: chlorophyll content, nitrogen rates, OBA 98, SAMMAZ 16

INTRODUCTION
Maize is a commonly cultivated crop in the savannah zones of Nigeria, as it is an important food for humans, and a source of fodder for animals. The grains are rich in vitamins A, C and E, carbohydrates, and essential minerals, and contain protein. They are also rich in dietary fiber and calories which are a good source of energy (https://www.iita.org/test-maize/). Nitrogen is one of the macronutrients which are required in relatively large quantities for good vegetative and reproductive development in maize. It is a component of protein and nucleic acids and when it is inadequate, growth is reduced (Adediran and Banjoko, 1995). It forms part of many important compounds like chlorophyll and enzymes responsible for many physiological processes in the plant. Nitrogen serves as an intermediary in the utilization of phosphorus, potassium and other elements in plants (Brady and Weil, 2007).

A blanket application of 120kg N ha^{-1} is usually applied in most maize fields in the Northern Guinea Savanna of Nigeria without taking much consideration of the inherent nitrogen content in the soil, variety of the maize used and even the financial capabilities of the farmers; as these small holder farmers have a high opportunity cost for their hard-earned money. Excessive application of nitrogen fertilizers often leads to low nitrogen use efficiency and subsequently, the increased loss of nitrogen through leaching and volatilization with its devasting effect on the ecosystem. This work is geared towards determining of performance of maize (*Zea mays* L.) varieties under varying nitrogen rates in Samaru.

MATERIALS AND METHODS
A field trial was conducted during the rainy season of 2015 at the Research farm of the Institute for Agricultural Research, Samaru (Lat 11^{0}11'N; Long 7^{0}38'E and 686m above sea level) which is located in the Northern Guinea Savannah ecological zone of Nigeria. The treatments consisted of two maize varieties [Open pollinated (SAMMAZ 16) and Hybrid (Oba 98)] and 5

nitrogen rates (0, 30, 60, 90 and 120N kg ha^{-1}). The treatments were laid out in a Randomized Complete Block Design (RCBD) with three replications. The gross and net plot sizes were 36m^2 and 18m^2 respectively. The land was harrowed twice and ridged at a spacing of 75cm and the field was marked out. Seeds were dressed with Apron star at the rate of 10 g sachet per 3 kg of seeds and sown manually at the rates of 2 seeds/hill and intra-row spacing of 25cm. Urea as the source of Nitrogen was applied as per the treatment in two split doses. Weeds were controlled using a pre-emergence herbicide (Atrazine) at the rate of 4l ha^{-1} (2.0 kg a.i ha^{-1}) immediately after planting and hoe-weeding were carried out 3 and 6 weeks thereafter earthing up was carried out. Plant height and number of leaves both at 12 weeks after sowing (WAS), leaf area index, chlorophyll content and intercepted photosynthetic active radiation which were taken at 50% tasseling; and grain yield ha^{-1} were assessed. The data collected were subjected to analysis of variance as described by Snedecor and Cochran (1978). Treatment means were compared using Duncan Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

According to the ratings for soil data interpretation for Savanna areas, the analysis presented in Table 1 shows that the soil at the depth of 0-15cm was loam, moderately acidic with high organic carbon and low total nitrogen. It also had high levels of available phosphorus, calcium, magnesium, sodium and effective cation exchange capacity (ECEC) with medium level of potassium. For the soil at 15-30 cm depth, the soil was also loam, strongly acidic with a low organic carbon, medium available phosphorus and high total nitrogen. Calcium and sodium in this depth was high, with medium levels of magnesium and potassium and high effective cation exchange capacity. The results from Table 2 shows that application of 60N ha^{-1} resulted in the highest values for all the parameters except for the number of leaves, although comparable with 30, 90 and 120N kg ha^{-1} for the leaf area index and; at par with 90 and 120N kg ha^{-1} for intercepted photosynthetic active radiation and grain yield ha^{-1}. The high nitrogen content of the soil at the depth of 15-30 cm could have warranted this, as nitrogen is mobile in the soil solution and must have accumulated in the sub soil. (Agvise Laboratories, 2019). The leaf area index (LAI) is an important parameter in crop growth as it reflects the leafiness of the crop. The leafiness reflects the photosynthetic capability of the crop (Prabhugouda *et al*., 2018) which in turn influences the photosynthetic radiation that is being intercepted by the leaves which further translates into yield. An adequate supply of nitrogen is associated with high photosynthetic activity, vigorous growth, and dark-green plant vegetation (Reading and interpreting a soil test, 2019). There was no significant interaction between the treatment factors.

Table 1: Physical and Chemical properties of soil in the Samaru during the 2015 rainy season

Location	**Samaru**	
Soil Depth(cm)	**0-15cm**	**15-30cm**
Physical Characteristics (g kg^{-1})		
Sand	420	200
Silt	420	360
Clay	160	440
Textural Class	Loam	Loam
Chemical Composition		
pH in H_2O (1:2.5)	5.8	5.5
pH in 0.01 M $CaCl_2$(1:2.5)	5.0	4.7
Organic Carbon (g kg^{-1})	6.1	3.2
Available Phosphorus (mg kg^{-1})	24.51	15.46
Total Nitrogen (g kg^{-1})	1.05	2.45
Exchangeable bases (cmolkg^{-1})		
Ca	7.39	9.72
Mg	1.47	1.57
K	0.19	0.16
Na	0.61	0.69
H+Al	0.80	1.20
ECEC	10.46	13.34

Soil as analyzed in Department of Soil Science Laboratory, Ahmadu Bello University, Zaria.

Table 2: Effect of nitrogen rates on the plant height, number of leaves, leaf area index, chlorophyll content, intercepted photosynthetic active radiation and grain yield ha^{-1} of maize varieties during the 2015 rainy season in Samaru.

TREATMENTS	**PLANT HEIGHT (cm)**	**NUMBER OF LEAVES**	**LEAF AREA INDEX**	**CHLOROPHYLL CONTENT(SPAD)**	**IPAR (μmol m^{-2}s^{-2})**	**GRAIN YIELD HA^{-1} (kg ha^{-1})**
Varieties(V)						
SAMMAZ 16	193.27	13.56	0.93	36.97	0.45	2587.44
OBA 98	188.67	13.33	1.15	36.58	0.50	2830.15
SE±	5.520	0.184	0.127	1.343	0.036	265.849
Nitrogen(N) (kg ha^{-1})						
0	178.80b	13.28	0.64b	26.78b	0.34b	1668.62c
30	180.91b	13.72	0.90ab	36.20a	0.42b	2134.53bc
60	220.36a	13.50	1.45a	42.17a	0.62a	3781.48a
90	191.02b	13.17	1.19ab	39.53a	0.51ab	2903.83abc
120	183.77b	13.56	1.03ab	39.18a	0.45ab	3055.52ab
SE±	8.728	0.290	0.201	2.123	0.057	420.344
Interaction						
V*N	NS	NS	NS	NS	NS	NS

Means followed by the same letters within a treatment group are not significantly different at 0.05 level of probability using DMRT. NS= Not significant.

CONCLUSION

In this study, the application of 60 kg N ha^{-1} increased the vegetative growth and improved the physiological components of the maize which resulted to the highest yield. The nutrient status of the soil should be taken into cognizance especially at the subsoil before the application of nitrogen fertilizer, even if it is a shallow rooted crop to avoid wastage of resources and leaching of excess nitrates into the environment. Either of the two varieties produced comparable yields which will be at the discretion of the farmer to use any of them for production.

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Effect of Light Regime on Callus Initiation in Oil Palm (*Elaeis guineensis* Jacq) Ortet *in vitro*

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ABSTRACT
The use of conventional seed for oil palm (Elaeis guineensis Jacq.) propagation is constrained by dormancy and such palms are known to differ from one another in terms of yield, oil quantity and vegetative characteristics. To overcome these difficulties in vitro techniques have been utilised but resulted in limited success and production cost is found to be higher than the conventional method. The attempt to reduce cost of production necessitated the assessment of the effect of light regime on in vitro explants regeneration. A factorial experiment in completely randomised design, with five replicates was conducted. Immature terminal leaves harvested from eight-year old dura, tenera and pisifera oil palm types cultured in each of three media; Murashige and Skoog (1962) (MS), modified MS and Eeuweens (1976). Each was supplemented with 160 mg l^{-1} Napthalene acetic acid (NAA) or 22 mg l^{-1} 2,4-Dichlorophenoxy acetic acid (2,4-D). Explants were incubated in uninterrupted light or darkness over the culture period in the experiment. Callus initiation from cultured explants were recorded and expressed in percentages. Data were subjected to ANOVA at P = 0.05. Callus initiation occurred in all oil palm types irrespective of light regime. Uninterrupted darkness promoted callus initiation and at higher rate than uninterrupted light. However, over all treatment combinations averaged 7.3 and 9.2% which were not significantly different in light and darkness, respectively. This implied that light is not necessary in callogenesis, resulting in less cost of production. Electrical energy which is usually in high demand is therefore conserved for use in other industrial processes.
Keywords: conserved, constrained, light regime, regeneration, ortet

INTRODUCTION
Oil palms derived from seeds are known to differ from one another in terms of yield, oil quality and vegetative characteristics. It was also speculated that up to 30 % oil yield improvement in tissue cultured palm planting materials over seedling planting materials could be achieved. Consequently, oil palm somatic embryogenesis system was embraced as a short-cut vegetative propagation pathway particularly from the point of view of rapid multiplication of individuals with desirable characters. This motivated extensive explorations in the early attempts at developing tissue culture protocol for the oil palm employing different parts of the palm as explants. An understanding of the physical, hormonal and nutritional requirements of the tissue culture process as well as that of the tissue to be cultured led to the successful plantlet production that was first reported by Jones (1974) and Rabechault and Martin (1976) though the tissue culture technology had since remained generally inefficient, still with a low average callus initiation rate in embryogenesis (Kushairi *et al*, 2010). As a follow up, feasibility study

on the use of *in vitro* propagation of some crops for the production of planting materials has been conducted and the cost of production was found to be much higher than conventional methods (Langyintuo, 1996). In the search for ways to reduce cost of planting material production it becomes necessary to assess the conduct of oil palm tissue culture (Paranjothy and Othman, 1982) by determining the effects of the cultural factors. One key factor in plant tissue culture is light. However, its influence on morphogenetic response of tissues *in vitro* is not very clear. In practice the quantity of it required in the culture of plants varies. Previous works reported morphogenetic responses in plant tissues either in light or in darkness. So far, there is none report on plant responses in both light and darkness. This is the basis for the present investigation.

MATERIALS AND METHOD

Immature leaf explants were harvested from eight-year old dura, tenera and pisifera oil palm types and cultured separately on Murashige and Skoog (1962), modified Murashige and Skoog (1962) and Eeuweens 1976 media amended with two different plant growth regulators, 160 mg l^{-1} Naphthalene acetic acid and 22 mg l^{-1} 2,4-Dichlorophenoxy acetic acid each. Organic supplements (meso-inositol, 0.1 g l^{-1}; thiamine-HCl, 0.005 g l^{-1}; Pyridoxine-HCL, 0.0005 g l^{-1}; nicotinic acid, 0.005 g l^{-1} and adenine sulphate, 0.004 gl^{-1}) were added to each culture medium. The Eeuweens culture medium was supplemented with 45 g l^{-1} sucrose while the MS media were supplemented with 30 g l^{-1} sucrose (Street, 1973). There were control treatments of the three culture media which were without plant growth regulators. A set of treatments was incubated under uninterrupted light while another set was incubated under uninterrupted darkness. The experiment was laid out in a completely randomised design. Renewal of culture media and plant tissue re-culture was done at regular interval of four weeks. Colour change of ortet *in vitro* and also time taken for callus initiation to take place in the cultured explants under the two light regimes was noted. Data on leaf explants callus initiation percentage was calculated thus:

$$\text{Callus initiation (\%)} = \frac{\text{No. of explants forming callus}}{\text{Total no. of explants units cultured}} \times 100$$

The cultured explants were inspected daily while records of observations were taken every two weeks for a period of sixteen weeks. Photographs of the initiated callus and other responses were taken. The data compiled were subjected to analysis of variance (ANOVA) at P = 0.05.

RESULTS AND DISCUSSION

Under uninterrupted light, in culture media supplemented with NAA, callus initiation commenced three weeks after inoculation and stopped after seven weeks. On the other hand, in culture media supplemented with 2,4-D callus initiation commenced five weeks after inoculation of explants in growth media and lasted five weeks. In uninterrupted darkness initiation of callus commenced in media supplemented with NAA, five weeks after inoculation and lasted eight weeks. In media with 2,4-D callus initiation also commenced five weeks after inoculation and stopped after five weeks as in uninterrupted light (plate 1-4).

Callus initiation rate ranged from 1.1% by Dura with 2,4-D in MS in darkness to 31.1% also by dura with NAA in Eeuweens medium, in darkness (Table 1). In culture media supplemented with NAA the highest leaf explants callus initiation rate averaged over oil palm types under uninterrupted light was 18.2 % in Eeuweens medium and 19.3 % in uninterrupted darkness also in Eeuweens medium (table 2). In medium supplemented with 2,4-D, the highest rates were 5.6 % in Eeuweens medium under uninterrupted light and 7.4 % also in Eeuweens medium in uninterrupted darkness (Table 2)

Table 1: Proportion of leaf explants initiating callus among 8 years old oil palm types in three culture media supplemented with optimum concentrations of plant growth regulators, NAA and 2,4-D

		Uninterrupted light		Uninterrupted darkness	
		Plant growth regulator		Plant growth regulator	
Oil palm type	[1]Culture medium	NAA [2](160 mg l^{-1})	2,4-D [2](22 mg l^{-1})	NAA [2](160 mg l^{-1})	2,4-D [2](22 mg l^{-1})
		%			
Dura	MS	14.4	5.6	14.4	1.1
	Mod. MS	25.6	4.4	25.6	4.4
	Ee	30.0	11.1	31.1	12.2
Tenera	MS	4.4	3.3	4.4	3.3
	Mod. MS	17.8	4.4	17.8	4.4
	Ee	17.8	3.3	18.9	5.6
Pisifera	MS	2.2	3.3	4.4	3.3
	Mod MS	3.3	4.4	5.6	5.6
	Ee	6.7	2.2	7.8	4.4

Grand mean: 94 ± 8.4. [1]Ms, Murashige and Skoog (1962); Mod. MS, Modified Murashige and Skoog (1962); Ee, Eeuweens (1976). [2]Values in brackets are the optimal plant growth regulator concentrations.

It is noteworthy that the trends in callus initiation rates were similar in light and darkness. The highest values of 18.2 % and 19.3 % in light and darkness, respectively were both obtained in Eeuweens culture medium supplemented with 160 mg l^{-1} NAA. Also averaged over culture media the callusing rates of 13.6 % and 14.4 % with NAA in light and darkness, respectively were not significantly different (P= 0.05). Likewise, the 4.4 % and 4.9 % callusing rates in light and darkness, respectively in media supplemented with 2,4-D (Table 3).

Table 2: Effects of culture medium and plant growth regulators on callusing rate among leaf explants averaged over 8 years old palm types in uninterrupted light and uninterrupted darkness

	Uninterrupted light		Uninterrupted darkness	
	Plant growth regulator		Plant growth regulator	
[1]Culture medium	NAA [2](160 mg l^{-1})	2,4-D [2](22 mg l^{-1})	NAA [2](160 mg l^{-1})	2,4-D [2](22 mg l^{-1})
	%			
MS	7.0	4.1	7.8	2.6
Mod. MS	15.6	4.4	16.3	4.8
Ee	18.2	5.6	19.3	7.4
LSD (0.05)	9.9	ns	11.2	4.0
[3]mean	13.6 a	4.7 b	14.5 a	4.9 b
C.V.	99.1	111.7	104.9	110.9

[1] MS, Murashige and Skoog (1962); Mod. MS, Modified Murashige and Skoog (1962) ; Ee, Eeuweens (1976).
[2] Values in brackets are the optimal plant growth regulator concentrations.
[3]Means in the row with the same letter are not significantly different (p = 0.05).
NAA = Naphthalene acetic acid, 2,4-D = 2,4-Dichlorophenoxy acetic acid.
C V, Coefficient of variation.

Table 3: Oil palm leaf explants initiation of callus with plant growth regulators (NAA and 2,4-D) as media supplements averaged over 8 years old oil palm types and culture media in uninterrupted light and darkness.

[1]Plant growth regulator	Leaf explants initiation of callus		Mean
	Uninterrupted light	Uninterrupted darkness	
	%		
NAA	13.6	14.4	14.0
2,4-D	4.7	4.9	4.8
LSD (0.05)	4.5	5.0	4.4
+Mean	9.2	9.7	

+ mean values in the row are not significantly different (P=0.05). [1]Naphthalene acetic acid (NAA), 2,4-Dichlorophenoxy acetic acid (2,4-D)

CONCLUSION

Callus initiation was possible under both light and darkness. Callus initiation under uninterrupted darkness occurred earlier than under uninterrupted light i.e. three to four weeks in darkness as against five to six weeks in light. Also more calli were formed in the dark than in light. The study revealed that callus initiation was possible in both light and darkness at rates not significantly different (7.7 % and 9.7 % in light and darkness, respectively) (P = 0.05).

Sogeke (1998) reported that light was an essential factor for initiation of callus in oil palm. On the other hand, Pinto-Sintra (2007) reported production of Portuguese grape (*vitis vinifera)* callus in darkness. Tarmizi *et al.* (2004) reported 12-hour photo period for callus initiation unlike in this study where both uninterrupted light and uninterrupted darkness were considered. These contrasting results reflect the fact that each of the studies only considered either light or darkness. However, taken together, they showed that callus initiation is possible in both light regimes. The process of callus initiation is independent of light energy supply and its absence does not limit callus initiation in oil palm in the present study. Rather it promoted callus initiation and at higher rate than uninterrupted light thereby creating for a reduction in the cost of production as less expenses will be incurred as electrical energy bill and the conserved energy as a result will be useful for other industrial processes.

Plate 1. Freshly inoculated immature oil palm leaf explants in nutrient medium

Plate 2. Callus initiated in chlorotic oil palm leaf incubation under

Plate 3. Oil palm leaf explants initiated callus after four weeks incubation under uninterrupted light

Plate 4. Embryonic calli (white coloured) initiated from oil palm leaf in four to five weeks of uninterrupted darkness

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Local Rice Granger Causality Test and Structural Breaks in Benue State, Nigeria (1980 – 2016)

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INTRODUCTION

Rice accounts for 715 kcal, 27% of nutritional supply of energy, 20% of nutritional protein and 3% of nutritional fat in most countries of Africa (*Kassali et al., 2010*). Local Rice is the fifth most prominent source of energy in diet for human race, responsible for about 9% of caloric intake (Food and Agriculture Organization, 2012). It is also a source of raw materials for industries and provides employment for the teeming Nigerian population from the point of production, processing, wholesales and retails (Marlia *et al., 2011*; Ayinbo 2014; Qisty*, et al* 2016). Local Rice account for about 75% of food consume during festivals and ceremonies like *Idil kabir*, charismas and marriage of different kinds in Nigeria (Ajijiola *et al*., 2012). Due to increasing contribution of local Rice to per capita caloric consumption of Nigerians, its demand has been increasing at a much faster rate than domestic production (Diako *et al., 2010*; Godwin. 2015) and CARD, 20150).

This position was also corroborated by the United States Department of Agriculture (USDA, 2012) and the Federal Ministry of Agriculture and Rural Development; (FMARD, 2016). USDA, 2012) also noted that milled local Rice utilization increased over the years, from 240 metric tonnes 1960 to 4,970 metric tonnes in 2011. Similarly, total demand for local Rice and allied products is projected to rise to 7.2 million tonnes by 2018 and production will be 3.7 million tonnes (Samuel. 2016; Bamba, *et al* 2010).

MATERIALS AND METHODS

The secondary data of local rice produced in Benue State from 1980 – 2016 were collected. The ADF was used to test for the stationarity of the data. The granger causality test was used to examine all the variables. The structural break points were also observed using grapy**.**

Stationary test on local Rice supply variables in Benue State

Local Rice supply variables in Benue State were also subjected to stationarity test using ADF. The lags of production, fertilizer and rainfall were stationary at level. Area and yield were not stationary at level but differenced and stationary at first difference. The Table 1 shows that only price was stationary at second difference.

Table 1. Stationarity test for yearly Rice production variables in Benue State(1980 –2016)

Variables	Observation	Lags	ADFvalues	t- statistics (Critical value)	Order	P – value
Production	36	0	4.240	4.240 (2.969)**	1(0)	0.0006
Area	36	0	4.064	4.064 (2.969)**	1(1)	0.0011
Yield	36	0	6.264	6.264 (2.617)***	1(1)	0.0000
Price	36	0	11.843	11.843 (2.969)***	1(2)	0.0000
Fertilizer	36	0	4.805	4.805 (2.617)***	1(0)	0.0001
Rain	36	0	3,903	3.903 (2.617)**	1(0)	0.0020

Source: Study result output, 2017. *** Significance at 1% and ** Significant at 5%. Lag length were selected based on AIC. Argumented Dickey Fuller analysis carried out in stata version 11.0.

Granger causality test result for Benue State

The causality results are inferred from the Chi^2 and $Pro\text{-}chi^2$ shown in Table 2 Considering the Granger causality test result in the Table 2, production, area, yield and rain equations were statistically significant at 1% and were said to have granger caused local Rice production in Benue State. The price and fertilizer were not significant but overall total contribution was statistically significant at 1% level. This means that all the variables jointly Granger caused Local Rice Production in Benue State from 1980 – 2016.

Therefore, the null hypothesis that all the lag co efficient of production equation was zero was not accepted.

The result from the Table 2 shows that the lags co-efficient of area, yield, rain and fertilizer were statistically significant at 1% and 10% level, only price was not statistically significant. The joint contribution of all lag variables was also statistically significant at 1% level. This means that lags of area equation Granger caused local Rice production in Benue State. The null hypothesis that lags co efficient of area equation were zero was rejected.

Table 2 further reveals that lags co-efficient of yield equation were all statistically significant at 1% level. The lags co efficient were all said to have Granger caused local Rice production in Benue State. The null hypothesis that lags co efficient of yield were zero was rejected. All the lags co efficient of yield equation Granger caused local Rice production in Benue State. The Table 2 further indicated that in price equation production, area, fertilizer and rain were all statistically significant at 1% level and were said to have Granger caused local Rice production. The statistically non-significant lag co efficient was yield. All the lags co-efficient of price equation Granger caused local Rice production and was statistically significant at 1% level. The null hypothesis that lags co efficient of price were zero was not accepted.

Table 2: Granger causality test result of Benue State

Equation	Excluded	Chi²	pro> Chi²
Production	Area	88.324***	0.000
Production	Yield	216.24***	0.000
Production	Price	1.543	0.819
Production	Fertilizer	4.937	0.290
Production	Rain	64.639***	0.000
Production	All	361.61***	0.000
Area	Production	100.05***	0.000
Area	Yield	121.48***	0.000
Area	Price	1.9369	0.747
Area	Fertilizer	8.1803*	0.085
Area	Rain	82.049***	0.000
Area	All	348.89***	0.000
Yield	Production	47.805***	0.000
Yield	Area	25.596***	0.000
Yield	Price	27.184***	0.000
Yield	Fertilizer	40.255***	0.000
Yield	Rain	18.601***	0.001
Yield	All	288.63***	0.000
Price	Production	28.527***	0.000
Price	Area	25.794***	0.000
Price	Yield	3.7999	0.434
Price	Fertilizer	107.72***	0.000
Price	Rain	15.672**	0.003
Price	All	433.18***	0.000
Fertilizer	Production	2,9217	0.571
Fertilizer	Area	5.9070	0.206
Fertilizer	Yield	4.2635	0.372
Fertilizer	Price	0.85578	0.931
Fertilizer	Rain	17.755**	0.001
Fertilizer	All	65.512***	0.000
Rain	Production	12.857**	0.012
Rain	Area	8.8694*	0.064
Rain	Yield	7.8169*	0.099
Rain	Price	12.1**	0.017
Rain	Fertilizer	10.324**	0.035
Rain	All	44,689**	0.001

*** Significance at 1%, ** Significant at 5% and * Significant at 10%
Source: Study result output, 2017

From the result it was inferred that all the lags do Granger caused local rice production. The rain and joint contribution of all lags variable co efficient in fertilizer equation were statistically significant at 1% level. This means that fertilizer also Granger caused local Rice production in Benue State. Above all, rain equation lags co efficient was statistically significant at 5% and10% level. All the co efficient Granger caused local Rice production in Benue State. The joint contribution of all lags co efficient in rain equation was statistically significant at 1% level. This is an indication that rain strongly Granger caused local Rice supply in Benue State.

Local rice supply structural break points in Benue State data series

Structural break point in data series is sudden shift in the time series data. This could be increase due to implementation of policies to boost production. There may be also fall in production due to disasters like drought, flood pest and dieses attack In Benue State data of Rice production 1980-2016, structural break points were indicated. Structural break has its null hypothesis as; H0. There is no structural break in the data series. Using ADF to identify these breaks. When the p-value of ADF is less than 5% critical value, it means the series has breaks. In this data series the ADF p-value is 0.06373. Therefore, the alternative hypothesis was accepted, and concluded the series has structural breaks as detailed in the figure 1 below

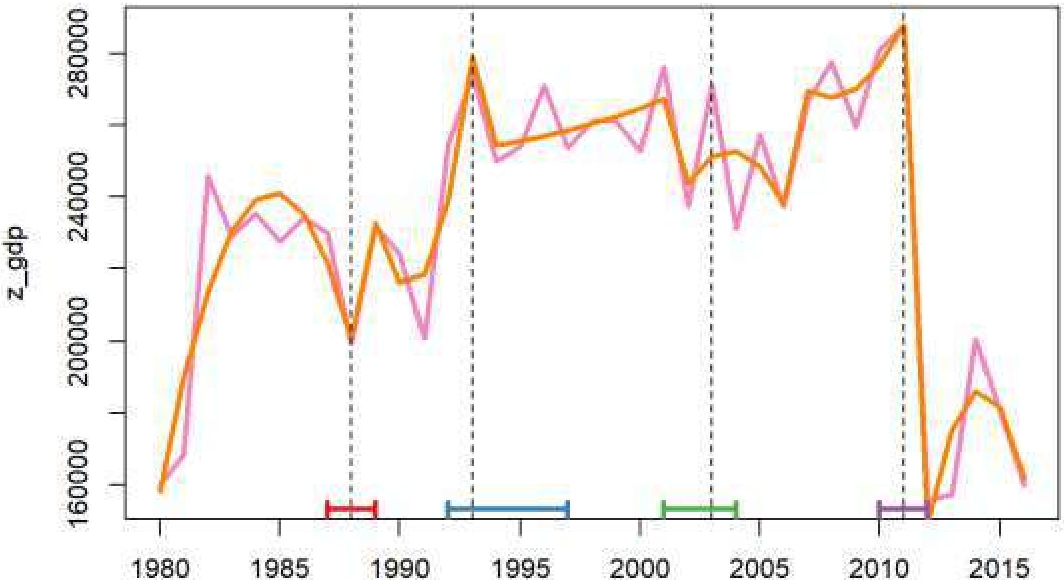

Figure 1: Structural break points in Benue State 1980-2016. Source: Benue Agricultural and Rural Development Authority (BNARDA)

The structural breaks in Benue State in 1987 may be due to flood that washed away the Rice farms. This was as a result of heavy rainfall that washed away the planting materials, and displaced many farmers away from their homes. The production started increasing may be as a result of introduction of Agricultural policies that boosted the local Rice production in 1993-1994. In 2003 there was heavy flood that washed away lands which affected rice production. The scenario of flood continued to repeat itself covering 2004. Now the production has improved with the introduction of dry season farming through Agricultural transformation agenda, Anchor borrowers' program.

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Evaluation of Organomineral Fertilizer Application Rate for Optimum Yield in Maize/Soybean Intercrop

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ABSTRACT

Field experiment was conducted at National Cereals Research Institute Badeggi, Niger State Nigeria to Evaluate the rate of organomineral fertilizer application for optimum yield in maize/soybean intercrop. The treatments consisted of one mineral fertilizer source (NPK 60:30:30) and five organomineral application rates: 200, 400, 600, 800, 1000kg/ha organomineral manure. There was a control experiment without any treatment. The Experiment was laid out in a Randomised Complete Block Design. Data such as plant height, leaf length, leaf breadth and plant vigour were collected at 3rd, 6th and 9th weeks after planting. Yield records were taken at harvest. Data collected were subjected to analysis using ANOVA. Results obtained from this experiment indicated that organomineral manure significantly influenced plant height, leaf length, number of leaves as well as yield of maize. It enhanced the plant height of soybeans. Organomineral applied at the rates of 800 and 1000kg/ha positively increased growth and tield parameters of intercropped maize and soybeans over above NPK fertilizer. I recommend the use of organomineral manure at the rates of 800 and 1000kg/ha for farmers growing maize and soybeans in the southern Guinea Savannah region of the country.

INTRODUCTION

Organomineral fertilizer is a lowinput technology of improving the poor nutritional status of tropical soils for sustainable crop production. It is a low input technology that can boost economic development since the money that would otherwise be spent on mineral fertilizer will be saved while other agricultural waste will be utilized as manure to enhance agricultural productivity. It combines the good attributes of both sources to enhance yield. In most tropical farming communities, the use of inorganic fertilizers to boost yield of crops cannot be under-estimated as they have been found to increase crop performance as well as the chemical properties of soils (Ojeniyi, 2000). However, the problem associated with the continuous use of chemical fertilizer is that while it can lead to high crop yield; it may cause pollution of ground water after crop harvest (Gordon *et al*. 1993), and have adverse effect/s on plant quality. Continuous dependence on chemical fertilizers may be accompanied by a decline in soil organic matter content, increased soil acidity, degradation of soil physical properties and increased rate of erosion due to instability of soil aggregates (Adeoluwa and Adeogun, 2010). Meanwhile, crop production across the ages depended mainly on organic manures such as poultry droppings, cattle dung, farm yard manure and pig manure. Organic wastes are cheap, readily available and more environmentally friendly than fertilizers. They constitute a cheap way of improving soil fertility by maintaining its organic matter. Research has shown that organic based fertilizers are less leached into ground water than the chemical fertilizer (Sridhar and Adeoye, 2003). They are however, associated with problems relating to inadequate availability, low quality, depending on the type, transportation and handling problems, high C:N ratio, heavy metal pollution and slow nutrient release (Ayeni L. S., 2008).

The single use of either organic or inorganic fertilizers in recent years have not really met the expected impact in boosting crop yield to cope with the ever increasing demand, hence, integrated nutrient supply have been advocated by the Food and Agricultural Organization of the United Nation (Olowokere, 2004). In view of this, the combined use of chemical fertilizers and inorganic manures (organomineral fertilizer) has been suggested (FAO, 2003). Other researchers such as Akanbi et al., (2005) and Olaniyi *et al.*, (2005) reported low response when sole NPK was used on okra and maize crops respectively.

In many parts of the World, emphasizes are greatly shifting from the single use of either organic or inorganic fertilizers to combined use. Now that Nigeria is facing the greatest challenges of food insecurity resulting from life insecurity and banditry activities coupled with the fast declining productivity of our soils, it becomes imperative that the combined use of organic and inorganic fertilizers (organomineral fertilizer) be encouraged and introduced to our numerous farmers in order to achieve their yield expectancy and maximum benefit associated with its introduction. Current researches on organomineral fertilizer have shown better yield performances than the single use of either of the two (Ojeniyi *et al.*, 2010). Studies by Ojeniyi *et al*. (2010) recorded positive responses of maize and pepper to organomineral fertilizers. Makinde *et al.,* (2010) recorded that the use of organomineral fertilizer enhanced better growth in *Amaranthus cruentus*.

There is presently no information on the rate of organomineral fertilizer required for optimum yield of maize/soybeans intercrop in the southern guinea savanna. Intercropping is major practice among farmers in that part of the country, thus the necessity for this experiment.

MATERIALS AND METHODS

The study was conducted on station at NCRI experimental field. Organomineral and mineral Fertilizer (60:30:30) were used for the trial. The Experiment was laid out in a Randomised Complete Block Design (RCBD) with three replications. Plot size was 4m x 3m with inter-row spacing 1m x 1m inter and within rows, for maize, while soybean was drilled at 0.005X1m on ridge crest in between the stands of maize, one Week After Planting maize. Both organomineral and mineral fertilizer were applied two weeks after planting soybean. The trial consisted of one treatment of mineral fertilizer rate 60:30:30 and five organomineral application rates: 0, 200, 400, 600, 800, 1000kg/ha organomineral manure. There was a control experiment without any treatment. All agronomic practices such as weeding, thinning and pest control were carried out appropriately. The treatment fertilizers were applied as split applications. Data were taken on plant height, leaf length, leaf breadth, plant vigour, days to 50% tasselling, days to 50% silking, days to 50% flowering, days to 50% podding, cob length, number of cob per plot, weight of 1000 seeds and grain yield. Data was collected from the field on three weekly basis. Composite soil sample was obtained before planting and application of Organo-mineral Fertilizer (OMF). The composite soil sample and organomineral were subjected to chemical and physical analysis. All data were subjected to statistical analysis using ANOVA.

RESULTS AND DISCUSSION

Results from table 2 indicated that treatment with organomineral up to 1000kg/h had significant impact on vegetative growth of maize in maize/soybean intercrop. Maize crops treated with organominerals at the rate of 1000kg/ha significantly enhanced plant height (141.9cm), leaf length (60.7cm) and number of leaves (11.67). Plants treated with sole NPK showed lower responses in plant height (133.6cm), leaf breadth (7.12cm) and some other parameters compared with all organomineral treatments. This is in agreement with the response patterns reported by Akanbi *et al.,* (2005) on okra and Olaniyi et al., (2005) on maize. Compared with other treatments, plants treated with 1000kg organomineral were highest in days to 50% tasselling (50 days) and plant vigour (65.3%). Plants under control treatment had the laest values in virtually all the data analysed, because of the low supply of nutrients from the soil as advanced by Adeoluwa and Adeogun (2010). Treatment with 800 kg/ha organomineral gave best performance in leaf breadth (8.17cm) and number of days to 50% silking (52 days). This result is in line with Makinde *et al*. (2010) in their work on *Amaranthus cruentus,* where the vegetative growth of maize was greatly influenced by organomineral. Almost all other parameters gradually raised with increase in quantity of organomineral. Yield performance of maize (table 3) indicated that application of organomineral fertilizer at the rate of 1000kg/ha very significantly influenced yield (1555.5kg) and weight of 1000 seeds (0.31kg). The same positive trend applied to 81 days obtained in days to maturity. These values are greater than the 916.7 and 0.26 obtained respectively when single fertilizer was applied. This could be as a result of integrated nutrient supply as advanced by FAO (2003) and Olowokere, (2004) relating to the use of organominerals.

Application of organomineral manure to the level of 1000kg/ha impacted significantly on Number of Branches of soybean (27.67) and Days to 50% podding (60 days) in maize/soybean intercrop. Values obtained for Plant height (84.6cm) and Days to maturity (94) of soybeans in (table 4) were best on plants treated with 1000kg/hac organomineral. Organomineral at the rate of 600kg/ha resulted to longest leaf length (14.5cm) in soybean, while its application at 800kg/ha influenced the best number of days to 50% flowering (44 days). Meanwhile values obtained across all the treatments gradually increased with increase in quantity of organomineral supplied. Soyabean plants under the control treatment demonstrated lowest performance across all the parameters (table 3). Treatment with 1000kg/ha organomunera significantly surpass that NPK.

These results are similar to the finding of Brown et al. (1995), who reported that the growth of okra plant was markedly influenced by the application of organomineral, NPK fertilizer and their combination as observed from the increased plant height and number of leaves compared to the control.

CONCLUSION

Compared with NPK fertilizer, organomineral significantly increased plant height, leaf length and number of leaves, in maize/soybean intercrop. It positively influenced maize yield and weight of 1000 seeds. Application of organomineral at the rate of 1000kg/ha enhanced plant height in soybeans and number of days to 50% podding. Organomineral manure at the rate of 800 and 1000kg/ha resulted to increase, in yield and growth parameters of maize and soybeans when they were intercropped. From this trial, organomineral manure at the rates of 800 and 1000kg/ha will be recommended for farmers growing maize and soybeans in the southern Guinea Savannah region of the country. The experiment shows that organomineral can be used conviniently to replace NPK fertilizer in maize soybeans intercrop, thereby enhancing productivity as little capital will be expensed to cultivate vast farm area. This will in turn aid in unlocking the potentials of agricultural value designed towards achieving sustainable economic development in nigeria.

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Table 1. Chemical composition of the organo-mineral fertilizer

Parameters	Ph	Ash (%)	Organic Matter (%)	Carbon (%)	N (%)	P (%)	K (%)	Na (%)	Ca (%)	Mg (%)
Values	7.08	41.68	58.31	15.95	2.75	2.52	0.82	0.68	0.55	0.36

Table2. Vegetative performance of maize, in maize/soybeans intercrop under organomineral fertilizer

Treatments	Plant height (cm)	Leaf length (cm)	Leaf breadth (cm)	Number of leaves	Days to 50% tasselling	Days to 50% silking	Plant vigour (%)
NPK (0kg) Organo (0 kg)	131.5	52.1	7.08	9.67	56.0	60	59.7
NPK	133.6	57.8	7.12	10.33	54.0	59	60.3
Organo (200kg)	137.5	56.3	7.37	10.00	51.0	57	62.7
Organo (400kg)	139.7	54.0	7.89	10.00	52.0	55	61.3
Organo (600kg)	136.7	58.3	7.46	10.33	52.0	53	61.3
Organo (800kg)	140.3	57.4	8.17	10.00	51.0	52	63.0
Organo (1000kg)	141.9	60.7	7.93	11.67	50	53	65.3
LSD 5%	0.03	0.01	NS	0.002	NS	NS	NS
CV	2.5	4.1	7.1	4.1	7.5	8.8	3.2

Table3. Yield performance of maize, in maize/soybeans intercrop under organomineral fertilizer

Treatments	Grain wt kg/ha	Weight of straw/plot (kg)	Weight of 1000 seed (kg)	Days to maturity
NPK (0kg) Organo (0 kg)	611.1	0.83	0.22	87
NPK	916.7	1.27	0.26	83
Organo (200kg)	805.6	1.33	0.24	84
Organo (400kg)	888.8	1.67	0.28	82
Organo (600kg)	1166.6	1.17	0.24	83
Organo (800kg)	1083.3	2.20	0.27	82
Organo (1000kg)	1555.5	1.23	0.31	81
LSD 5%	0.01	NS	0.01	NS
CV	25.9	51.8	9.7	4.0

Table 4. Performance of soybeans, in maize/soybeans intercrop under organomineral fertilizer

Treatments	Plant height (cm)	Leaf length (cm)	Number of branches	Days to 50% flowering	Days to 50% podding	Days to maturity
NPK (0kg) Organo (0 kg)	70.2	11.9	15.0	49.00	71	99
NPK	78.1	14.2	21.0	47	64	96
Organo (200kg)	77.3	12.9	22.67	46	65	96
Organo (400kg)	78.7	12.5	16.67	45	63	96
Organo (600kg)	80.2	14.5	24.67	46	62	95
Organo (800kg)	74.3	14.2	18.33	44	63	95
Organo (1000kg)	84.6	13.1	27.67	45	60	94
LSD 5%	NS	NS	0.04	NS	0.02	NS
CV	7.7	9.4	21.0	4.6	4.8	4.0

Effect of Legume Inoculant and Biochar on the Growth, Nodulation and Yield of Soybean (*Glycine max*. L. Merrill)

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ABSTRACT
The experiments were conducted at the Teaching and Research Farm, Faculty of Agriculture, Shabu –Lafia Campus of Nasarawa State University, Keffi, during 2018 and 2019 cropping seasons to examine the effects of Legume Inoculant and Biochar on the growth, nodulation and yields of Soybean. The experiments were laid in Randomized Complete Block Design (RCBD). Biochar at the rates of 0, 4, 8 and12 tons/ha was incorporated into the ridges before the Soybean seeds were planted as uninoculated (without legume inoculant) and inoculated (coated with legume inoculant) respectively. All data collected were subjected to analysis of variance (ANOVA) using GENSTAT Statistical Package while least significant different (LSD) was used to separate treatment means at 5% probability. The results revealed that inoculated plots recorded significantly (P<0.05) taller soybean plant, higher number of branches, nodules number per plant and grain yields (kg/ha) against uninoculated plots. The results also showed that biochar at the rate of 8 tons/ha produced significantly (P<0.05) tallest soybean plant, highest number of branches, nodules number per plant and grain yields (kg/ha) compared to other rates of biochar applied while the highest dose of biochar (12 tons/ha) applied did not necessarily influenced and increased Soybean growth and yield. Legume inoculant and biochar at the rate of 8 tons/ha is therefore recommended for sustainable Soybean in the study area.
Keywords: Biochar, growth, inoculant, soybean, yield

INTRODUCTION
Seed inoculation is the practice of covering (coating) the seed surface with a nitrogen Fixing bacteria (Rhizobium or Brady rhizobium) prior to planting. This farm practice is characteristically done for legume such as soybeans, beans, groundnuts etc. Most soils do not or contain few bacteria (rhizobial) hence the need to inoculate legume seeds with appropriate strains of bacteria prior to planting becomes necessary (Peace, 2017). Seed inoculation improves biological nitrogen fixation in Legumes (Folnovic, 2019). Inoculation of soybean seeds with appropriate strains of rhizobia improves Soybean growth, nodulation and yields (Abbasi *et al.,* 2008 and Kubota *et al.,* 2008).

Biochar is a heterogeneous and chemically complex materials made by heating biomass under the exclusion of air (Pyrolysis) (Wilson, 2014a, Wang *et al.,* 2016). It is one of the oldest soil amendments in the history of agriculture (Wilson, 2014b). Biochar incorporated into the soils to improves soil fertility, increases soil water holding capacity, improves soil aeration, releases plant nutrients and raises soil pH value (Schemidt and Wilson, 2014).

Soybean (*Glycine Max*. L. Merill) is a species of legume, widely grown for its edible bean which has numerous uses. It is an excellent source of dietary fibre, vitamins and minerals. Soybean is the only available crop that provides an inexpensive and high quality source of protein comparable to meat, poultry and eggs (Manral and Sexana, 2003).

There is increase in demand of Soybean as it is being made into various traditional food products such as soy- cake, soy- milk, soy- soup, etc in Lafia by local populace but the use of legume inoculant and biochar to improve poor soil for the cultivation of the crop have not receive much attention in the study area. Hence the need for this study to encourage local farmers to increase the production of the crop to meet the increasing demands. Therefore, the aim of this study is to find the effects of legume inoculant and biochar on the growth, nodulation and yield of Soybean in Lafia, southern Guinea savanna of Nigeria.

MATERIALS AND METHODS

The experiments were conducted at the Teaching and Research Farm, Faculty of Agriculture, Shabu-Lafia Campus of Nasarawa State University, Keffi, during 2018 and 2019 cropping seasons. The experiments were laid in Randomized Complete Block Design (RCBD). Biochar at the rates of 0, 4, 8 and 12 tons/ha was incorporated into the ridges before planting the seeds. The soybean seeds were planted as uninoculated (without legume inoculant) and inoculated (coated with legume inoculant) respectively on four (4) ridges of 2 m long spaced at about 75 cm, made manually using local hoes. Four (4) seeds were planted per hole at a recommended planting spacing of 5 cm between plants. The seedlings were thinned to two plants at two weeks after planting (WAP). The following parameters were measured: plant height, numbers of branches and nodules per plant and seed (grain) yield kg/ha. All data collected were subjected to analysis of variance (ANOVA) using GENSTAT statistical package while least significant different (LSD) was used to separate treatment means at 5 % probability.

RESULTS AND DISCUSSION

The result showed that plots treated with legume inoculant had significantly ($P<0.05$) taller plants than the plots without legume inoculant across all sampling periods in 2018 and 2019 cropping seasons respectively (Table 1). The result of the effect of various rates of biochar on soybean plant height (cm) indicated that, at all sampling periods, in both cropping years, biochar at the rate of 8 tons/ha produced significantly ($P<0.05$) the tallest soybean plant over the other rates of biochar applied. The result further revealed that the highest dose of biochar did not increase height of soybean plant in both cropping years. This results is in line with the findings of Kubota *et al.* (2008) and Diep *et al.* (2002) reported that inoculation of soybean seeds increased its growth.

Table 1: Effect of Legume Inoculant and Biochar on Plant Height (cm) of soybean at 4, 6, 8, 10 and 12 (WAP) during 2018 and 2019 Cropping Seasons

		2018 WAS					2019 WAS			
TREATMENT	4	6	8	10	12	4	6	8	10	12
Inoculant										
Uninoculated	15.0b	24.3b	38.8b	43.7b	45.3b	16.0b	25.1b	40.2b	44.9b	45.0b
Inoculated	15.7a	26.2a	40.3a	47.6a	49.3a	17.8a	36.5a	42.1a	49.9a	50.2a
LSD	0.08	0.09	0.10	0.09	0.09	0.11	0.23	0.15	0.17	0.22
Biochar (tons/ha)										
0	14.9b	24.2c	38.9c	44.1c	45.9c	15.5c	21.6d	39.9c	46.1c	46.5b
4	16.0a	26.2b	40.0b	46.6b	48.2b	17.6b	27.9b	42.1b	48.1b	49.2a
8	15.9a	26.4a	40.4a	48.0a	48.9a	19.1a	28.9a	42.7a	49.2a	49.2a
12	14.6b	24.2a	38.8c	43.8d	46.0c	15.3d	24.9c	40.0c	46.0c	46.0c
LSD	0.11	0.12	0.14	0.12	0.13	0.16	0.75	0.22	0.12	0.15
Interaction										
I × B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Values with the same letter within a column are not significant at 5% probability.
NS = Not significant.

In 2018, at 4, 8, 10 and 12 WAP, plots treated with legume inoculant produced significantly (P<0.05) more number of branches per soybean plant compared to uninoculated plots. At 6 WAP in 2018 and at 4 and 6 WAP in 2019 cropping years, there was no significant difference in the number of branches per plant respectively (Table 2). However, in 2019, at 8, 10 and 12 WAP, plots treated with legume inoculant recorded significantly (P<0.05) higher number of branches per plant than uninoculanted plots. In both cropping seasons, at 4 WAP, application of biochar did not significantly (P<0.05) enhanced number of branches per soybean plant while, at 6, 8, 10 and 12 WAP, biochar at the rate of 8 tons/ha produced significantly (P<0.05) highest number of branches per soybean plant against other levels of biochar applied. This results is in line with the findings of Kubota *et al.* (2008) and Diep *et al.* (2002) reported that inoculation of soybean seeds increased its growth.

Table 2: Effect of Legume Inoculant and Biochar on Number of Branches of soybean at 4, 6, 8, 10 and 12 (WAP) during 2018 and 2019 Cropping Seasons

		2018 WAS					2019 WAS			
TREATMENT	4	6	8	10	12	4	6	8	10	12
Inoculant										
Uninoculated	2.3b	2.8a	3.2b	3.9b	4.0b	2.1a	2.5a	3.1b	3.8b	3.9b
Inoculated	2.5a	3.3a	3.4a	4.1a	4.1a	2.1a	2.7a	3.5a	4.2a	4.3a
LSD	0.06	0.68	0.12	0.06	0.06	0.13	0.25	0.21	0.24	0.26
Biochar (tons/ha)										
0	2.2a	2.6c	3.0c	3.8c	3.8c	2.1a	2.6c	3.1c	3.7b	3.7c
4	2.4a	3.2b	3.4b	4.4b	4.4b	2.1a	2.8b	3.7b	4.0b	4.1b
8	2.4a	3.8a	4.5a	4.5a	4.5a	2.3a	3.7a	4.0a	4.4a	4.5a
12	2.3a	2.0d	2.9c	3.3d	3.5d	2.1a	2.3d	3.0c	3.7b	3.9c
LSD	0.22	0.38	0.18	0.08	0.08	0.20	0.06	0.21	0.24	0.27
Interaction										
I × B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Values with the same letter within a column are not significant at 5% probability.
NS = Not significant.

The result indicated that the plots treated with legume inoculant produced significantly (P<0.05) more number of nodules per soybean plant than uninoculated plots in both cropping seasons (Table 3). This results is in agreement with the findings of Senevirante *et al.* (2000) who reported that nodulation of soybean was significantly enhanced as a result of inoculation of soybean seed with rhizobia. The result also showed that biochar at the rate of 8 tons/ha produced significantly (P<0.05) highest number of nodules per soybean plant than against other rates of biochar applied in 2018 and 2019 cropping seasons respectively. However highest dose of biochar applied (12 tons/ha) did not significantly increased number of nodules per plant in both cropping seasons. This results is in line with the findings of Mete *et al. (2015)* who reported that nodulation increased with the increase in application of biochar. Bayan (2013) who reported that biochar at 2% in pot experiment significantly enhanced soybean plant growth and increased nodule formation by 35% over the control and 5%.

Table 3: Effect of Legume Inoculant and Biochar on Number of Nodules of soybean during 2018 and 2019 Cropping Seasons

TREATMENT	2018	2019
Inoculant		
Uninoculated	14.0b	12.1b
Inoculated	20.5a	15.9a
LSD	0.27	0.23
Biochar (tons/ha)		
0	12.7d	11.2d
4	17.5c	15.3b
8	20.8a	16.4a
12	18.1b	13.0c
LSD	0.08	0.33
Interaction		
I × B	NS	NS

Values with the same letter within a column are not significant at 5% probability.
NS = Not significant.

Table 4 below shows the result of the effect of legume inoculant and biochar on seed (grain)yield (kg/ha) of soybean during 2018 and 2019 cropping seasons. The result showed that, in both cropping seasons, inoculated plots produced significantly (P<0.05) higher seed (grain) yield/ ha of soybean compared to uninoculated plots. Similar trend of results was reported by Mathenge *et al.* (2019) that inoculated plots produced significantly (P<0.05) higher seed(grain) yield/ ha of soybean compared to uninoculated plots. The result also indicated that application of biochar at the rate of 8 tons/ha recorded significantly (P<0.05) the highest seed (grain) yield ha of soybean against other rates of biochar applied in both cropping seasons. This results is in line with the work of Mete *et al. (2015) who* reported that seed (grain) yield of soybean increased on average by 67% as a result of application of biochar compared to the control. The positive response of soybean to inoculation revealed that the introduced Rhizobia had more competitive ability than the indigenous Rhizobia bacteria in the soil of the study area.

Table 4: Effect of Legume Inoculants and Biochar on Seed Yield (kg/ha) of Soybean during the 2018 and 2019 Cropping Seasons

TREATMENT	2018	2019
Inoculant		
Uninoculated	751.0b	760.0b
Inoculated	1201.7a	1212.3a
LSD	0.11	0.13
Biochar (tons/ha)		
0	739.0d	745.0d
4	1180.0b	1187.3b
8	1304.0a	1316.7a
12	1053.7c	1066.0c
LSD	0.16	0.19
Interaction		
I × B	NS	NS

Values with the same letter within a column are not significant at 5% probability.
NS = Not significant.

CONCLUSION

From the results of this study it can be concluded that legume inoculant significantly (P<0.05) and positively influenced soybean plant height, numbers of branches and nodules per plant and grain yield of soybean against uninoculated. Application of biochar at the rate of 8 tons/ha was found to have performed significantly (P<0.05) better as reflected in all the variables measured compared to all other rates (levels) of biochar applied. However, highest dose of biochar applied (12 tons/ha) did not significantly (P<0.05) increased growth and yield parameters of soybean tested in this study. Seeds inoculation with legume inoculant and biochar at the rate of 8 tons/ha is therefore recommended for sustainable soybean production and yield increase in the study are

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Evaluation of Rice Husk Ash (RHA) as a Bio-pesticide for Management of *Sitophylus Zeamais* Motschulsky (Coleoptera: Curculionidae) on Sorghum

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ABSTRACT
This project is aimed at addressing the challenges related to the indiscriminate use of pesticides for the storage of sorghum by exploring the use of natural products as preservative against damages caused by this species. Therefore, rice husk ash made for control of stored grain insects was examined for better recommendation to users, and eight (8) treatments RHA $600^{O}C$ (0.05g), RHA $900^{O}C$ (0.05g), RHA $600^{O}C$ (0.1g), RHA $900^{O}C$ (0.1g), RHA $600^{O}C$ (0.15g), RHA $900^{O}C$ (0.15g), Permethrin (0.1g), and a Control (untreated) were used. Among the treatment means compared, the results showed that permethrin at 0.1g dosage was still more effective in controlling Sitophylus zeamais infesting stored sorghum compared to other treatments. From the results obtained, Rice Husk Ash have some resemblance to permethrin in terms of pesticidal effects for controlling maize weevil infestation. It also showed that the pesticidal effects of these treatments reduced with increase in time (duration), with no effects on the germination potential of the treated seeds, hence, both treated and un-treated seeds were 98% viable in this experiment.
Keywords: rice husk ash, bio-pesticide, maize weevil, sorghum storage, treatment.

INTRODUCTION
Use of synthetic chemical insecticides have been the major approach to the control of agriculturally important insect pest but the adverse effects posed by these chemical insecticides has led researchers to find safer means of controlling the insect pest of stored products generally (Okonkwo and Okoye, 2002; Ogendo *et al*., 2004). Some of the drawbacks that trimmed down the use of synthetic chemical insecticides include pest resurgence and resistance, lethal effects on non-target organisms, chemical residues and their effect on both human and environmental health (Ogendo *et al*., 2004). Because of the public awareness of these adverse effects, botanical products have been relied upon as an alternative way of controlling insect pests of stored products as they are believed to be easily biodegradable, eco-friendly and have low mammalian toxicity. Despite the effectiveness of these botanical pesticides, they have not been generally accepted because consumers find the after-effects posed by these pesticides on foods unacceptable (Okonkwo and Okoye, 2002). Such effects include colour change, odour and change in taste of the treated foods. In USA, pyrethrins and piperonyl butoxide were effective and approved for use as a treatment for insect-resistant packaging on the outer layer of packages or with adhesives (Anwar et al., 2005). Neem oil extract was also found to be effective against *R. dominica, Sitophilus granarius, Tribolium castaneum* and *Trogoderma granarium* when used to treat jute bag but its efficacy was found to be greatly reduced after 60days of storage (Anwar et al., 2005). Therefore, an acceptable method of application of these bio-pesticides is required, in order to make them more acceptable (Singh and Anupama, 2020; Tariq *et al*., 2010). The rice husk ash (RHA) needs to

be properly examined for better recommendation, hence, the need to carry out this study. The objectives of the study include:

i. To determine the effects of treatments on maize weevil infesting stored sorghum.
ii. To investigate the shelf-life of treatments on storability of treated sorghum grains.
iii. To determine the effect of treatment on germinability of treated seeds.

It will be important to determine the efficacy of Rice Husk Ash (RHA) formulations in preserving stored sorghum grains and seeds for future global food security. Hence, the need to investigate the efficacy of stored sorghum treated with RHA (rice husk ash) for protection of stored grains against insect pests.

MATERIALS AND METHODS

Sorghum (CSR01 white variety) used for the study was sourced from a farmer in Bida Local Government Area of Niger State. The sorghum was cold-shocked to disinfect samples prior to use. Five full 50 kg capacity bag of rice husk was collected from a rice mill at Balogun Fulani Community in Ilorin East Local Government Area of Kwara State. About 25 kg of rice husk was washed at a time with portable water and then sun-dried, piled into a heap, set on fire and allowed to burn under the sun. One hundred and twenty grams (120 g) each of charred rice husk was placed into two porcelain crucibles. A box-type resistance furnace was heated from room temperature to 600^{o}C and 900^{o}C, respectively. After the desired temperature was reached and maintained for several minutes, the two porcelain crucible with rice husk was placed in the furnace and ashed completely for 5 hours. When the ashing time was completed, the crucibles with completely ashed RHA was removed from the furnace and cooled in air. Before the experiment, RHA was sieved to obtain fine particles.

One hundred (100) unsexed adult ***Sitophilus zeamais*** got from Yankaba Market were reared inside 360 ml kilner jars holding 250g of sorghum to mate and oviposite. Hence, the culture was retained up-till F1 progeny emergence.

Procedure for Admixing RHA: 100g lot of sorghum was placed in separate cylindrical glass jars, and admixed separately with RHA (600^{o}C and 900^{o}C) at dose rates of 0.05 (RHAL), 0.1g (RHAM), and 0.15 (RHAH) 100 g-1 of sorghum respectively. Another lot of 100g sorghum was placed in a cylindrical glass jar, and admixed with permethrin 0.6% ai (Rambo^{TM}) at dose rate of 0.167g 100 g-1of sorghum. Untreated sorghum was also placed in another separate cylindrical glass jars for the negative control. The jars were manually shaken vigorously for approximately 3-5 minutes, to achieve proper and uniform coating of grains with the various dusts. From each seed lot in the glass jars (100g) and nine 10g lots were placed in labeled experimental vials. Subsequently, twenty *S.zeamais* (mixed sex) adults were placed in each vial, vials were covered with muslin clothe to allow aeration and prevent insects from escaping. Three samples (vials) were taken from respective treatment and examined for insect mortality at 7 day, and 14 days post treatment; as presented in table 1 below. The remaining three samples from each treatment was sieved to remove all insect at 14 days post treatment, vials were closed and returned to the laboratory table for an additional 25 days to mark 40 days post-treatment before the number of F1 progeny in each vial was determined.
Data Analysis: Data collected were subjected to Analysis of Variance (ANOVA), and means were separated using the DMRT at 5 % confidence level.

RESULTS AND DISCUSION

Effect of Treatments on Number of Live Insects

The result for respective treatment is shown in table 1 below. The result showed that RHA 600^{O}C at 0.05g had higher mean value (38.6667) than all other treatments in terms of number of live insects; it was followed by RHA 900^{O}C at 0.05g and RHA 600^{O}C at 0.15g (31.4444 and 30.1111) which were at par. RHA 600^{O}C at 0.1g was lower and significantly similar to RHA 900^{O}C at 0.05g and RHA 600^{O}C at 0.15g, but higher and significantly similar to the control (18.0000^{ab}). RHA 900^{O}C at 0.1g (16.7778^{a}) had lower mean compared to the control (18.0000^{ab})

in terms of number of live insects but it was higher than RHA 900^{O}C at 0.15g (10.2222[a]), Permethrin had the least mean value (8.3333[a]) but it was at per with RHA 900^{O}C at 0.1g (16.7778[a]) and RHA 900^{O}C at 0.15g (10.2222[a]).

This means that Permethrin (8.3333[a]) was the best treatment for control of *Sitophilus zeamais* among the treatments compared, and its similarity to RHA 900^{O}C at 0.1g (16.7778[a]) and RHA 900^{O}C at 0.15g (10.2222[a]) also shows that these treatments had pesticidal effects for controlling the insects. These findings are in agreement with reports by Tariq *et al*. (2010); permethrin-dust controlled insect attacks compared to other dust formulations of bio-pesticides. The result was also at variance with findings by Singh and Anupama (2020), who reported that there was no loss from the insect pests when soybean is treated with rice husk ash.

Table 1. Effect of Treatments on Number of Live Insects

Treatments	Number of live Insects
RHA 600^{O}C (0.05g)	38.6667[d]
RHA 900^{O}C (0.05g)	31.4444[cd]
RHA 600^{O}C (0.1g)	27.3333[bc]
RHA 900^{O}C (0.1g)	16.7778[a]
RHA 600^{O}C (0.15g)	30.1111[cd]
RHA 900^{O}C (0.15g)	10.2222[a]
Permethrin (0.1g)	8.3333[a]
Control	18.0000[ab]
SE ±	6.037

Means with the same letter are not significantly different at 5 % level of significance using DMRT.

Evaluation of treatments at different Durations

The result of treatments at different application duration is illustrated in table 2 below. The result showed that at 40 days duration, higher mean (39.1250) of live insects was observed in all the treated samples. The least mean (11.9167) was observed at 14 days, it was similar to the mean (16.7917) at 7 days, but significantly different from the mean at 40 days.
This showed that the efficacy of these agents of insect control was reducing with increase in time which means that the longer treated samples stayed the less effective these treatments become, which supports findings by Anwar *et al.* (2005).

Table 2: Result of treatments at different application durations

Durations	**Live insects**
At 7 days	16.7917[a]
At 14 days	11.9167[a]
At 40 days	39.1250[b]
SE ±	6.037

Note: means with the same letter(s) are not significantly different at $P \leq 0.05$ using DMRT.

Germinability test of seeds treated with rice husk ash (RHA)

The result (table 3) showed both treated and un-treated seeds to be approximately 98% germinable. This means that these treatments did not affect the germination potential of the treated seeds and supports findings by Okonkwo and Okoye (2002); Ogendo *et al*., 2004, whom reported that germination was not significantly affected by storage treatments.

Table 3. Effect of Treatments on Germinability of Treated Seeds

Treatments	Percentage germination
RHA 600^{O}C (0.05g)	98 %
RHA 900^{O}C (0.05g)	99 %
RHA 600^{O}C (0.1g)	99 %
RHA 900^{O}C (0.1g)	98 %
RHA 600^{O}C (0.15g)	99 %
RHA 900^{O}C (0.15g)	98 %
Permethrin (0.1g)	98 %
Control	98 %

CONCLUSION

The results showed that permethrin at 0.1g dosage was more effective in controlling *Sitophylus zeamais* infesting stored sorghum. The result also showed that Rice Husk Ash have some resemblance to permethrin in pesticidal effects for controlling maize weevil (*Sytophylus zeamais*) infestating stored sorghum. The result also showed that the pesticidal effects of these treatments reduced with increase in time (duration), with no effects on the germination potential of the treated seeds, hence, both treated and un-treated seeds were 98% germinable in this experiment.

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The Raphia Palm and its Usefulness in Nigeria

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ABSTRACT
There are twenty species of Raphia palms indigenous to Africa and only R. taedigera originated from Southern America. However, seven of these Raphia species are indigenous to Nigeria namely R. hookeri (Mann. and Wendl.), R. vinifera (Beaur), R. sudanica (Chev.), R. manni (Wendl.), R. regalis (Becc.), R. mambillensis (Otedoh) and R. africana (Otedoh). Results from the study shown that Raphia palm is a versatile crop with all parts having economic value and useful for everyday livelihood, however, it is being neglected and presently its exploitation is in the wild. The Raphia palm is a very important crop in Nigeria because it provides income and employment to thousands of people in Nigeria especially in the South – South geo political zone. It also provides raw materials to various industries ranging from paper manufacturing to confectionary industries in Nigeria. The major product which the palm is known for is the palm sap (palm wine) which is very rich in minerals and vitamins. This popular product (palm sap /palm wine) is always requested for in any ceremonies at various communities both in the urban and rural area of Nigeria. Palm wine on fermentation and distillation yields industrial alcohol (ethanol) local gin and also the Raphia palm fruit contains oil in the Raphia mesocarp which extracted can be converted to biodiesel. However, Raphia palm being a multipurpose uses, it domestication in Nigeria is still an infant stages with exploitation still from the wild and homestead. This may be attributed to its uniqueness of flower once and die may and also inadequate information on developed technology for its cultivation. In order to domesticate Raphia production in Nigeria the Federal Government mandated the Nigerian Institute for Oil Palm Research (NIFOR) to research on Raphia palms in 1964 through aggressive research on the palms.
Keywords: Raphia palm, usefulness, multipurpose, uses

INTRODUCTION
Raphia palm is a monocotyledonous plant belonging to the family Palmaceae and is characterized by their compound pinnate leaves which distinguished them among other palms, as having the largest leaves in the plant kingdom. The origin of *Raphia* palm is traced to tropical Africa based on the reports of several scientists among who were Dalziel (1937), MqCurrah (1960), Hussel (1965), Otedoh (1974, 1975) etc. Udoesn (2008) reported that there are twenty species of Raphia palms indigenous to Africa and that only *R. taedigera* originated from Southern America. However, seven of these Raphia species are indigenous to Nigeria namely *R. hookeri* (Mann. and Wendl.), *R. vinifera* (Beaur), *R. sudanica* (Chev.), *R. manni* (Wendl.), *R. regalis* (Becc.), *R. mambillensis* (Otedoh) and *R. africana* (Otedoh) (NIFOR, 1982). In 1964 the Nigerian Institute for Oil Palm Research (NIFOR), Benin City was mandated by the Federal Government of Nigeria to carry out research on Raphia palms so as to popularize its cultivation.

Raphia palms thrives best in high rainfall area with high relative humidity throughout the year (Aghimien., 1989). In Nigeria, the ecological habitat favouring the growth of Raphia is mostly located within latitude $4^{o}15^{1}$ N and $5^{o}30^{o}$N and longitude $7^{o}50^{1}$ and $8^{o}30^{1}$ E. This area cuts across different ecological climatic and vegetational zones. It stretches in patches from the coastline (freshwater swamp) through the rainforest (flooded plains), depressions and wet areas to the derived Savanna (River fringes, areas with impervious sub soil and high water table) of the northern fringes of South-South Nigeria. The palms are popular in South-South, South East and South West Zones of the Country but predominantly in the South – South States namely Akwa Ibom, Bayelsa, Cross River, Delta, Edo and River States of Nigeria. It is estimated that over 180 million Raphia palms grows in Nigeria (NIFOR, 2008).

Raphia palm is a versatile crop with almost all parts having economic value and useful for everyday livelihood (Obahiagbon, 2009). Every part of Raphia palm tree is useful economically, both in the food industry sector and the art sector. It can also be a main source of lipid since it yields edible oil, which can be use and exploit as a cheap and local product which lead to a decrease of resource wasting and environmental pollution (Ndon, 2003). The different parts of Raphia palm include:- the fronds, leaves, trunk and roots and these parts give a wide range of products which are of benefit to mankind. It is a crop of great economic and social importance, owing to its usefulness as a source of raw materials for our local industries such as building, manufacturing, furniture, confectionary, construction and explosive (Ndon, 2003 and Otedoh, 1982). It is also identified as a source of raw materials for pulp and paper manufacture industry (Odeyemi, 1985 and Vianny *et al*., 2020).

Raphia palm a non-timber forest products (NTFPs) play a central role in the tropics and also play vital roles in low-income food-deficit countries such as Nigeria (Africa). The importance of these products in the diet, social life and livelihood systems of Nigerians is well-documented (Ugwu, 1996). Owing to their high commercial values, these products provide a source of income, not only to the resource exploiters themselves, but also to a wide range of market intermediaries –middlemen such as wholesalers and retailers. Socio-economic benefits of a sustainable Raphia palm plantation could include poverty alleviation and long-term employment opportunities. Moreover, the exploitation of Raphia palm tree is increasing over years in Nigeria, due to the high demand of its derived products such as palm sap, bamboo, raphia fiber, piassava, etc (Ndon, 2003. Proper assessment of the existing Raphia palms exploitation is a sine qua non to enhancing Raphia palms cultivation and increased its value chain. Information obtained will also provide a directory of agricultural research projects and agro-allied business in the target areas as well as aid in the development of packages of technologies for increased agricultural production.

MATERIALS AND METHODS

The study area

The study was carried out in four states of Nigeria, namely Akwa Ibom, Bayelsa, Delta and Edo State. These States were chosen because, they form a major part of the Raphia palm-forest belt of Nigeria.

Sampling procedure

The study was conducted through descriptive survey research with a multi- structured interview approached. Data was collected by means of structured interview and data collection were structures to capture palm wine tapers, marketers, palm wine distillers, furniture makers, Raphia farmers and artisans within each community where the Raphia palm is dominants. The communities identified were Ikot Ikpene and Abak in Akwa Ibom State, Onuebum in Bayelsa State, Otegbo and Esaba in Delta State and Aguomokpe in Edo State. Data were collected on the basis of one on one interview of the respondent. Qualitative data was obtained through participatory techniques and the interview was conducted by the Researcher with the help of two local interpreters. A total of one hundred and twenty respondents were interviewed made of 20 palm wine tappers, 20 palm wine distillers, 20 Raphia palm explorers, 20 furniture marker 20 artisans and 20 marketers. Questions were asked on socio-economic status of respondent's, livelihoods activities, types of equipment use for Raphia palm processing and market availability. Data collectedvwere subjected to descriptive statistical analysis.

RESULTS AND DISCUSSION

Raphia distribution in Nigeria

Raphia palms thrives best in high rainfall area with high relative humidity throughout the year and ecological habitat located within latitude $4^{o}15^{1}$ N and $5^{o}30^{o}$N and longitude $7^{o}50^{1}$ and $8^{o}30^{1}$ E. This area cuts across different ecological climatic and vegetation zones. It stretches in patches from the coastline (freshwater swamp) through the rainforest (flooded plains), depressions and wet areas to the derived Savanna (River fringes, areas with impervious sub soil and high water table) of the northern fringes of South-South Nigeria. The palms are popular in South-South, South East and South West Zones of the Country but predominantly in the South – South States namely Akwa Ibom, Bayelsa, Cross River, Delta, Edo and River States of Nigeria. It is estimated that over 180 million Raphia palms grows in Nigeria (NIFOR, 2008). In Nigeria, Raphia palms traditionally is an important economic crop because all parts of Raphia palms are important and the palm products are of much economic importance in Nigeria particularly in the South-South Nigeria. In some towns in South-South Nigeria like Ikot Ikpene in Akwa Ibom State is popularly called Raphia city because of the economic activities centred on Raphia products in the town. As far back to 1891, piassava known in commerce as "Calabar or Lagos bass" has been contributing its quota as an essential export commodity of Nigeria (Udosen *et al*., 2008).

Economic contribution of Raphia palms to Nigeria economic

The results of data analysis as presented in Table 1 shows that 100 % of the respondents agreed that Raphia palm is useful and highly profitable economic palms but highly neglected by Nigeria Government (Local, State and Federal). Raphia palm cultivation is a good source of economic development for the South – South States of Nigeria and the entire nation as a whole. The main economic benefits of Raphia palms contribution includes generation of foreign exchange, food security, employment, poverty alleviation, provision of raw materials among others (Ndon, 2003 and Otedoh, 1982). It is also identified as a source of raw materials for pulp and paper manufacture industry (Odeyemi, 1985).

Economic usefulness of Raphia Palm

Raphia palm is a versatile crop with almost all parts having economic value and useful for everyday livelihood (Obahiagbon, 2009). Every part of Raphia palm tree is useful economically, both in the food industry sector and the art sector. . It is a crop of great economic importance, owing to its usefulness as a source of raw materials for our local industries such as building, manufacturing, furniture, confectionary, construction and explosive (Ndon, 2003 and Otedoh, 1982). It is also identified as a source of raw materials for pulp and paper manufacture industry (Odeyemi, 1985 and Vianny *et al*., 2020). Some of the most highly valued products of Raphia palm includes palm wine; biodiesel, ethanol, sago (flour), waxy (floor and shoe polish) and also some of the products are widely gained prominence attention in Nigeria (NAD, 2002, NIFOR, 2008).

Palm sap (Palm wine): The most highly valued products of Raphia palm is the palm wine Plate 1. Palm sap (wine) is derived from *Raphia hookeri* by tapping the young inflorescence (Gledhill, 1972 and Otedoh, 1981). Over 50 million people of Nigeria takes palm wine and is one of the items usually requested in traditional marriage ceremony and dispute settlements (Obahiagbon and Osagie, 2007). Palm wine is very nutritive, it contains minerals and vitamins as well as yeast, water and sugar. The palm wine contains eleven essential elements which the body cannot synthesize in its own, which the body need for its growth and development (ANAS, 2001). Apart from containing this essential element, it also contains three essential water soluble vitamins which the body cannot synthesis on its own (ANAS, 2001). *Raphia hookeri* is capable of producing between 1,600 litres to 3,200 litres of fresh palm wine / palm with a tapping duration ranging from 59 to 90 days depending on the ecology as well as the environment (Imogie,et al., 2016.; Ndon, 2003). Demand for *Raphia* palm wine is on the increase because it is specially required in traditional ceremonies like payment of dowry, marriage ceremony, village meeting, resolution of conflicts, demarcation of land boundaries and pouring of liberation (NAD, 2002). Because of the nutritive value of palm wine it is now bottled under hygienic condition by NIFOR (1983) to further widen the scope of acceptance and distribution for consumers Plate 1. *Raphia* products have widely gained prominence attention in Nigeria (NAD, 2002).

Industrial alcohol or local gin (Ethanol) and biodiesel

Palm wine on fermentation and distillation yields industrial alcohol (ethanol) local gin Plate 2 (NIFOR, 1971). The oil from *Raphia* mesocarp Plate 3, when extracted can be converted to biodiesel (Abigor *et al*., 2003). The seed contain mesocarp that contain oil and the oil if extracted from the mesocarp of *Raphia* fruit and could be used in stupefying fish (Udosen *et al*., 2008). The *Raphia* oil when extracted with water may be used for cooking and for production of confectionary, embrocation, candle, soap and hair cream (Ndon, 2003). The mesocarp of the matured and ripped fruits serves as food for man. In the food industry sector, the mesocarp of the ripe raphia fruit pulp is rich in many nutrients such as lipid (40-52%), protein (6.1%), carbohydrate (61.4%), vitamins such as niacin (0.27 mg), vitamin A (0.15 mg) and minerals (3%), can be used as food supplement (Esiegbuya *et al*.,2013).

Piassava

Piassava is a coarse fibre from the base of the petiole of the Raphia fronds Plate 4. It is used for making brush, weaving of fish traps, chairs, climbing ropes, tying of thatch houses e.t.c. Piassava when in the absence of Oxygen and the resultant charcoal mixed with nitre and sulphur produced explosive known as gun powders (Otedoh, 1976). It is used locally for the weaving of fish traps, hats, and so on Plate 5. It is also useful in the manufacturing of climbing roles and for tying purposes of animals, such as goat, sheep and fowls as well as canoes to post. In the riverine area, most fishermen use the container made from piassava in the conveyance of the catch to their homes or market places.

Raffia

The raffia is a long thin strip of fibre as soft as silk, about half feet wide and five feet long Plate 6. When twisted it is used as twine to weave mats, baskets, hats, shoes, school bags, conference bags, among others. The leaflets of *Raphia* palm can be used for the manufacturing of roofing mats used in thatch houses construction in rural environments.

Raphia trunk and palm fronds

The trunk and leave frond of *Raphia* palm has pulp and long fibre suitable for the manufacture of paper (Odeyemi, 1984). It is therefore hopeful that from the utilization of these species in our paper factory will save foreign exchange for Nigeria over the importation of exotic raw materials. The trunk provides building raw materials for the construction of local houses and temporary bridges, Plate 7.

Other uses

Raphia palms has wide range of uses and this include interior decoration or fittings of automobile, bags, furniture’s, beads, shoes Plates 8 and 9.

CONCLUSION

Raphia palms provide not only an important support for sustainable rural development but also a way for livelihood support and maintaining livelihood security for the rural people. It plays greater role in livelihood diversification, food security, household asset accumulation, employment generation, financial savings are some of the opportunities rural producers and sellers gain from being livelihood in *Raphia palms* enterprise.

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Plate 1: Bottled palm sap

Plate 5: Fish trap

Plate 3: Raphia fruit

Plate 10: Raphia textured

Plate 11: Raphia bags

Plate 12: Raphia products

Plate 10: Women involved In weaving using Raphia Raw material

Plate 8: Various products artifacts from Raphia palm raw materials

Plate 9: Various art design from Raphia palm trunk.

Production of Quality Polynesian Arrowroot (*Tacca leontopetaloides*) Starch from Freshly Harvested Amora Tubers

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ABSTRACT

Quality Amora starch was produced from freshly harvested Amora tubers at NRCRI, Umudike. Appropriate starch extraction method was used for the extraction. The analyses of quality specifications control measures such as moisture content and pH were carried out using standard methods. Other analyses done were percentage peel loss, percentage starch yield and percentage residue yield. The chaff (residues) was equally converted into flour and preliminary evaluation done on the residue. The result shows that freshly harvested Amora tubers yielded an average peel loss 14.63±0.19%; starch yield 22.57±0.09%; residue (fibrous chaff) yield 7.41±0.08%; moisture content 11.9±0.22% and pH 6.8±0.10. The result also shows a remarkable increase in pH values with increase processing in the production of the Amora starch. The fermented residue gave good flour. The starch results show a potential for the use of amora for industrial starch production for food and non-food purposes which could benefit the export market and local income generation.

Keywords: Amora tubers, fermented residue, percentage peel loss, starch extraction

INTRODUCTION

Starch serves as one of the major biomaterials used in food (54%) and non-food (46%), industries. The non-food industries include pharmaceutical, plastics, cosmetics, textile, and adhesives (RMRDC, 2018). Polynesian Arrowroot tubers (locally known as Amora in North Central Nigeria) tuber is considered to be bitter if untreated. Though the tuber has high starch yield, it is unpalatable, taste bitter, produce inflammation and show occasional toxicity (Raymond, 2018). The starch has been extracted outside Nigeria and sold in quantity to Europe, where it was used in bread making. It also has various local medicinal uses. People in the middle belt region of Nigeria use the starch in preparing their local delicacies (Kunle *et al*., 2003).

To provide a workable strategy for the production of high quality amora starch, for food and non-food industrial utilization of the crop

MATERIAL AND METHODS

Fresh amora tubers were harvested 11months after planting at NRCRI Umudike. Appropriate starch extraction method was used to extract quality starch from freshly harvested amora tubers as shown in Figure 1. Plate 1 shows photographs of some operational steps used in the extraction. The peeling was done by careful removal of the tubers outer thin layer with kitchen knives. Multiple washing methods were used for thorough release of the starch milk and astringent taste. The resultant slurry was allowed to settle into two layers (free supernatant liquid and the thick starch slurry). The supernatant layer was serially removed by decanting until clean clear liquid was obtained. The starchy sediment was then flash dried, cooled and packaged with food grade polyethylene bags. The unit and sub unit operations were thoroughly monitored by food scientists. Quality specifications control measures such as moisture content, and the pH, among others for quality root starch were done. Other analyses done were percentage peel loss, percentage starch yield and percentage residue yield. The chaff (residues) was equally converted into flour and preliminary evaluation done on the residue.

Fresh amora tuber

⇩

Peeling

⇩

Washing

⇩

Grating

⇩

Sieving

→ Residue/By product/Fibrous chaff

⇩

Sedimentation

⇩

Decanting

⇩

Drying

⇩

Cooling

⇩

Packaging

⇩

Quality Amora Starch →

Figure 1: Quality starch extraction from fresh amora tubers

Plate 1: Photographs of some operational steps in amora starch extraction. A = Fresh amora tuber, B= peeled, washed amora tubers steeped in water, C= Grating and sampling of amora mash (pulp), D = Multiple washing of pulp to free amora starch, E=decanting washed wet amora starch cake, F= flash drying of wet amora starch cake and G = packaged quality amora starch.

RESULTS AND DISCUSSION

The process gave a clean white amora starch. The Result shows an average of peel loss 14.63±0.19%; starch yield 22.57±0.09%; residue (fibrous chaff) yield 7.41±0.08%; moisture content 11.9±0.22% and pH 6.8±0.10. Figure 2 shows the pH values along the processing. The pH values were of the fresh tuber 6.30; grated mash 6.55; starch slurry 6.80 and dried starch 7.29. The pH values decreased with processing, which could be due to the removal of bitterness. The experimental amora starch pH value, falls within reported value 6.9 (Raymond, 2018). The fermented residue also gave good flour. The starch results show a potential for the use of amora for industrial starch production for food and non-food purposes in the country. This starch production could benefit our export market and local income generation.

Table 1: Results of some amora starch parameters

Parameters	Peel loss (%)	Starch yield (%)	Residue yield (%)	Moisture content (%)	pH
Values	14.63±0.19	22.57±0.09	7.41±0.08	11.9±0.22	6.8±0.10

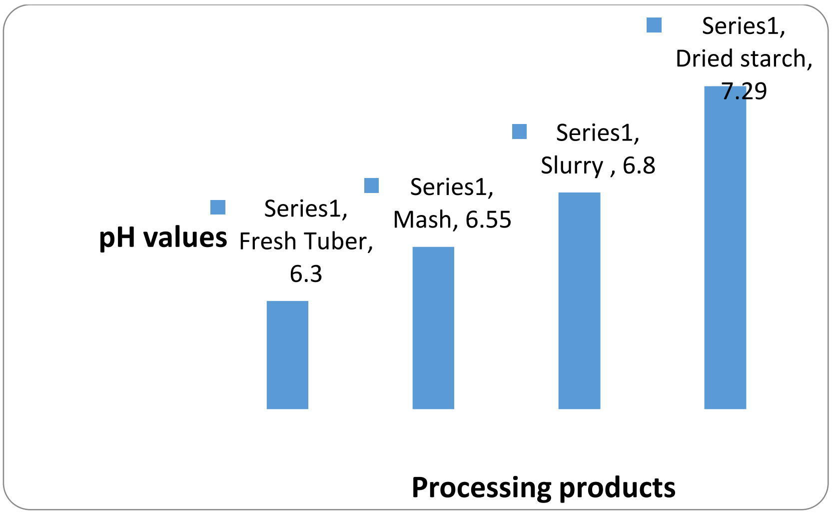

Figure 2: The pH values of fresh amora tuber, intermediate and final starch

CONCLUSION

The starch results show a potential use of amora for industrial starch production for food and non-food purposes which could benefit our export market and local income generation.
It is recommended that further in-depth works on the food forms, physicochemical, rheological properties of the starch and by-products be done.

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Effect of Organic Fertilizer Rates on Productivity of Hot Pepper (*Capsicum chinense* (Jacq.) Varieties in Minna, Nigeria

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ABSTRACT
A study was conducted to evaluate the effect of organic fertilizer rates on productivity of hot pepper (Capsicum chinense Jacq.) varieties, under screen house at Federal University of Technology, Gidan Kwano Campus Minna, and in a farmers' field in Minna, Nigeria, in the 2019/2020 dry season. A 3 x 3 factorial treatment was laid out in a Completely Randomized Block Design (CRD) in the screen house and Randomized Completely Block Design (RCBD) in the field, with four replications in the screen house and three replications in the field. The treatment consisted of three organic fertilizer rate (0, 1.5 and 3.0 t ha^{-1}) and three hot pepper varieties (Mbgakpa, Dan-Sokoto and Dan-Zaria). Data were recorded on plant height, number of branches per plant, fruit length, fruit diameter and yield. Results showed that under screenhouse and field conditions the application of 1.5 and 3.0 t ha^{-1} of organic fertilizer recorded significantly similar taller plants, more branches, longer fruits than the application of organic fertilizer at 0 t ha^{-1}. Bigger fruits were recorded with the application of organic fertilizer at the rate of 1.5 t ha^{-1} than the control and 3.0 t ha^{-1} organic fertilizer. The application of 3.0 t ha^{-1} of organic fertilizer recorded higher fruit yield in the screenhouse, but under field situation the application of 1.5 and 3.0 t ha^{-1} organic fertilizer recorded similar higher fruit yield than the control. The use of Mgbakpa variety recorded significantly taller plants and higher number of branches, similar with Dan-Sokoto under field condition. The use of Dan-Sokoto produced longer fruits than the other varieties. Dan-Zaria and Dan-Sokoto produced significantly similar bigger fruits than Mgbakpa. Dan-Sokoto and Dan-Zaria recorded significantly similar higher fruits yield than Mbgakpa which recorded the lowest fruit yield. It can be concluded that sowing of Dan-Sokoto or Dan-Zaria with the application of 1.5 t ha^{-1} organic fertilizer can be used to obtain higher fruit yield of hot pepper in this Agro-ecological zone of Nigeria.
Keywords; Hot pepper, Screenhouse, Farmers field, Organic fertilizer, Varieties.

INTRODUCTION
Hot Pepper (*Capsicum chinense*) is a specie of pepper native to the Americas and belongs to the family Solanaceae. Its varieties are well known for their exceptional heat (Nabhan, 2014). The hottest pepper of the world are members of this species. Seeds of C. *chinense* have been found in cave dwellings in Central America that indicates the natives have been consuming chili since 7,000 years ago, but have only been available in areas outside Americas for about 400-500 years following the Columbia exchange (Nabhan, 2014). In Nigeria, four types of pepper are recognized on the basis of fruit form namely, "Atawere" - Bird peppers (*Capsicum frutescens*), Atarodo" – Scotch bonnet (*Capsicum chinense*), "Sombo" - Cayenne pepper or red pepper (*Capsicum frutes*cens) and "Tatase" (*Capsicum annuum*) (Adesina *et al*., 2014). The *Capsicum* fruits are an excellent source of natural, micronutrient antioxidants (vitamins

C and E and carotenoids) which is important in preventing or reducing chronic and age-related diseases (Palevitch and Craker, 2012).

The use of organic fertilizer is important in the maintenance of soil fertility and crop productivity (Verma, 2004). Organic fertilizers increase soil water retention, slow release of nutrients and contributes to the residual pool of organic nitrogen and phosphorus in the soil (Kassa *et al*., 2018). Organic fertilizers can enhance efficiency and reduce the need for chemical fertilizers, to improve the soil fertility and soil health (Myint *et al*., 2010). In Nigeria, pepper production is low due to poor genetic potentials of most cultivars available to farmers, use of poor-quality seeds, pest and disease infestation, restriction of production to a single farming season, low income and pervasive poverty among small holder farmers (Omotayo *et al*., 2015). Another major problem attributed to the underperformance of pepper production is due to the technical inefficiencies of crop production system in terms of large-scale irrigation schemes, (Adelodun *et al*., 2020), and lack of effective irrigation systems in developing countries (Walters and Jha, 2016). And the high-water scarcity currently being experienced globally (Walters and Jha, 2016), which is seriously affecting agricultural production, especially in arid and semi-arid areas (Abdelkhalik *et al*., 2020).

Studies identified that in the past decades the use of various kinds of chemical fertilizers, has caused undesirable effect on the soil environment, both structural and microbial (Singh *et al*., 2020), and has resulted in soil acidification and changes in soil chemical properties, leading to soil degradation, environmental pollution and reduce crop yield (Su *et al*., 2021), and there is urgent need to restore it by implementing organic agriculture (Singh *et al*., 2020).

Intensive inorganic fertilizer usage in agriculture causes so many health problems and unrecoverable environmental pollution. To reduce and eliminate the adverse effects of Synthetic fertilizers on human health and environment, new agricultural practices have been developed called organic agriculture (Sharma and Chetani, 2017). Organic farming is an alternative to sustainable agriculture that is more inclusive and has become a widespread phenomenon (Rahmaniah *et al*., 2020), and as a sustainable agriculture it integrates three main objectives - environmental health, economic profitability, and social-economic justice (Rahmaniah *et al*., 2020). Organic farming maximizes reliance on farm-derived renewable resources for managing ecological and biological processes and integrations, to provide acceptable crop production and an appropriate return to the human and other resources employed (Hartatik and Setyorini 2021), and it can significantly increase the log of productivity and crop income and reduce total household expenditure, food expenditure, and poverty (Yang, 2020).

MATERIALS AND METHODS

The experiment was conducted in the screen house and under field condition simultaneously, at the Federal University of Technology, Gidan Kwano, Minna, in the 2019/2020 dry season. A 3 x 3 factorial treatment was laid out in a Completely Randomized Block Design (CRD) in the screen house and Randomized Completely Block Design (RCBD) in the field, with four replications in the screen house and three replications in the field. The treatment consisted of three organic fertilizer rate (0, 1.5 and 3.0 t ha^{-1}) and three hot pepper varieties (*Mbgakpa, Dan-Sokoto and Dan-Zaria).*

Three nursery beds of 1m x 1m were prepared with the use of simple hand hoe and the three varieties of pepper seeds were broadcasted each on it identified bed with a mixture of fine sand and firmed with some soils. These seeds were raised in a nursery bed for six weeks. A shade was made using palm fronds on top of the nursery beds to protect the seedlings from harsh weather conditions and subsequently removed for hardening before transplanting. Organic fertilizer was incorporated into the experimental pots and plots at the rate of 0, 1.5 and 3 t ha^{-1} two weeks before transplanting the pepper seedlings. Seedlings of six week's old were transplanted after sowing, at 5-6 true leaf stage with their root ball each at a depth of 5 cm, one plant was maintained in each of the pot, in the screen house experiment and the pots were well watered before transplanting the seedlings.

The field was irrigated a day before transplanting and irrigated immediately after transplanting. Seedlings were transplanted out on the field at a plant spacing of 50 cm x 50 cm between plants, alley of 50 cm between treatment plots and 1 m between replicates. Plants were irrigated in the screen house with the use of watering-can at regular interval to maintain moisture throughout the growth period. And in the field experiment, a controlled amount of water was distributed under low pressure, through a piped network and applied to each plant in the experimental plots, the water was supplied at regular interval as required by the pepper plant to ensure it optimum growth. Data were recorded on plant height, number of branches per plant, fruit length, fruit diameter and yield. Data collected was subjected to Analysis of Variance (ANOVA) using statistical analysis system (SAS version 9.0) 2012. Treatment means were separated using least significant difference (LSD) at 5 % level of probability.

RESULTS AND DISCUSSION

All growth parameters and yield parameters test differed significantly due to the different varieties tested under different locations as shown by the analysis of variance. All parameters showed significant results.

Plant Height

There was a significant increase in plant height at both locations. In the screen house at 6 and 9 WAT, the application of organic fertilizer at 3.0 ha $^{-1}$ recorded taller plants than 0 and 1.5 t ha $^{-1}$ which had similar shorter plants, but under field condition, the application of 1.5 and 3.0 t ha^{-1} organic fertilizer showed similar taller plants than 0 t ha^{-1}. In terms of landraces response, under the screenhouse condition *Mgbakpa* recorded taller plants than the other landraces. But under filed condition, at 6 WAT, *Mgkakpa* recorded taller plants similar with *Dan-Sokoto* at 9 WAT, than *Dan-Zaria* which had the shortest (Table 1).

The taller plants produced by *Mgbakpa* pepper varieties could be attributed to the inherent genotype characteristics coupled with its adaptability to the environmental condition which supported its utilization of available growth factors and hence the production of taller plants. This result is in agreement with the findings of Nkansah *et al*. (2017) who reported that Kukulkan pepper variety had the highest height of (93.7cm) under green house and (43.9cm) under field condition than Caribbean, Crusader, Califonia, Embella, F1 Nobili, Guardian, pepper 1 and yellow pepper varieties in Ghana.

Table 1: Effect of organic fertilizer on plant height of some pepper varieties under field and screen house conditions at 6 and 9 WAT

	Plant height (cm)		Plant height (cm)	
	Screen house		Field	
	Weeks after transplanting		Weeks after transplanting	
	6	9	6	9
Fertilizer (F)				
0	32.92b	53.42b	14.11b	21.81b
1.5	33.83b	59.08b	18.70a	30.76a
3.0	40.67a	68.92a	18.73a	33.09a
LSD (0.05)	5.35	6.89	2.26	5.99
Variety (V)				
Dan Zaria	33.50a	57.33b	15.19b	24.82b
Dan Sokoto	37.67a	57.92b	17.95a	29.39ab
Mgbakpa	36.25a	66.17a	18.40a	31.44a
LSD (0.05)	5.35	6.89	2.26	5.99
Interaction				
F x V	NS	NS	NS	NS

Means with the same letter(s) under the same column are not significantly different from each other at ($P \leq 0.05$) by LSD.

Numbers of Branches

Significant differences were observed among the number of branches both in the screenhouse experiment and the field experiment. Number of Branches. Under screen house, the application of organic fertilizer at the rate of 3.0 t ha $^{-1}$ recorded higher branches similar with the application of organic fertilizer at the rate of 1.5 t ha $^{-1}$ than the 0 t ha $^{-1}$ which had the lowest at 6 and 9 WAT respectively. In field condition, similar higher number of branches were obtained in plots given 1.5 and 3.0 t ha $^{-1}$ organic fertilizer than 0 t ha-1 at 6 WAT. But at 9 WAT plot treated with 1.5 t ha $^{-1}$ organic fertilizer had higher number of branches similar with 3.0 t ha $^{-1}$ than 0 t ha-1 which recorded the lowest.

The Landraces *Mgbapka* recorded higher number of branches than the other landraces under the screenhous condition. But in the field at 6 WAT *Dan-Sokoto* and *Mbapka* recorded similar higher number of branches while at 9 WAT *Dan-Sokoto* recorded the highest similar to *Mgbapka* compared to *Dan-Zaria* which had the lowest number of branches (Table 2). The higher number of branches produced by *Mgbakpa* variety may be due to taller plants, higher number of leaves and wider stems produced by the genotype which supported it photosynthetic processes and utilization of soil water and nutrients for the development of branches in our study.

Table 2: Effect of organic fertilizer on number of branches of some pepper varieties under field and screen house conditions at 6 and 9 WAT

	Number of branches		Number of branches	
	Screen house		Field	
	Weeks after transplanting		Weeks after transplanting	
	6	9	6	9
Fertilizer (F)				
0	6.0b	18.0b	7.0b	21.0b
1.5	8.0ab	22.0ab	11.0a	32.0a
3.0	10.0a	27.0a	10.0a	26.0ab
LSD (0.05)	3.20	4.63	3.21	7.99
Variety (V)				
Dan Zaria	8.0a	20.0b	6.0b	21.0b
Dan Sokoto	9.0a	19.0b	11.0a	30.0a
Mgbakpa	7.0a	28.0a	12.0a	28.0ab
LSD (0.05)	3.20	4.63	3.21	7.99
Interaction				
F x V	NS	NS	NS	NS

Means with the same letter(s) under the same column are not significantly different from each other at ($P \leq 0.05$) by LSD.

Fruit Length

Significant differences were observed among the landraces both in the greenhouse and field experiment. The application of the organic fertilizer at 1.5 t ha $^{-1}$ and 3.0 t ha $^{-1}$ recorded similar longer fruits than 0 t ha $^{-1}$ which had the lowest in both condition. In terms of the landraces, *Dan-Sokoto* produced longer fruits that the other landraces under both conditions. The longer fruits produced by *Dan-Sokoto* variety may be due to it genetic constituent which allow the partitioning of the utilized growth factors (solar radiation, water and nutrients) towards fruit production rather than towards it growth development (Table1.2).

Fruit Diameter

The application of 1.5 t ha $^{-1}$ organic fertilizer recorded bigger fruits than the other the other rates in the field. The landraces of *Dan-Zaria* and *Dan-Sokoto* recorded similar bigger fruits than *Mgbapka* under both conditions (Table1.2). The wider stems produced by *Mgbakpa* varieties could be attributed to it genetic make-up, its adaptability to the environment and the production of the taller plants and higher number of leaves which enhanced it photosynthetic ability and in turn led to the production of bigger stems. This finding is in line with the work of Nkansah *et al*. (2017) who reported that Kakulkan pepper variety recorded thicker stems of (1cm) under green house and (0.89cm) in open field than the pepper 1 variety which recorded thinner stems in Ghana.

Fruit Yield

The application at 3.0 t ha $^{-1}$ organic fertilizer recorded higher fruit yield than the other rates in the screenhouse condition. Under the field condition, application at 1.5 and 3.0 t ha $^{-1}$ recorded similar higher fruit yield than 0 t ha $^{-1}$ which had the lowest. The landraces *Dan-Zaria* and *Dan-Sokoto* produces similar higher fruit yield than *Mgbapka* in the screenhouse and *Dan-Sokoto* produced higher fruit yield similar with *Dan-Zaria* compared to *Mgbapka* which recorded the lowest in the field (Table1.2). The higher fruit yield produced by *Dan-Zaria* and *Dan-Sokoto* varieties might be attributed to their genetic characteristics and adaptation to the environmental conditions.

Table 3: Effect of organic fertilizer on number of fruit per plant, fruit length, fruit diameter and fruit yields of some pepper varieties under field and screen house conditions at 6 and 9 WAT

	Screen house			Field		
	Fruit length (cm)	Fruit diameter (cm)	Fruit yield (kg ha^{-1})	Fruit length (cm)	Fruit diameter (cm)	Fruit yield (kg ha^{-1})
Manure (M)						
0	2.05b	2.76a	2041.90c	2.06b	2.46b	1225.40b
1.5	3.19a	2.69a	4148.70b	3.26a	2.69a	3938.10a
3.0	3.36a	2.50a	6044.80a	3.17a	2.43b	3795.00a
LSD (0.05)	0.46	0.42	1404.20	0.29	0.23	426.28
Variety (V)						
Dan Zaria	2.40b	3.31a	4262.80a	2.25b	2.95a	2952.20ab
Dan Sokoto	3.86a	3.17a	5537.50a	4.14a	2.97a	3262.40a
Mgbakpa	2.34b	1.48b	2435.20b	2.11b	1.66b	2743.80b
LSD (0.05)	0.62	0.42	1404.20	0.29	0.23	426.28
Interaction						
F x V	NS	NS	NS	NS	NS	NS

Means with the same letter(s) under the same column are not significantly different from each other at ($P \leq 0.05$) by LSD.

CONCLUSION

The application of organic fertilizer at 1.5 and 3.0 t ha $^{-1}$ increase plant height, number of branches, fruit length, fruit diameter and fruit yield than 0 t ha-1 (control). In both screenhouse and field condition, the landrace *Mgbapka* was superior in the production of taller plants and higher number of branches than the other landraces which had the lowest under both conditions. *Dan-Zaria* and *Dan-Sokoto* produced longer fruits, bigger fruit and higher fruit yield than *Mgbapka* which had lowest in both screenhouse and field conditions.

It is recommended that small holder farmers should grow *Dan-Sokoto* landrace with the application of 1.5 t ha $^{-1}$ organic fertilizer for optimum yield of pepper in this Agro-Ecological Zone of Nigeria.

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Physicochemical Characteristics of Some Common Fonio (Acha) Accessions (*Digitaria exilis* and *D. Iburua* Kippis Stapf) of NCRI Badeggi-Nigeria

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ABSTRACT
Physicochemical characteristics, Kinetics of Water uptake and distention patterned of eight different accessions of fonio, collected at the research station of NCRI Badeggi- Nigeria selected from the germbank of the institute kept for research purposes were evaluated.. The aim is to characterized, evaluate and compare the physicochemical properties, Kinetics of Water uptake and distention patterned of these landraces that are cultivated in Southern Guinea Savanna zone of Nigeria. Physical properties studied includes pericarp color, processed seed color kernel size, at 400um,500um, and 700um, using American standard sieve (ASTM) 1000-kernel weight and moisture content. Results showed that fonio accessions had higher energy value when compared with other cereals (360 kcal/100g). Angyoune an exile eco-type has the highest carbohydrate (±73.18) and fiber (±7.64). Kureep also an exilis accession recorded highest in protein content (±10.6%), while Ma'am accession gives the highest fat content (±3.42) in these samples. Amylose contents of these accessions are unarguably very high when compare to other cereals such rice, sorghum and millet, from 25% in danpeep an iburua to 28% in Gonge'hala. for D. exilis. Respectively), indicative of the non-waxy endosperm In terms of minerals composition Agyoung had the highest iron content of (±10.06) while the calcium and manganese in Dinant accession were ±32.07 and ±60.02 respectively

Keywords: ***lines landraces, Physicochemical Properties, Acha Nutritional composition***

INTRODUCTION
Acha a small-sized grain of the genus Digitaria is an ordinary cereal grown in Western Africa (Zhu, 2020:Ayenan, 2018:stapf, 1915). Acha or Fonio as is popularly known *D. exilis* and *D.iburua* commonly found in West-Africa and generally exploited as wild cereal in Nigeria or Togo (Haq and Ogbe, 1995). Researchers have wondered on the origins and evolution of the domesticated fonio Initial investigation implicated the wild D. longiflora (Retz.) Pers., an annual weed widely distributed in tropical Africa, as the possible progenitor of D. exilis (stapf, 1915) and (Dalzil, 1937) .while D. longiflora is more close to D. fuscescens Henr. (Henrard, 1950) and reasonably claimed affinities of D. exilis with the wild D. *barbinodis* Henr., Concerning D. iburua, (stapf, 1915) suggested the wild D. *ternate* whereas (porteres, 1976) considered D. *barbinodis* as its likely ancestor. Additional wild species like D. *tricostulata* (Hackel) Henr. And D.*atrofusca* (Hackel) Camus is cited as morphologically close to D. iburua but they are geographically remote from the areas of diversity of the crop (Haq . and Ogbe, 1995) Acha are popular among the native because they thrive well and are resilience in infertile and drought-prone areas of West-Africa. Compared with major cereals, such as wheat and rice, acha is a type of underutilized cereal grains with potential for food applications (Mbosso, *et al.*, 2020). Acha has attracted attention from some other parts of the world for food applications (Abrouk, *et al*., 2020; Jideani, 2012; Laheri, 2018). For example, fonio is being

actively and commercially promoted in the United States as a "healthy" grain (Roseboro, 2020). European Union has recently approved fonio as a novel food (European Commission., 2018) . The yield of fonio is low. This is largely due to the fact that the grain is mostly grown on marginal lands with minimal input (Abdul & Jideani, 2019). Increasing effort to improve the genetic diversity and agronomic properties of fonio through breeding programs is being done with promising outlooks (Abdul & Jideani, 2019; Abrouk *et al.*,2020; Ayenan *et al*., 2018; Goler & Kwon-Ndung, 2020; Kanlindogbe, Sekloka. & Kwon-Ndung, 2020) Exert statistical figures on the amount of fonio cultivated in the region is not known. (FAOSTAT, database, 2003) But then, it is estimated that a total area of 347, 350 ha was devoted to acha cultivation in Africa in 2002 with Nigeria providing almost half of the area. (Abdurrahman *et al.,* 2015) It has been estimated that about 70,000 metric tons of acha was been produced annually in Nigeria. (Adoukonou-Sagbadja *et al.,*, 2010).

The productions of fonio grains keeps increasing and has reached over 600,000 tonnes per year (FAOSTAT, 2020) Fonio traditional dishes are well appreciated among the locals in areas where it's cultivated. Federal government of Nigeria is well aware of the huge nutritional and economic potential inherent in fonio among other neglected crops of Africa and is selected for genetic improvement through conventional breeding.by national research institute Badeggi, an institute under federal ministry of agriculture and rural development (FMARD) Yields are low (0.6–0.9 t/ha, often under 0.2 t/ha in the zone) and highly influenced by climate hazards (Adoukonou-Sagbadja, *et al,*2006; Haq and Ogbe 1995). Acha, mainly grown as a staple food, is tasty and has high nutritional value (Jideani 1990 : Ballogou *et al.,* 2013). The yield of fonio is low when compere to major world crops. This is largely due to the fact that the grain is mostly grown on marginal lands with minimal input (Abdul & Jideani, 2019). Increasing effort to improve the genetic diversity and agronomic properties of fonio through breeding programs is being done with promising outlooks (Abdul & Jideani, 2019; Abrouk *et al.,*2020; Ayenan *et al.,*2018; Goler&Kwon-Ndung, 2020; Jideani & Jideani, 2011; Kanlindogbe, Sekloka, & Kwon-Ndung, 2020; Sidibé, *et al,* 2020).

Fertilizers may also be used to increase the fonio yield. Knowledge of the nutritional properties and food applications of fonio is essential to support the development of the breeding programs. The grains have a high distension capacity. That a family of seven to ten people will comfortably consume about 2kg of processed grain (Jideani, 1990). However, grain yields are usually low (400-1000kgha-1), but this could be changed through improved husbandry practices, evaluation and selection of promising genotypes or by other breeding methods The major constituents of acha are carbohydrates and proteins. However, other components of the seed such as lipids, minerals and vitamins are of great significance in human nutrition. According to (Jideani , 1990), acha is one of the most nutritious and best-tasting of African cereals. The grains are rich in methionine and cysteine essential amino acids vital to human health which are lacking in many major cereals. Such as rice, maize, wheat among others. (Abdurrahman *et al.*, 2015) Diets from acha are recommended for lactating women and diabetic patients (Temple and Bassa, 1991; Jideani and Akingbela, 1993) reported that due to its high iron content and low glycemic index respectively.

The lack of pure accessions to its evaluation and characterization. (Ballogou *et al.*, 2013) have been a critical issue. Also, (Jideani and Akingbala.,1993) report that efforts to confirm the effects of specific agronomic practices on growth and development of different accessions or have so far been confounded by the effect of mix-up accessions. This issue is largely put to rest by National Cereal Research Institute Badeggi. The institute has develop technologies for a novel agronomic practices of Acha (*Digiteria exilis* and *DIgiteria iburua).* Presently there is lack of research on physicochemical properties compering different accessions of fonio with the objective of finding latern unique attribute The aim of this work was to provide information on the physicochemical attributes of some pure line accessions of acha *(Digitaria exilis* and *Digitaria iburua)* grain cultivated at NCRI Badeggi.

MATERIALS AND METHODS

The material used includes; pestle and mortar, incubator, American standard sieve also called ASTM sieve with nominal aperture ranges of 0.5mm,0.7mm 1mm respectively(Brennan *et al.*,1981). The two ecotype of Acha accessions vig; *Digitaria Iburua* and *Digitaria exilis* were obtained from the genebank evaluated at NCRI Baddeggi. *Digitaria Iburia* accessions used in this study were *Dampep, Jipel, Dinat Ma·an,* while those of Digitaria *exilis,* were *Agyong, kureep, Gonghala, Gindiri*. Preparation of Samples: the samples were dehusked manually using pestle and mortar after incubating for 10 minutes in an oven at 50 ^{o}C.

Determination of Physical Properties

Pericarp color was determined by the reflex activity and absorptive capacity using a colorimeter when light was passed through the seed samples. Kernel size was determined by passing the seed sample through the sieve of ASTM with nominal aperture ranges of 500 μm,700 μm and 1000 μm respectively standard (Brennan *et al.*,1981). One thousand (1000) kernel weights were determined using an electronic weighing balance. The amount of water absorbed by the kernels was determined by the methods of (Food and Agriculture Organization (FAO), 1989). Pericarp colour was subjectively evaluated and endosperm type was determined by squashing the kernel and staining with dilute iodine solution (Jideani and Akingbala, 1993). The kernel size, and the pericarp colour were each determined using triplicate samples of the sample.

Chemical Analysis

For proximate analysis samples were dried at 60°C to constant weigh using the method of (Association of Official Analytical Chemists (AOAC), 1980) and milled into fine powder. The total ash, crude lipid, crude fiber and crude protein (N × 6.25) were determined according to the recommended method of Association of Official Analytical Chemists (AOAC, 2005). Amylose was determined as described by (Robyt. and Bemis, 1967) and modified by. Chukwu (2009). four replicate samples of the products were used to determine the energy value by bomb calorimeter. Analyses for moisture, total ash, crude fibre, crude lipid, crude protein, crude fibre, amylose and NFE were all carried out using three replicate samples of the products. Starch was isolated by the wet milling procedure of (Akingbala, 1982). Steeped grain was milled using a mortar and pestle since the kernel were too tiny for a blender. The slurry obtained was screened through a 75 µm British standard sieve (Laboratory Test sieve, Endecotts Ltd., London, UK). The dry starch cake was pulverised into fine powder using a mortar and pestle. Swelling and solubility of starch samples were measured on dry basis using the method described by (Akingbala and Rooney, 1987) three replicate samples were used for the analysis. Data were analysed using analysis of variance and Duncan's tests described by (Montgomery, 1991) were used to separate the sample means that had significantly difference.

RESULTS AND DISCUSSION

Table 1 shows some physical characteristics of both "Acha" (*Digitaria exilis* and *Digitaria Iburua*) species in terms of color of the pericarp and the polished seeds 100 kernel weight, kernel size(%) 400 μm, kernel size (%) 500μm, and kernel size (%) 700μm. All the D.iburua accessions were observed to have brownish pericarp excerpt for Dinat accession that had reddish pericard and dehulled seed. Also among the D. iburua accessions, it was noted that *Dampep*, and *Jipel* had the highest Kernel weight & kernel size % 400 μm and *Dinat* recorded the highest kernel size % of 500μm and 700 μm. The least kernel weight and size 700μm and 500 μm were recorded by *Ma'an, Dampep* and *Jipel* accession.

Table1: Physical Characteristics of both Acha (*Digitaria exilis and Digitaria Iburua)* accessions

Acession name	Pericarp colour	Polished processed	1000 kernel weight(g)	Kernel size(%) 500μm	Kernel size(%) 700μm	Kernel size(%) 1000μm
Digitaria Iburua						
Dampep	Brownish	,,	0.59±0.04[a]	87±0.04[a]	55±0.23[a]	4±0.12[a]
Jipel	Brownish	,,	0.56±0.20 [a]	93±0.23 [a]	45±0.22 [a]	4±0.22 [a]
Dinat	Reddish	,,	0.53±0.23 [a]	89±0.33 [a]	57±0.14 [a]	5±0.01 [a]
ma'an	Brownish	,,	50.58+0.2[a]	90±0.41 [a]	52±0.16 [a]	4±0.11 [a]
Digitaria exilis						
Agyong	White	Brownish	0.50±0.06 [a]	77±0.12[b]	44±0.44 [a]	2±0.12[b]
Kure'ep	Brownish	,,	0.43±0.01[b]	78±0.22[b]	43±0.13 [a]	1±0.03 [b]
Gonghala	Brownish White	,,	0.49±0.04 [a]	84±0.43[a]	35±0.21[b]	--
Gindiri	Brownish White	,,	0.39±0.04	79±0.13	31±0.03	--

Notes: Means with the same letter in a given column are not significantly different (p ≤0.05) by the Duncan multiple range test. 1000-kernel weights are means of three replicates. Kernel size values represent means of three replicates.

Fonio grains (unmilled) measured between 1.5 and 1.8 mm long and approximately 0.9 mm wide (Ballogou *et al.,*2013; Irving and Jideani 1997). Kernel size distribution and sample weight indicated that there were significantly larger size kernels in *D. iburua* than in *D. exilis.* The average kernel appeared to have diameter slightly greater than 710 μm and not less than 500 μm (Jideani and Akingbala, 1993). Husks are removed, to get whole grains, paddy fonio weight constituted about 23 %. fonio is the unarguably the tiniest grain known.

The pericarp color is almost all through brownish excerpt for *Agyong* which was near white. The polished seeds of *Digitaria Iburua* are whitish in while those of *D. exilis* are Brown. The heaviest and the largest in terms of seed weight and size were *Dampep* and *Dina*t accessions were *Dampep* and the largest size goes to *Dinat.* While among the *D.exilis* accessions, *Agyong* accession had white pericarp and brownish dehulled seeds. *Kure'ep* accession, on the other hand, had brownish pericarp and dehulled seeds. While *Gong-Hala* and *Gindiri* accessions had the brownish white pericarp and brownish dehulled seeds The highest 1000 kernel weight and kernel size (%) of 500 μm & 700 μm was obtained from *Agyong* accession see table 1 but *Gong-Hala* gave the highest kernel size(%) of 400μm than the other accessions. While the lowest 1000 kernel weight (g) & kernel size (%) of 500μm and 700μm and 400μm were recorded by *Gindiri* and *Agyong* accessions respectively. In terms of size and weight, acha grains, with a diameter between 500μm and 700 μm and an average weight of about 4.5% that of pearl millet, 1.7% the weight of sorghum and less than 0.2% the weight of the maize kernel (Jideani and Akingbala, 1993; Chukwu, 2009) fonio is acclaimed to be the tiniest grain in the universe its therefore imperative to use the modern agronomic practices to develop and improve its size. as is done in cereal crops such as maize. All the accessions reached optimum water absorption after a steeping period between 15-20 hours (Figure 1-4). Maximum water uptake occurred after 25 hours. There was no statistical difference in the amounts of water absorbed by the kernels of the two species until after 20 hours of steeping when *D. Exilis* absorbed more water than *D. iburua*.

The energy value in this sample of *acha* from *(*337.3±0.15 in *Gindiri* to 360.13±0.16 KJ.g^{-1}in *kureep* for exilis accessions and 342.26±0.12 in *Dinat* to 348.86±0 KJ.g^{-1} in *Ma'am* for iburua accessions) compares well with the values 378Kcal/100g,358 Kcal/100g,367 Kcal/100g,379 Kcal/100g,374 Kcal/100g and335 Kcal/100g reported from other investigators (FoodData., 2020;Annongu, *et al.* 2019;Ladan, *et al.* 2018;Koréissi-Dembélé, *et al.* 2013a;Barikmo, *et al.* 2007;Irving & Jideani, 1997) respectively. Amylose contents of these accessions are unarguably very high from 25% in *danpeep* an iburua to 28% in *Gonge'hala* for D. exilis respectively), indicative of the non-waxy endosperm in Acha Amylose is a polysaccharide made of α-D-glucose units, bonded to each other through α(1→4) glycosidic bonds. And Because of its tightly packed helical structure, amylose is more resistant to digestion than other starch molecules and is therefore an important form of resistant starch. Starches with higher amylose content will be less susceptible to gelatinization. These starches with higher amylose content do not easily hydrolyse to glucose; that is probably the reason for low glycemic index of starches with higher amylose content. Therefore, amylose content at this level may impart functional properties which might spawn awareness in the use of this cereal plant.

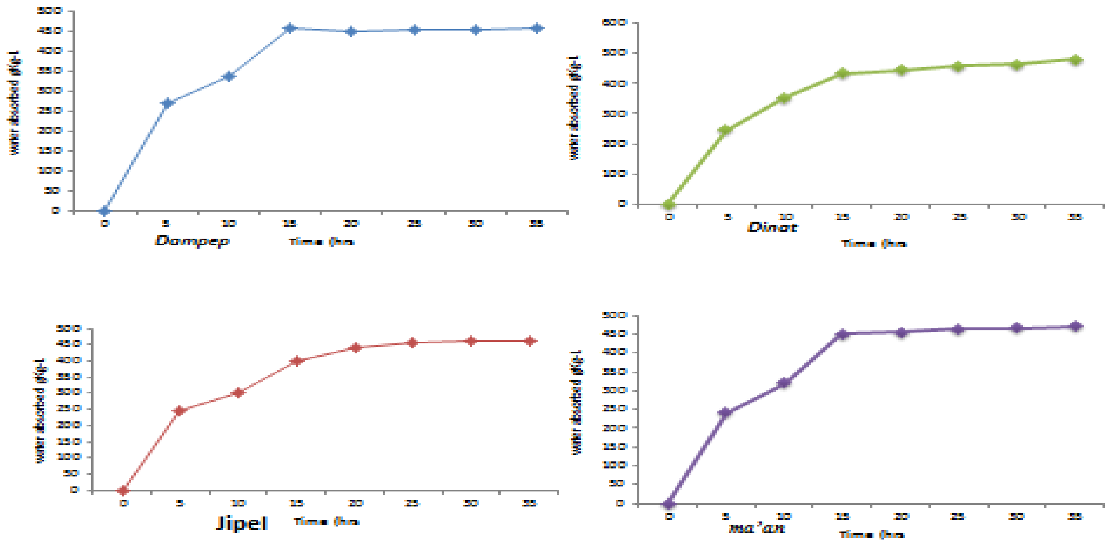

Figure 1a: Kinetics of Water uptake in D. iburua *different landraces*

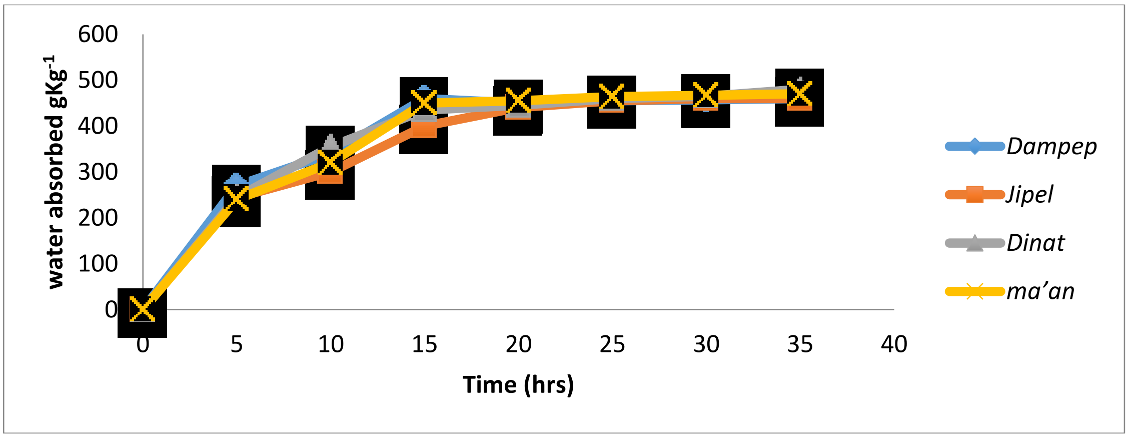

Figure 2b:**Kinetics of Water uptake in *D. iburua* combined.**

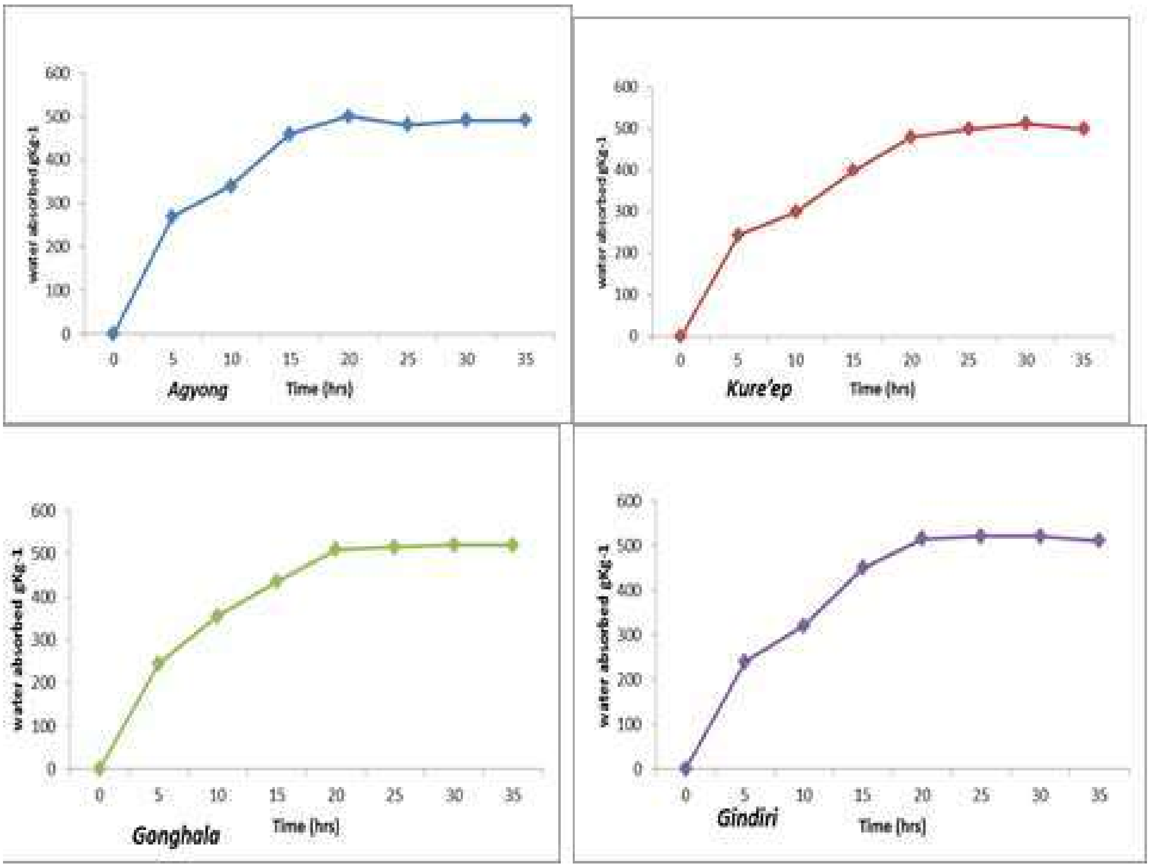

Figure 2a: Kinetics of Water uptake in *D. exilis different* landraces

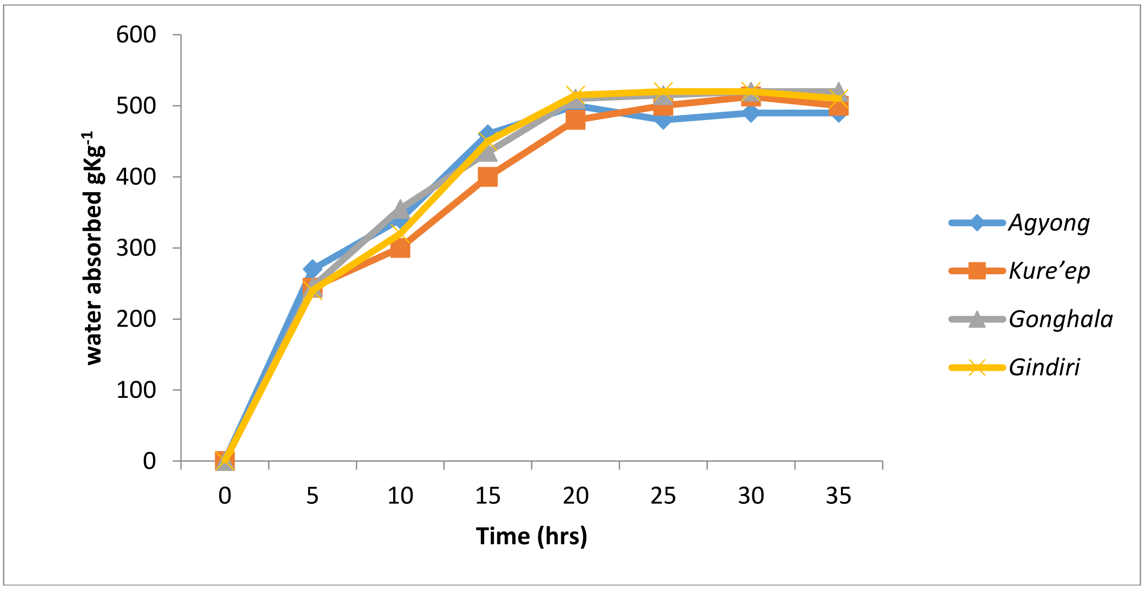

Figure2b: Kinetics of Water uptake in *D. exilis* combined together

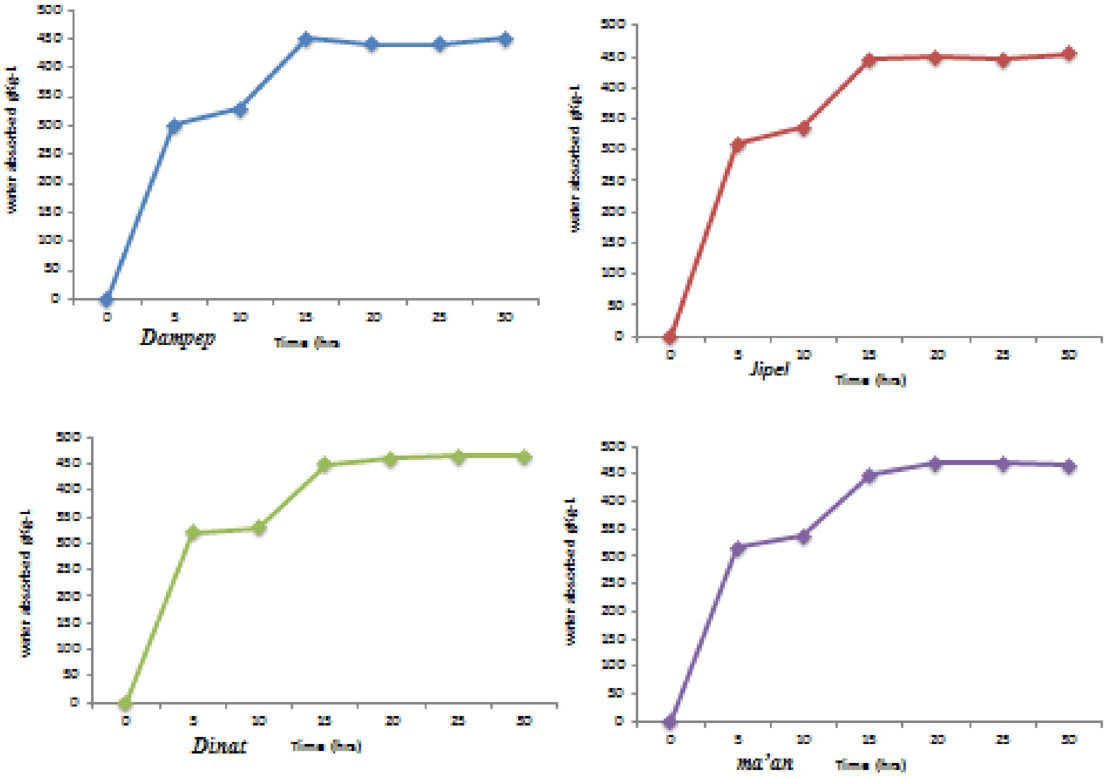

Figure 3a: Kinetics of the Distension patterns of *D. iburua* starches in the four studied accessions

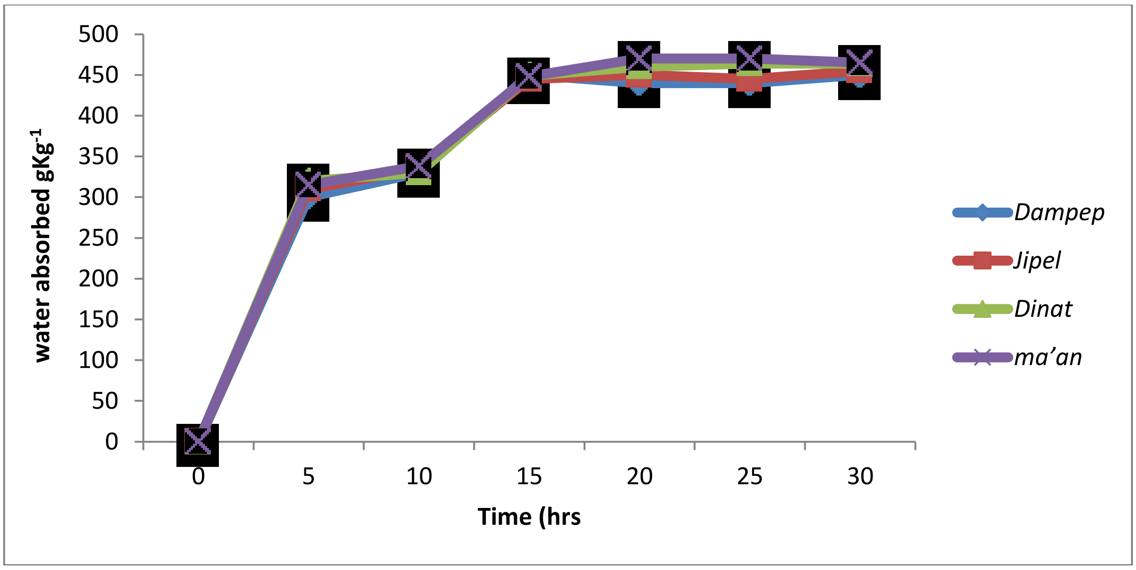

Figure 3b: Kinetics of the Distension patterns of *D. iburua* starches in the four accessions combined

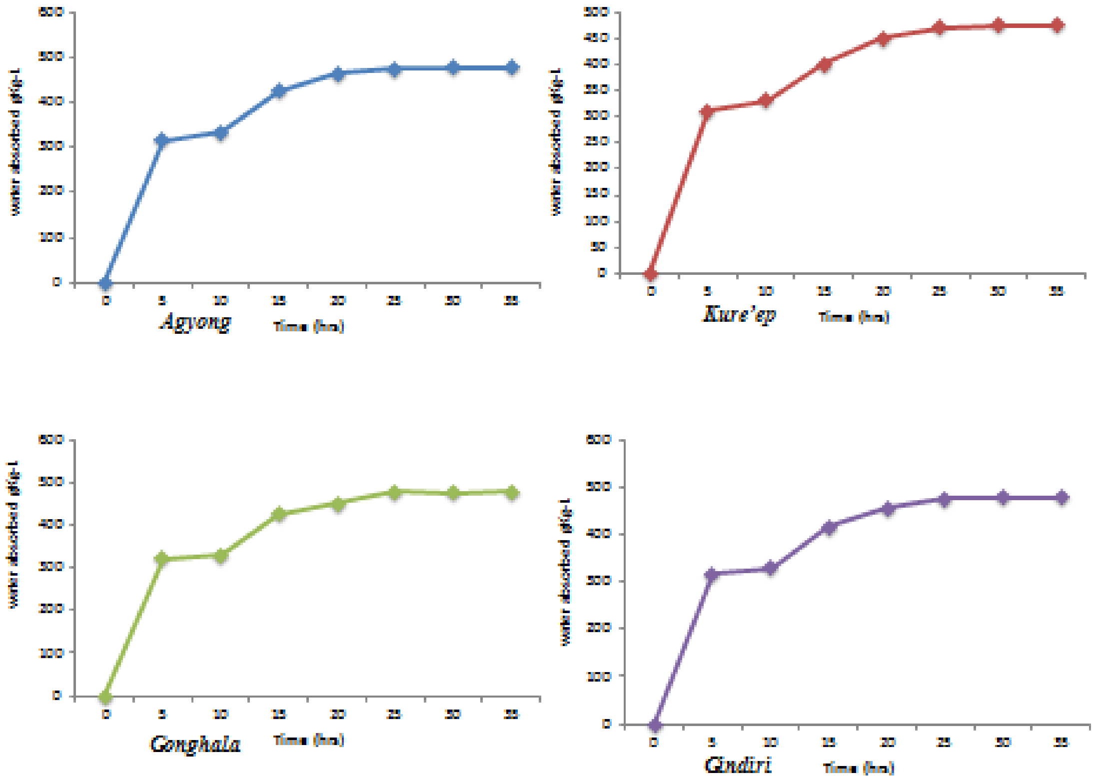

Figure 4a: Kinetics of the Distension patterns of the starches of D. *exilis* accessions

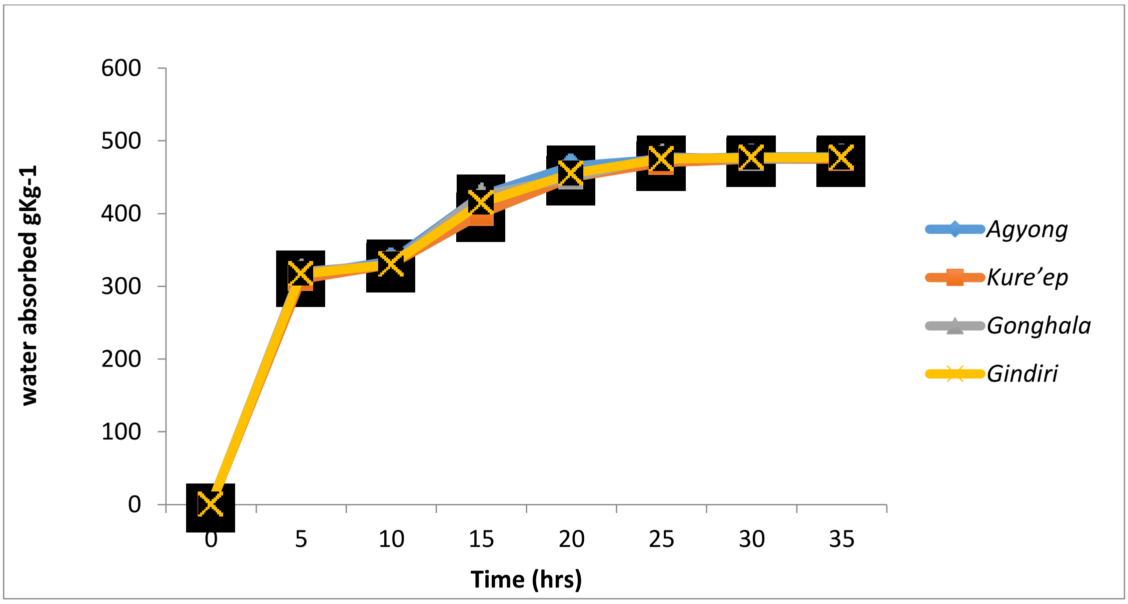

Figure 4b: Kinetics of the Distension patterns of *D. exilis* starches combined

Distension of starches from *D. exilis* and *D. iburua* are presented in Figures 3 and 4. There was a significant difference in the swelling power of starch from the two *Digitaria* species. This is a reflection of the lipid and amylose contents (Table 2). (Dengate, 1984) stated that differences in distension behavior appear to be caused by differences in lipid and amylose contents, together with granule size distribution. Therefore, the insignificant difference in distension power observed for starch from *D. exilis* compared with that from *D. iburua* may be attributed to the insignificant difference in lipid and amylose contents. (Table 2). Jideani and Akingbala (1993) reported that the significant difference in swelling power observed for starch from *acha* compared with maize may be due to the greater amylose content (28 g.kg–1) of *D. exilis* and *D. iburua* starches compared with the maize starch (23 g.kg–1), and to differences in the molecular arrangement of the starch granules due to species. The characteristic two-stage swelling observed in other starches when the temperature of the starch dispersion was raised from 60 to 95°C (Jideani and Akingbala, 1993) was also observed for *D. exilis* and *D. iburua* starches (Figure 3&4). This is indicative of two sets of bonding forces within the granule that relax at different temperatures (Rasper, 1969; Loos, *et al.,* 1981).

Acha Nutritional composition

Carbohydrates. In Table 2, the highest carbohydrate value of 80.99% was recorded in *Jipel* (D.iburua) accession while *kureep* (Exilis) had the least carbohydrate value 69.8%.carbohydrate values can have values as high as as 91% Jideani and Akingbala 1993) and varieties of values like 80%,70%,74%,77%,80% as reported by (FoodData., 2020;Annongu, *et al.,*2019;Ladan, *et al.,* 2018;Koréissi-Dembélé, *et al.,*2013;Coda,*et al.,* 2010) a very low value of 67,9% was reported by (Serna, 2003) these differences could be exploited in making choices in breeding experiments The major constituent of fonio is carbohydrate, which form the main source of energy for humans and other organisms. It forms the basis of several important industrial applications in the food and confectionaries and offers environmentally friendly raw materials for renewable energy. (Ballogou *et al.,*, 2013). It is reported that the carbohydrates from acha grains also have many potential uses in food and nonfood applications. (Ballogou et al 2013)

Fibers: Table 2 indicated that *Agyong* accession had the highest fiber content of 4.64% while *Gyong-hala* had the lowest fiber contained 3.21%. Similarly, other researchers obtained results within the ranges of 4.1%,4.8%,2.2%,2.9%,2.3%,1.0% and 0.8% by (Jideani and Akingbala, 1993;Irving and Jideani, 1997;FoodData., 2020;Annongu, *et al,* 2019;Ladan, *et al,* 2018;Koréissi-Dembélé, *et al,* 2013;Coda *et al,*, 2010) Fibers are constituent of lignin and polysaccharides other than starch, which is the fraction that is being consumed as food and is not degradable in the gut. The high variation in the fiber contents of Acha grains could be attributed to environmental influences, or and genetic factors. It has been reported that Acha has the highest average fiber value compared to sorghum (2.7%), millet (2.0%) and Rice (0.9) (Cruz *et al.,* 2011) Hemicellulose, cellulose and lignin contents of Acha grain were respectively 3 %, 4 % and 0.5% respectively Cruz (2011). The composition of the fiber components in fonio was observed to be higher and unique from other cereals. This suggests that the physicochemical, functional, and nutritional properties of fonio fiber and polysaccharide fractions may be significantly different from those of other cereals as well. For instance, their fermentation process in human GIT may be different to other known cereals. Still, these results are unsettled as more studies are required to illustrate the dietary fiber components of fonio (Zhu, 2020). All cereals are considered as rich sources of insoluble dietary fiber mainly cellulose and insoluble hemicelluloses According to some authors; a high fiber diet may reduce the risk of cardiovascular diseases, colonic cancers, and diabetes. (Serna, 2003).

Energy value: The energy value obtained in this study ranged from 337Kcal/100g in *Gindiri* accession to 360 kcal/100g in *(kureep*) accession. The energy value of acha has been investigated by (FoodData., 2020; Annongu,*et al,* 2019; Ladan, *et al,*2018;Koréissi-Dembélé, *et al,* 2013;Coda, *et al,* 2010) to be 378 kcal/100g, 358 kcal/100g, 367 kcal/100g,379 kcal/100g and 374 kcal/100g respectively. The result obtained was higher than that reported by (Serna, 2003) for other cereals such as rice (180.91 kcal/100g KJ/kg), maize 169.82 kcal/100g and sorghum 162.45 kcal/100g. Our results were in full agreement with previous researchers.

Proteins: Protein content of Acha grains recorded in this study ranged from 7.47% in *Ma'an* accessions to 10.69% in *kureep* accessions see table 2 with a mean value of 8.69% for the eight accessions. These results are in agreement with the values reported by (Cruz *et al*, 2011) with a mean value of 8.05 % (Ballogou *et al* 2013), 10%, 7.7%and 44% were also recorded for (Annongu, *et al.,*2019; Ladan,*et al.* 2018) and (FoodData., 2020) respectively The high protein value recorded in this work could be attributed to purity and distinctness of the Acha accessions used.

Lipids: Lipids are relatively minor constituents in cereal grains. However; they are significant in human nutrition as energy source and essential fatty acids. The values obtained in these accessions ranged from 2.78% to 3.42% in *Jipel* and *Ma'an* accessions with a mean average of 3.078%. other workers (FoodData., 2020;Annongu, *et al.,* 2019;Ladan, *et al.,* 2018;Sadiq, *et al.,* 2015;Glew,*et al.,* 2013) obtained 1.1%,4.3%,4.7%,3.1%,2.7%, respectively This result is in line with Serna (2003).who reported that fat in Acha grains ranged from 1.3 % to 5.2 % with a mean value of 3.25 %. The mean value of fat obtained for Acha grains in this study are comparable to the average lipid contents reported for sorghum (3.2 %) and higher than that of rice (2.5 %) Serna (2003).

Table:2 Chemical Compositions of some accessions of Acha cultivars cultivated in different Agro- ecological zone of Nigeria

NAME of Accessions	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	Carbohydrate (%}	Energy Value (kcal/100g)	Amylose %
Digitaria Iburua								
Dampep	6.36±0.20^{a}	2.59±0.14^{b}	8.42±0.42^{b}	3.04±0.^{a}	4.04±.01^{a}	72.55±.03^{a}	347±0.17^{a}	25^{a}
Dinat	4.46±0.04^{b}	1.27±0.21^{a}	8.43±0.30^{b}	3.22±0.50^{a}	4.21±0.^{a}	75.27±0.09^{a}	342.26±0.12^{a}	25.5^{a}
Jipel	7.95±.02^{a}	1.39±0.31^{a}	8.25±0.22^{b}	2.78±.07^{b}	3.88±0.^{a}	80.99±0.12^{a}	345.02±0.16^{a}	26^{a}
ma'an	6.48±2.1^{a}	1.33±0.12^{a}	7.47±01^{b}	3.42±0.4^{a}	4.32±0^{a}	74.10.±.08^{a}	348.86±0.18^{a}	26^{a}
Digitaria exilis								
Agyang	7.84±0.3^{a}	1.33±0.23^{a}	9.69±0.32^{a}	2.94±0.2^{a}	4.64±0.1^{a}	70.59±0.18^{a}	357.94±0.18^{a}	27.5^{a}
Kureep	7.31±0.2^{a}	2.06±0.12*	10.69±0.51^{a}	3.13±0.1^{a}	3.97±0.1^{a}	69.84±0.16^{a}	360.13±0.16^{a}	27.3^{a}
Gonge'hala	7.42±0.1^{a}	1.66±0.41^{a}	8.94±0.31^{b}	3.08±0.2^{a}	3.21±0.1^{a}	73.45±0.14^{a}	352.76±0.14^{a}	28^{a}
Gindiri	6.84±0.12^{a}	2.23±0.31^{a}	7.52±0.12^{b}	3.02±0.4^{a}	4.43±0,1^{a}	74.96±0.15^{a}	337.3±0.15^{a}	26.9^{a}

Means with the same letter in a given column are not significantly different ($p \leq 0.05$) by the Duncan multiple range test. Energy values, Protein, lipid, crude fibre, ash, are means of three replicates on dry weight basis.

Ash: The highest ash content was obtained in *dampep* (2.59%) accession and the lowest in *Dinat* (1.27%) with a mean value of 1.7% A low ash content of (1 %) was reported by Jideani and. Akingbala(1993) and Fliedel *et al.* (2004). while 2.5% , 3.5%, and 3.7% were reported by (Ladan, 2018) Serma. (2003) and (Annongu, 2019) respectively.

Minerals: Table 3 indicated the mineral content of the eight (8) Acha accessions. The major mineral elements obtained in the acha grains in the study were magnesium, phosphorus, and potassium, Sodium, Iron, manganese, and Calcium. The results of table 3 showed that Calcium ranged from 29.00mgL^{-1} in *Jipel* and *Ma'an* accession to 32.62 mgL^{-1} in *Kure'ep* accession. Sodium (Na) content varies between 0.57 mgL-1 and 0 .34 mgL^{-1} ,K from 0.19 mgL^{-1} to 34 mgL^{-1}, Mg content was between 45.91 mgL^{-1} to 43.22 mgL^{-1}, Fe level was 10.06 mgL^{-1} to 6.85 mgL^{-1}, Mn was-32.62 mgL^{-1} to 50.01 mgL^{-1} and Zn from 6 .78 mgL^{-1} to 9.83 mgL^{-1}- (Egbebi and Muhammad 2016) obtained much higher value for potassium of 0.39mgL^{1}

A close observation at these two tables reveals that the *Agyong* and *Dampep* accession has better combinations of nutritional composition than the other accessions. However, among the iburua species, *Dampep* had a good nutritional combinations table 3. Acha is unique in having very high iron, calcium, and sulfur-containing amino acids (methionine and cysteine) which are vital in growth and development, also critical for replenishment after anemia related illness.

Table 3: Acha Mineral Analysis (mg/Kg)

NAME	Mg	Zn	Fe	Ca	Mn	Na	K
Digitaria iburua							
Dampep	45.91^{a}	7.45^{a}	9.77^{a}	29.08^{a}	43.72^{a}	0.43^{a}	0.31^{a}
Dinat	43.70^{a}	6.78^{a}	7,68^{a}	32.07^{a}	50.01^{a}	0.34^{b}	0.24^{b}
Jipel	44.10^{a}	9.09^{a}	6.85^{a}	29.00^{a}	32.62^{b}	0.44^{a}	0.32^{a}
ma'an	45.60^{a}	7.64^{a}	8.05^{a}	29.00^{a}	45.76^{a}	0.45^{a}	0.27^{b}
Digitaria exilis							
Agyong	44.08^{a}	8.76^{a}	10.06^{a}	30.76^{a}	40.65^{a}	0.51^{a}	0.30^{a}
Kureep	43.62^{a}	8.57^{a}	9.37^{a}	32.23^{a}	48.34^{a}	0.47^{a}	0.34^{a}
Gyong-Hala	43.22^{a}	9.83^{a}	8.73^{a}	31.25^{a}	43.11^{a}	0.48^{a}	0.31^{a}
Gindiri	43.90^{a}	8.90^{a}	8.50^{a}	31.01^{a}	44.70^{a}	0.57^{a}	0.19^{b}

Means with the same letter in a given column are not significantly different ($p \leq 0.05$) by the Duncan multiple ranges test. Mg^{2+} ,Zn^{2+} ,Fe^{2+} ,Ca^{2+} ,Mn^{2+} ,Na^{1+} K^{1+} are means of three replicates.

CONCLUSION

Physicochemical properties of two ecotypes of Fonio (Acha) (*Digitaria exilis and Digitaria Iburua*) grains are near similar. Nutritional benefits of fonio include gluten free, antidiabetic, antioxidant, anticancer, and other properties. Fonio could be processed into a range of food products, including malts, beverage, sourdough bread, puddings, crackers, semolina, breakfast cereals, and weaning foods all of which are considered gluten free. Fonio has the potential for utilization and modification into a range of pharmaceutical products. Largely, fonio grains can complement other cereal grains in nutriceutical applications. Chemical composition, physicochemical and nutritional properties, and food applications of fonio were summarized. The result of 1000-kernel weight showed that *D. exilis* and *D. iburua result is not significant* were of the lightest grain cereals. Whole grain fonio is a source of macronutrients, such as starch, dietary fiber, lipids, and proteins. The protein in fonio contains more methionine and cysteine than those of other cereal grains. Although, protein and lipid contents were however higher than most cereals the result is not significant, The very high amylose content of 280 $g.kg^{-1}$ may convey useful stuffs which could spawn universal awareness in the use of these cereals. Fonio is also a source of micronurients, minerals such as Fe and Zn, and vitamin B. The properties of acha also make it a good candidate for use as food and as well as raw material for several domestic and industrial applications. NCRI Badeggi Niger state Nigeria has over hundred different accessions in stock undergoing genetic purification Work is on advanced stage towards production of novel varieties of Acha. Exploration of acha nutritional characterization is therefore imperative due to its devise uses, including health regiment.

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Assessing Effects of Seed Phosphorus Concentration on Cowpea in Low Phosphorus Soil

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ABSTRACT

Cowpea is an important source of food and feed for humans and livestock, respectively. Despite the significance of the crop and recent advances in cowpea production technologies, the average yield on most farmers' fields remains below 600 kg/ha, partly due to poor soil fertility especially low available soil phosphorus (P) and nitrogen. Seed P content is believed to influence the early vigour and performance of the crop and may play a significant role in achieving good yield in poor P soils. Therefore, this study was undertaken to determine the impact of seed P content on the performance and dry matter production of cowpea at the seedling stage. The research was conducted under screenhouse conditions at the Department of Plant Science, Ahmadu Bello University, Zaria in 2016. Twenty cowpea genotypes were planted on an acid-washed river sand in two groups of P concentrations; 0 and 30 mg/kg soil, representing no-P and high P treatments. A total of 500 g of the river sand was weighed into each of 120 pots for the two P treatments and Hoagland nutrient solutions with slight modifications was used to water the plants weekly. P was provided in the high P treatment using calcium phosphate monobasic. The experiment was laid out in a randomized complete block design in three replications. The results revealed no significant differences exist in the shoot and root dry weight of the genotypes assessed between the two P treatments, except for plant height. These results demonstrate that the seed P was responsible for supporting and maintaining early seedling growth of the shoot and root system of cowpea regardless of the P content of the growth medium. This finding is important for studies targeting screening cowpea for P use efficiency and other related legumes. It will further help in determining critical periods to supply P to soils after cowpeas are planted.

Keywords: acid-washed river sand, calcium phosphate monobasic, genotypes, growth medium

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) is an important grain legume in the dry savannah regions of sub-Saharan Africa (SSA), cultivated on over 14 million hectares with an annual production of about 8.9 MT of grains (FAOSTAT, 2020). The crop is a major staple food in SSA, especially in the dry savannah regions of West Africa. The grains are a major source of plant proteins and vitamins for man, feed for animals, and a source of cash income (Boukar *et al.*, 2018), while the young leaves and immature pods are eaten as vegetables in some areas (Gómez, 2004). There is a big market for the sale of cowpea grain and fodder in West Africa. In Nigeria, farmers who cut and store cowpea fodder for sale at the peak of the dry season have been found to increase their annual income by 25% (Dugje *et al.*, 2009). Despite the dramatic increase in cowpea production in the SSA, the crop's yield has remained one of the lowest among all grain legumes in the region, averaging at 450 kg/ha in 2006 - 2008, which is half of the estimated yields in all other developing regions (Abate *et al.*, 2011). The low yields are due to several constraints including poor soil fertility and use of low yielding variety (Olufajo and

Singh, 2002). P is the most needed element for legume production in many tropical soils, which are inherently low in nitrogen and plant available P.

There is a considerable genetic variation for cowpea's performance under low soil P and external application of P conditions (Sanginga, Lyasse and Singh, 2000; Mohammed *et al.*, 2021) via different mechanisms. Although, the total soil P content usually exceeding the plant requirements, but the low mobility of soil P can restrict its availability to plants. Soluble P in the soil solution should be replaced rapidly by P delivery from bulk soil to the rhizosphere to meet plant demand. Therefore, P dynamics in the rhizosphere are mainly controlled by plant root growth and function and are also highly related to the physical and chemical properties of soil. Because of the unique properties of P in soil such as low solubility, low mobility, and high fixation by the soil matrix, the availability of P to plants is majorly controlled by two key processes; (1) spatial availability and acquisition of P in terms of plant root architecture as well as mycorrhizal association, and (2) bioavailability and acquisition of P based on the rhizosphere chemical and biological processes.

Seed size and its P reserve are believed to be associated with the tolerance of crop plants to soils with low P content. A lot of research has been carried out relating the size of common bean, and cereal seeds to the P content and the performance of these crops. There are limited reports on the effect of cowpea seed size and seed P on the performance of the plant, especially at the seedling stage. Therefore, this study was designed to achieve the following objectives, to; determine the impact of seed P content on seedling performance and dry matter production, and determine the relationship between seed dimension traits and the seed P concentration.

MATERIALS AND METHODS

The research was conducted under screenhouse conditions at the Department of Plant Science/Institute for Agricultural Research, Ahmadu Bello University (IAR/ABU) between August and September 2016. The soils used for this study was acid-washed river-sand. The sand was washed with 1% HCl to reduce the level of salt accumulation, organic matter, and level of P. The river sand was obtained from the river bank around the "Block of 9 Flats Quarters", at Ahmadu Bello University Zaria. The river sand was used because of its inert nature and low level of essential nutrients especially N and P. The sand was aired and sieved with 2.00 mm sieved and 500 g of acid-washed river-sand was weighed into each of a total of 120 nursery pots, already lined with a black polythene bag to prevent loss of sand and water.

Twenty genotypes of cowpea of different seed size from the cowpea breeding unit of IAR/ABU Zaria were used for the experiment. A modified Hoagland nutrient solution used by Rothe (2014) on some cowpea genotypes was adopted; 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 $CuSO_4$, and 0.5 mM $Ca(H_2PO_4)_2$. The no-P treatment did not receive P source (Ca $(H_2PO_4)2.H_2O$), whereas the high P treatment contained 0.5 mM of $Ca(H_2PO_4)_2$. The genotypes were planted under the two P treatments (0 mg and 30 mg P/kg of soil) as no-P and high P using modified Hoagland nutrient solution, where all other nutrients required for normal growth and development were supplied except the P. The experiment was laid in a randomized complete block design with three replications. Prior to planting, seeds were treated with commercial seed treatment (*Dress Force*) according to the manufacturer's recommendation, and 100 ml of reverse osmosis (RO) water was applied to all pots prior to planting. Pots were watered with 50 ml of nutrient solution on 7 days after planting (DAP), 14 DAP and 21 DAP. RO water was applied to the pots occasionally to prevent wilting.

The experiment was terminated at 3 weeks after planting, where all the plants were uprooted, and shoots were detached from the roots at above soil surface using Secateurs. Shoot and root samples were dried at 65^{o}C for 48 hours in an Incubator and weighed to determine dry matter production of the genotypes. The following variables were measured; seed P concentration, plant height (cm), shoot dry weight (g) and root dry weight (g). In addition, the average seed length, seed diameter of the genotypes were recorded using a digital Vernier calliper and weight of 100 seeds was measured using a digital scale. Data collected was subjected to analysis of variance using the statistical analysis system (SAS 9.4) software and means were generated for comparison between low and high P treatments. Pearson product-moment correlation was computed between seed quality traits and seed P concentration.

RESULTS AND DISCUSSION

Performance of cowpea under two soil phosphorus conditions at the seedling stage

There was a highly significant difference for plant height of the genotypes within respective treatments (no-P and high P) and between the low and high P treatments (Table 1). However, the differences between the genotypes for the shoot and root dry weights were not significant within and between the two P treatments (Table 1). There was wide range for seed related traits; SDWT-100 (9.2 – 27.6 g), SDL (6.6 – 21.0 mm) and SDD (4.8 – 7.8 mm) (Table 2), which further confirm that the genotypes were of different seed sizes while the seed P concentration varied from 3.2 to 4.3 g/kg for the genotypes used. The results of the correlation revealed that both the seed length and diameter to be highly correlated with seed weight (g/100 seeds) (Table 3).

The non-significance differences in the shoot and root dry weight between no-P and high P treatments show that seedling growth and development was mainly supported by the inherent seed reserves including P and was not due to the externally applied nutrient of the growth medium. The responses observed for the treatments is expected to be due to P since the two treatments received all the nutrient inputs from Hoagland solution except P which was applied at varying levels (zero and high P). This demonstrates that the seed P content was responsible for supporting early plant establishment because even plants on high P treatment might have used little or none of the P applied at the early seedling phase.

Table 1: Mean squares of cowpea genotypes evaluated at seedling stage under two soil phosphorus levels in a screenhouse in 2016

Source of variation	Plant height (cm)	Shoot dry weight (g)	Root dry weight (g)
Genotypes	10.5**	0.37	0.005
Treatments	24.8**	0.33	0.000
Grand Mean	9.7	0.14	0.050

** $p < 0.01$

Table 2: Means of cowpea genotypes evaluated at seedling stage under two soil phosphorus levels in a screenhouse experiment in 2016

Genotypes	Plant height (cm)			Shoot dry weight (g)			Root dry weight (g)			SDWT-100 (g)	SDL (mm)	SDD (mm)	Seed P Conc. (g/kg)
	LP	HP	Mean	LP	HP	Mean	LP	HP	Mean	Mean	Mean	Mean	Mean
Achishiru-Brown	8.6	13.5	11.0	0.05	0.11	0.11	0.05	0.04	0.04	9.2	6.6	4.8	3.8
Aloca-local	5.3	9.0	7.1	3.02	0.11	0.11	0.03	0.07	0.07	16.8	9.0	6.4	4.1
Biu-local	8.8	11.2	10.0	0.05	0.20	0.20	0.11	0.04	0.04	27.6	21.0	7.8	3.5
Dan-Ila	6.5	9.3	7.9	0.01	0.02	0.02	0.01	0.04	0.04	14.1	9.7	6.4	3.4
GPL85-LPS	9.7	10.5	10.1	0.04	0.02	0.02	0.04	0.02	0.02	10.0	7.2	5.9	3.5
GPL88	7.5	8.9	8.2	0.01	0.04	0.04	0.01	0.02	0.02	11.0	7.5	5.4	3.3
GPLS91-6	8.2	8.7	8.4	0.08	0.04	0.04	0.07	0.06	0.06	12.2	7.0	5.9	3.4
Ife-3	6.8	7.5	7.2	0.05	0.04	0.04	0.05	0.01	0.01	14.0	7.0	5.9	3.5
Ife Brown	8.5	9.5	9.0	0.02	0.10	0.10	0.01	0.04	0.04	16.2	9.0	6.5	4.3
IN06I	8.1	8.3	8.2	0.01	0.04	0.04	0.01	0.04	0.04	18.6	9.2	6.6	4.2
KVX1002	11.0	10.1	10.6	0.23	0.01	0.01	0.07	0.01	0.01	16.7	9.4	6.6	4.3
SAMPEA-1	11.1	9.9	10.5	0.15	0.05	0.05	0.06	0.04	0.04	20.0	9.3	7.1	3.4
SAMPEA-10	NA	NA	NA	0.17	0.06	0.06	4.70	0.02	0.02	18.2	9.1	7.0	4.3
SAMPEA-11	10.9	13.3	12.1	0.06	0.30	0.30	0.06	0.10	0.10	22.0	9.9	7.0	3.6
SAMPEA-14	10.0	9.7	9.9	0.12	0.04	0.04	0.08	0.01	0.01	18.8	8.7	7.7	3.3
SAMPEA-15	12.9	9.5	11.2	0.15	0.21	0.21	0.08	0.24	0.24	21.5	10.4	6.8	4.2
SAMPEA-2	8.6	10.1	9.3	0.01	0.08	0.08	0.01	0.04	0.04	17.3	8.9	6.6	3.6
SAMPEA-4	10.9	11.2	11.0	0.14	0.05	0.05	0.10	0.04	0.04	19.9	9.0	6.9	3.5
SAMPEA-5	0.1	NA	0.1	0.01	0.17	0.17	6.67	0.10	0.10	18.9	7.5	5.6	3.2
SAMPEA-6	10.6	10.7	10.7	0.11	0.05	0.05	0.06	0.04	0.04	13.4	7.9	6.0	4.2
Mean	8.6	10.1	9.1	0.2	0.1	0.1	0.6	0.1	0.1	9.2	6.6	4.8	3.2
Min	0.1	7.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	27.6	21.0	7.8	4.3
Max	12.9	13.5	12.1	3.0	0.3	0.3	6.7	0.2	0.2	16.8	9.1	6.4	3.7

SDWT-100 = seed weight g/100 seeds, SDL = seed length (mm), SDD = seed diameter (mm) and Seed P conc. = seed phosphorus concentration

Table 3: Pearson product-moment correlation seed dimension traits and seed phosphorus concentration of some cowpea genotypes

	SDL	SDD	SDWT-100
SDD	0.67*		
SDWT-100	0.76**	0.83**	
Seed-P-Conc.	0.02	0.09	0.06

**, *Significant correlation ($p < 0.01$) and ($p < 0.05$) respectively. SDL = seed length (mm), SDD = seed diameter (mm), SDWT-100 = weight of 100 seeds, & Seed P conc. = seed phosphorus concentration

Cowpea is majorly used for its grains, known to be rich in protein and vitamins. Tolerance to low soil P is suspected to be influenced by seed available P content and root system architecture of the crop in some genotypes. The mineral content of seeds is important for crop plants especially under sub-optimal soil environments with one or many nutrient deficiencies. In the present study, there was no significant association between seed P and the response of the genotypes under low soil P content of the growth medium. This may be due to few numbers of genotypes used in this study, which is not in a real sense representative of genetic diversity of cowpea genetic resources. However, in common bean, a close relative of cowpea, it was observed that varieties with large-seeds were better than the small-seeded types under low soil P deficiency in terms of seedling growth and dry matter production (Teixeira *et al.*, 2016). Also, increased seed P has been found to be associated with more nodulation and high plant vigour in common bean. For studies reporting an association between seed P and response under low P, have recommended taking seed P into account when investigating P uptake of crop plants. Though high P uptake under low P condition has been reported for cowpea genotypes that are large-seeded (Ojo et al., 2006; Rothe, 2014), this kind of association was found to be heritable and progenies of crosses between large-seeded with high P uptake and small-seeded with low P-uptake genotypes showed that backcrosses to each parent produced even larger seeds with more seed P (Rothe, 2014). It is believed that genotypes that are large-seeded aided seedlings with high P uptake via their seed available P reserve to develop large root surface area that enhances the quick acquisition of P for early seedling growth. The P content of seeds depends on several factors especially the P content of the growth medium. Thus, varieties with high P reserves are more expected to take up higher P from the growth medium like soil or nutrient solution.

CONCLUSION

From the present study, though there was no significant difference in the performance of cowpea genotypes evaluated at the seedling stage for shoot and root dry matter under the two P levels. It can, therefore, be deduced from these results that the seed reserves including seed P concentration were responsible for the early seedling performance of cowpea since both the no-P and high P treatments had similar performance when treated with Hoagland nutrient solution that varied in just P content. Though the number of cowpea genotypes used in this experiment is small compared with many available germplasms for the crop, it can, therefore, be inferred that seed size (seed length and diameter) and weight of seeds (g/100 seeds) have no significant association with the amount of P contained in the seed.

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Management of Invasive Aliens in Nigeria

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ABSTRACT

Invasive aliens are living organisms that invade new areas either through migration or through human aids and become a problem in new areas. Invasive aliens have been identified as enemy of conservation and agriculture and food security today. The best method of management of invasive aliens is to avoid introduction. This involves enactment of laws, risk analysis and border control with the help of National Agricultural Quarantine Service. Another management strategy is monitoring and taking action immediately any invasive alien is detected or noticed. Though most practiced management strategy is maintenance by chemical, mechanical, cultural and biological control. Another method of control in Nigeria is to find a positive use for invasive aliens. Among the common invasive aliens in Nigeria are fall armyworm (Spodoptera frugiperda), Witch weed (Striga species), Siam weed (Chromolaena odorata), Mexican sunflower or Tree marigold (Tithonia diversifolia), Leucaena (Leucaena leucocephala), Gliricidia (Gliricidia sepium). These pests are managed in various ways in Nigeria.

Keywords: Invasive aliens, migration, risk analyses, management strategy

INTRODUCTION

Invasive aliens are biotic entities- plants, animals, pathogens and other organisms taken intentionally or unintentionally from their nativity to another ecosystem and eventually become a nuisance to new environment by causing economics, environmental and health hazards. They cause damage to other biotic life or biodiversity by out-competing, or eliminate or cause reduction and decline in the native biodiversity. They can achieve this by feeding on the native biodiversity en-mass as a result of their population achieved through rapid multiplication and reproduction. It can be by predation or by transmission of pathogens. It can also be by allelopathic method, thereby dis-stabilizing and disrupting their new environment and thereby affecting ecosystem functioning. Common invasive aliens especially plants which are common in Nigeria include *Tithonia diversifolia*, *Chromolina odorata*, *Leucaena leucocephala*, *Gliricidia sepium*. The recent invasive alien in Nigeria which is an insect is Fall armyworm (*Spodoptera frugiperda*)

***Spodoptera frugiperda* (Fall Armyworm)**

Over 200 years ago, fall armyworm (FAW), *Spodoptera frugiperda* (J.E Smith), was recognized as a serious economic pest (Luginbill 1928; Wiseman 1987). It is one of only a few insects that periodically disperse and breed throughout the United States of America (Wiseman 1987). Fall armyworm (*S. frugiperda*), therefore is an insect pest native to the Tropical and Sub-Tropical Regions of America. It is a long distance migratory and transboundary pest. It is an harmful insect that has been rapidly spreading out in African continent (Goergen *et al*., 2016; IPPC, 2016). Recent reports have confirmed that the recent introduction and rapid spread of Fall armyworm (FAW) has emerged as a great challenge to Maize production, threatening food security for the majority of households in Africa (Kafaci 2019). FAW turn the leaves of Maize and cereals to rag looking mass, thus reducing photosynthetic ability of the cereals thereby reducing the yield.

Some farmers in Nigeria claims that with the first notice, spraying with cypermethrine at 10ml/ 10 litres of water will be efficacious in the control of FAW on a field. Some farmers used organic insecticides that worked as systemic insecticide immediately they notice infestation. Most smallholder Farmers in Africa, however cannot afford spraying insecticide for controlling FAW (Kafaci, 2019). Developing and deploying IPM strategy based on reliable scientific knowledge on FAW biology, ecology and migratory behaviour, is indispensable (Kafaci, 2019).

Chromolaena odorata (Siam Weed)

Chromolaena odorata (L.) R.M King and Robinson (Syn. *Eupatorium odorata*) belongs to the family Asteraceae. Siam used is another invasive aliens in Africa. It is produced from seeds and also vegetatively from basal shoots. It is a troublesome weed of open cultivated fields, roadsides, plantain crops and cocoa plantation. It is wide spread in Africa from the coastal fringes to the rainforest to the southern edge of the Guinea Savanna (Akobundu *et. al*., 2016).

Siam weed normally produce many seeds and this makes invasive. It also produces allelopathic substance that makes the surrounding weeds die and wither away. Siam weeds normally changes the surrounding ecosystem due it its reaction to burning. It increases burning and heat in a slash and burn farming communities. This makes seeds of other weeds to die and almost go into extinction, whereas because of large seed production and probably because of the resistance of its seed to burning, Siam weed increases its boundary and spread, thus invading more territory. Its seeds also are airborne. Yoruba in Nigeria calls it “Akintola”. It was named after a renowned politician in Nigeria.

The way farmers manage it are hand pulling, hoe weeding, slash and burn and the use of herbicides. However, farmers also use it for making green manure and farmyard manure. It is also used ethno-botanically by squeezing the leaves and apply the water extracts to a fresh wound to stop bleeding.

Figure 3: Rabbit Farmer harvested Tithonia diversifolia *to feed his rabbits*

Figure 4 A lady holding Chromolaena odorata

***Tithonia diversifolia* (Mexican Sunflower; Tree Marigold)**

Tithonia diversifolia (Hemsl.) A. Gray, is a bushy, perennial weed. It can grow up to 2-5m. It can reproduce from seeds and from vegetative regrowth of the basal stem when the plant is cut. The inflorescence is a solitary capitulum on a peduncle 7-15cm long with large orange-yellow florets 5-10 cm across. The fruit is a compressed and awned achene about 6mm long (Akobundu *et. al*., 2016).

The plant was probably introduced into West Africa as an ornamental plant but later become invasive alien. It probably has affinity for lead, which is why it is common on roadsides. Although an unidentified plant is trying to outcompete the tree marigold on the major highway in Nigeria. The Yorubas in Nigeria call it "Sepeleba" literally meaning "put a curse on Malaria" because of its efficacy in treating Malaria fever. It is also called 'June 12". This is propably due to its becoming prominent in 1993 when a presidential election was annulled in Nigeria. Like Siam weed, it produces fire resistant numerous seeds while its stalk make fire hotter during farmers' slash and burn. This destroy the seeds of other plants while its own seed survive and grows luxuriantly in the following rainy season. It also produces allelopathic substances and modify environment to suit its own flourishing. Farmers use it as green manure and farmyard manure. It is controlled by hand pulling, hoe weeding, slash and burn and also either by ordinary water decoction or by hot water decoction. It is administered by drinking.

Leucaena leucocephala

Leucaena leucocephala belongs to the family Fabaceae and subfamily Ceasapiniodeae. It is another invasive alien in Nigeria. It is a small fast growing mimosoid tree native to southern Mexico and northern Central America (Belize and Guatemala) and is now naturalized throughout the tropics. Common names include white lead tree, jumbay, river tamarind, subabul, amd white popinac. International Union of Conservation of Nature (IUCN) considered *Leucaena leucocephala* as one of the 100 worst invasive aliens in the world (Wikipedia, 2019). It is managed by cutting and burning. However, Leucaena is known for its nitrogen fixing property. It is used for fencing and firewood. It is also used for charcoal production. More importantly it is used as a browse plant to feed goat and sheep. A highly relished food in Nigeria is pounded yam. It can be referred to as "goat pounded yam "considering the way goat relished it.

Gliricidia sepium

Gliricidia sepium often referred to as Gliricidia also belongs to the family Fabaceae. It is also a leguminous plant and therefore has the ability to fix nitrogen in the soil. It is called ''Agunmaniye'' by Yorubas in Nigeria. It is used for live fencing, as fodder, firewood and green manure and for intercropping (Wikipedia, 2019). Because the survival rate of the "cuttings" is high, therefore it is commonly used for shade construction in Nigeria in villages by trade unions (artisans) and traders. The traders selling agricultural produce normally construct their make shift rectangular or square shades with *G. sepium*. Also, motorcycle transporters also sometimes construct their stations with Gliricidia. *Gliricidia sepium* also has ethno-botanical use of treating malaria by decoction with water. The management is by cutting down and used as a firewood or used in making charcoals.

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Responses of Boabab (*Adansonia degitata*) to Organic and Inorganic Manure in Semi-Arid Region of Nigeria

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ABSTRACT
A set of experiment was set to evaluate the growth of Baobab (Adansonia digitata) with responses to organic manure and NPK fertilizer in semi-arid region of Nigeria. The experiment was set up at permanent forest nursery site of Ministry of Environment Zone II, Jahun Local Government Area of Jigawa State. The treatments include four (4) levels of cow dung manure (0, 30, 20 and 10g per plot) and NPK (15, 10 20 and 0kg per plot.) and neem tree leaves 10g per each pot. The experiment was laid completely randomized and replicated three times. Characters measured include the seedling height (cm), number of branches, number leaves and stem girth (mm). The results obtained was analyzed using discreet method like mean, media and mode. Result revealed that there was significant effect of treatment in all the characters measured where 30g of cow dung + 10g neem leaves excelled in both characters, where 11.73cm height, 7 number of branches and 16 number of leaves and stem girth up to 2.9mm in diameter and the control is the least. Therefore, 30g+10g neem leaves is recommended in the experimental area and that the tree doesn't need much in organic fertilizer for its growth.
Keyword: Adansonia degitata, Semi –Arid Region, NPK, Cow dung

INTRODUCTION
Adansonia degitata is commonly referred to as (Boabab or monkey bread in English, Kuka in Hausa, Hamaraya in Arabic, pan de seoze in French, Mbubu in swahilli and after brotbaum in German (Somande *et al*., 2014)). It belongs to the family bombaceae and order malvaceae (Essien *et al*., 2015). The tree is of utmost important in the region (Savannah Region of Nigeria) and in the world at large in many ways.

The importance of the tree includes the use of the pulp as food or drink, the leaves are added after grinding in soup, the pulp is eaten row or fresh and in dry powder foam as soap. It is used also as vegetable and oil is extracted from the seed which is eatable by man in cooked foods. The rope is used in making ropes and paper mills, basket, bags and other weaving craft (*Burkins, 2000*). The pulp is used in treatment of ailments like fever, diarrhea, malaria, and it is used as source of vitamin c. It is also used in treatment of eye problem and in the case of measles in children (*FAO, 2014*). The leaves are used as animal feeds (Essien *et al*., 2015). In view pharmacological importance the tree contains a lot of chemicals which can be used as row materials in chemical industries.

The name *A. degitata* commemorates the French botanist, Michael Adanson (1727-1806). Who lived in Senegal for 6 years and write work on that country's national history, Lenners dedicated the genus and species to him. Degitata means shape.

The tree is an African origin and now grows in warmer part of the world (Nwachuku *et al*., 2015) the tree lives to an old age up to 1000 years and can grow up to 60 feats tall and its trunk may reach up to 30-50 feet in diameter.

The root has an extensive tap root system up to 6 meters. It can survive in the dry climate and it can store massive amount of water in the stem collected by the tap roots and stored. Information on baobab revealed that Leaves are foliated oblong-ovate. Leaves drops during winter and appear in spring (Nwachuku *et al*., 2015). The flowers are white in color and are large. There are up to 5 petals and is feathery. The flower has a shot life span and is pollinated by birds, insects and wind. (Williams, 2002).

The importance of the tree includes the use of the pulp as food or drink, the use of leaves in soups and the pulp is eaten fresh and in dry powders for soup and it is use as vegetable eatable oil from the seed used in cooking. The back is use in making bags and other weaving materials (Essien *et al*., 2015). The pulp is used in the treatment of fever, diarrhea, malaria and it is a sources vitamin c. Pulp extract when extracted is used in the treatment of eye problem and in the treatment of measles in children (FAO, 2014). The leave is used in feeding our animals. (Rahuj *et a,l,* 2015). In view of pharmacological activities, the tree contains a lot of chemicals which can be used as sources of row materials in chemical industries (F11RO, 2013).

MATERIALS AND METHOD

Study Area

The experiment was conducted in Jahun L.G.A at permanent forest nursery site of Jigawa state ministry of environment zone II Jahun. Jahun local government of Jigawa state is located at longitude 9.56N and 12.08E. The area is located in the Sudan Savannah Region of Nigeria. Annual rainfall 600mm and annual temperature is 27^{o}c - 15^{o}c during hamattan (December to January). There is a strong wind at the onset of the raining season (June-July). The soil of the area is sandy and sandy loamy except in the Padama areas where clay or clay loamy exists. Raining season is from June to October while dry season is from November to May. The experiment consists of seven treatments NPK (0kg/ha, 10kg and 15kg/ha) and cow dung (0, 10, 30 and 40kg/ha) and powdered neam leaves (10kg/ha) in each case except the control. Baobab seeds and the treatments were randomized in a complete block design and replicated three (3) times. Data measured included plant height (cm) number of branches, number of leaves and stem girth (mm). The cultural practice followed in the cause of this experiment includes:

Soil preparation: The soil was mixed thoroughly with different level of NPK fertilizer (10, 15g, and 20g) and filled in five polythene pot per treatment including 10g of neem leave powder, cow dung manure (10g, 30g, and 40g) and filled five (5) polythene pots per treatment including 10g neem leave powder, and sand (3kg) was filed in five (5) polythene pots to serve as a control. The treatments were arranged in the following order;

T1 Sand 3kg (control)
T2 NPK 10kg + Sand 3kg +Neem leaves 10kg
T3 NPK 15g + Sand 3kg + neem leaves 10kg
T4 NPK 20kg + Sand 3kg + Neem leave 10kg
T5 Cow dung manure 10kg +Sand 3kg + Neem leaves10kg
T6 Cow dung manure 30kg + Sand 3kg + Neem leaves 10kg
T7 Cow dung manure 40kg + Sand 3kg + Neem leaves 10 kg

Watering is carried out from seven days morning and evening before sowing.
Two (2) seeds per polythene pots were sown after treated with boiled water for ten hours.
Watering continues for two times daily (morning and evening) with the exception of rainfall days.
Thinning was carried out to one stand per poly pot.
Weeding at two (2) weeks interval was conducted.

Data Collection

The data collected includes; Plant height (cm), number of leaves, number of branches, girth diameter (mm).

RESULTS AND DISCUSSION

The result in table (1) presents the mean seeding height of *A. digitata*. It indicated that there was significant difference among treatments. Seeding height treated with 30g of cow dung + 10g neem leaves with mean value of 11.73 cm, and NPK 15g + 10g neem leaves produced the least (7.31cm).

Number of leaves was significantly affected by treatment s the result showed that treatment 30g + 10g neem leaves produced the highest number of leaves (6.00). Where 15g NPK + 10g neem leaves had mean value (5.24) and the least was the least with mean value of (3.50).h parameters the NPK and manure treatment where the responses follow the gradients ie cow dung produced highest seedling height and number of leaves followed by NPK. This indicated that cow dung has the ability to produce different primary and secondary nutrient in the soil. Cow dung and manure increases the availability of nutrient in the soil. This is the same with the findings of Abubakari *et al* (2015) where organic manure increased yield and yield parameters. Cow dung also reduces the acidity of soil. (Liang *et. al.,* 2012; Rinaldi *et al*., 2015) report

Table II present the number of leaves per stand, it was affected by the treatments, where, 30g cow dung + 10g neam's leaves produced the highest number of stems (7.00) followed by NPK 15g this coincide with the work of Abubakari *et al* (2015) where the responses of growth characters are influenced by cow dung more than NPK.

The treatment affects the steam girth where (table 2) revealed that 30g cow dung + 10g neem leaves produced stem with 0.29mm thick and has the highest thickness (performance). Followed by NPK 15g +10g with mean value of 0.27, while 10g cow dung + 10g neem leaves was the lowest, with 0.25mm thick. There were no significance differences observed between treatments with respect to steam girth.

CONCLUSION

The result obtained from the experiment indicated that plant height, number of leave, number of steam and steam girth was affected by the treatments where the organic matter has the most significant effect on the growth and performance of the tree. So if we want domesticate the tree we can use the organic manure (cow dung) and followed by in organic fertilizer (NPK). The result obtained from the study showed that the best as it shown healthy growth in both height, number of leaves, number of steam and steam girth. Therefore, it is recommended that 30g +10g neem leaves should be adopted in the experimental area, and domestication is very important due to the quality of the tree and its significance.

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Table 1: Treatment mean for seedling height and number of leaves of Adansonia digitata in Semi- Arid Region of Nigeria

Treatment	Height (cm)	Number of leaves
Cow Dung		
0g	3.50	3.50
10g	7.91	3.56
30g	11.73	6.00
40g	7.31	4.00
NPK		
10g	7.31	4.01
15g	11.52	5.24
20g	7.8	3.53

Table 2: Treatment mean for seedling Girth and number of branches in Semi -Arid Region of Nigeria

Treatment	Girth diameter(mm)	Number of Branches
Cow Dung		
0g	0.25	2.00
10g	0.27	4.00
30g	0.29	7.00
40g	0.26	4.00
NPK		
10g	0.26	3.00
15g	0.27	5.00
20g	0.26	3.00

Comparative Effect of Bio Slurry, Cow Dung and Inorganic Fertilizer on the Growth and Yield of Maize

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ABSTRACT

The quest of seeking for alternative means of enriching the soil other than the use of scarce and expensive synthetic fertilizer which has adverse effect on the soil and bulky nature of organic manure gives the drive for this study. An experiment was conducted at the Horticulture and Floriculture unit of Federal College of Agriculture Ibadan to determine the comparative effect of bio slurry, cow dung and inorganic fertilizer on the growth and yield of maize. The experiment was arranged in a complete randomized complete design having four treatments replicated three times. The treatment applications were, cow dung, NPK and bio slurry all at the rate of 90 kg N/ ha. The growth and yield parameter collected were plant height (cm), stem girth (cm), leaf area (cm^2), number of leaves and yield of maize (kg/ha). Data collected were subjected to analysis of variance (ANOVA) and significant means were separated using least significant difference (LSD). The result obtained from this work showed that maize treated with NPK gave yield which was comparable to those of bio slurry but significantly higher from those of cow dung while control had the least yield. Hence bio slurry is recommended since it competes favourably with NPK in terms of yield.

Keywords: bio slurry, synthetic fertilizer, organic fertilizer, yield

INTRODUCTION

Energy is required in agriculture for crop production, processing and storage, poultry production and electricity for farmstead and farm settlements. The energy demand required to meet up with the agricultural growth of Nigeria is high and growing every year. Energy propels agricultural mechanization, which minimizes the use of human and animal muscles and its inherent drudgery in agriculture. The low level of agricultural mechanization in Nigeria can be attributed largely to the lack of affordable energy, leading to the dismally low power-use intensity of 0.18 kW/ha as compared to globally recommended average of 0.4 kW/ha (Itodo, 2007). One of the ways of generating energy for farm mechanization is from biogas. Biogas can in turn be generated from animal dung, human excreta and biodegradable materials through the use of a digester.

Bio-slurry can be considered as a good quality organic fertilizer. Analysis of representative cow dung and pig dung slurry samples from biogas plants has shown bio-slurry contains both macro and micro nutrients besides appreciable quantity of organic matters. Bio-slurry is a good fertilizer for crops and improves the soil fertility, soil structure and yields of crops. It is often better than regular Farmyard Manure (FYM) and may also reduce the use of chemical fertilizers. With the right rate of 10 to 20 tons/ha in irrigated areas and 5 tons/ha in dry farming, crops can show significant increase in yields. Indeed, bio-slurry increases crop revenues by 25 percent on average. It is used to improve soil fertility, soil structure, and crop productivity, and it can be an excellent fertilizer (Wamars, 2013). Biogas slurry is considered a good source of organic fertilizer as it contains considerable amounts of both macro (N, P, K) and micronutrients (Zn, Mn, B) that are necessary for plant growth (Alam, 2006). Use of biogas slurry is providing a sustainable way for agriculture, environment and farming communities. However, with many advantages derived from the use of bio-slurry, not many farmers are familiar with the use of bio-slurry. Also, with the changes in the global climate system and the demand for more food together with more nutrients for the growing population, new innovations in policy as well as institutions are required to meet these needs.

Maize is a cereal that is regarded as a heavy feeder crop because it requires nitrogen in relatively large quantity for optimum performance. In maize production, nitrogen is considered as an important yield determinant factor and its availability in sufficient quantity throughout the growing season is essential for optimum maize growth (Kogbe and Adediran, 2003). There is the need therefore to look at the effects of bio-slurry on the performance of a crop plant that requires these macro nutrients in considerable quantity. The objective of these study therefore is to look at the effect of bio-slurry on the growth and yield of maize.

MATERIALS AND METHODS

Description of Experimental Site

The experiment was conducted at the floriculture and horticultural department of Federal College of Agriculture Ibadan. Ibadan is located in the southwestern part of Nigeria and lies between longitude $3^0 54^{11}$E and latitude $7^0 23^{11}$N. The annual mean rainfall is 1250 mm per annum and is classified under the sub- humid tropical zone. The rainfall pattern is bimodal and soil type is ferric luvisol. The average temperature is about 30^0C.

Land preparation and lay out

The land was mechanically prepared with the use of plough and was harrowed 2 weeks later. Marking out of plots was done with the use of measuring tape and pegs. The whole experimental site was 38x6 m^2 which was divided into 32 plots of 1x1m^2. Each plot was separated by 0.5m furrow. Soil samples from the top soil were randomly collected at different points from 0 - 20cm depth with the use of a bucket auger. The soil samples were air dried, crumbled, sieved and mixed before composite sample was done in the laboratory for routine soil analysis.

Preparation of Bio- Slurry

Bio -slurry was prepared by collecting fresh cow dung and placing it in a bio gas digester constructed at the engineering department of Federal College of Agriculture Ibadan. The cow dung was left in the digester to ferment for 40 days and afterwards brought out and then applied to the plots.

Experimental Design and treatment application

The experimental design was laid out in a Randomized Completely Block Design (RCBD) with eight treatments replicated three times. Each replicate was separated by 0.5m. Two varieties of maize were used. The treatments applied were include cow dung, bio slurry and NPK all at the rate of 90kg/ha for each of the varieties used. Cow dung was applied at 2 weeks before planting, while bio-slurry was applied 2 days before planting and NPK was applied two weeks after planting. Hence the treatments were:
T1: treatment of maize with cow dung
T2: treatment of maize with NPK
T3: treatment of maize with bio- slurry
T4: maize with no treatment

Description of planting Materials
White maize BR 9928 which is DMR-W was gotten from seed store of Institute of Agriculture and Research Training (IAR&T) Ibadan.
Cultural practices:
Two seeds were sowed at a spacing of 25 cm x 75 cm. The plots were weeded at two weeks interval.

Data collection
Growth and yield parameters were taken from four tagged plants of each plot to access the response of the treatments applied. They include:
Plant height (cm): Plant height of maize was measured using a ruler from the base of the plant to the tip of the last emerging leaf.
Leaf Area (cm^2): The length and breadth of the plant were measured with ruler and multiplied with a constant K (0.75) to determine the leaf area (Elings, 2000).
Number of leaves: number of leaves from each tagged plants were counted and recorded.
Stem girth (cm): Stem girth was measured using venire caliper and recorded in cm
Maize yield (kg): The weights of the harvested maize taken were using a scale and recorded in kg

Statistical Data Analysis
All the data collected were subjected to Analysis of Variance (ANOVA) and the significant means were separated using Least Significant Difference (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

Physical and Chemical Properties of the Soil
Table I showed that the pH of the soil was acidic (6.1), available Phosphorus was 30.58g/kg, organic Carbon was low which is 0.782(g/kg) total Nitrogen was very low which is 0.092 (g/kg) The textural class of the soil is sandy loam.

Chemical composition of cow dung and bio- slurry
Analysis of Bio slurry and cow dung used for this experiment in table 1 showed that nitrogen content of cow dung was low (0.168 g/kg) while that of bio- slurry was lower (0.12g/kg); phosphorus in cow dung was 0.23g/kg while that of bio-slurry was 0.10. Potassium in cow dung was 0.90g/kg while that of bio- slurry was 0.24k/kg.

Effect of treatment of plant height of Maize (cm)
Effect of treatment on maize plant height as seen in table 2 showed that treatment effect was significant on plant height of maize throughout the period of observation. At 2 weeks after sowing (WAS), maize treated with cow dung was statistically similar to those treated with NPK but were significantly (<0.05) taller than others with control having the least value. At 4WAS, maize treated with cow dung were significantly (<0.05) taller than others while maize treated with NPK and bio- slurry were statistically similar in height but were also significantly (<0.05) taller than control. At 6WAS, maize plants treated with cow dung were statistically similar with those treated with NPK and bio-slurry but were taller significantly (<0.05) than control. The same trend was observed at 8WAS.This could be the effect of mineralization of the manure which leads to quick release of nutrient into the soil for increase in plant height.

Effect of Treatment on leaf area of Maize (cm^2)
Effect of treatment on maize leaf area was presented in Table 2. At 2WAS, leaf area of plants treated with NPK, significantly (<0.05) wider than those plants with cow dung and control but was statistically similar with those treated with bio-slurry. At 4 WAS, maize treated with NPK was significantly higher than those treated with cow dung. At 6 WAS, maize treated with bio-slurry was statistically the same with those treated with cow dung and NPK but significantly higher than control. Same trend was observed at 8 WAS.

Effect of treatment on Maize Number of Leaves

Results of the treatments on maize number of leaves in Table 2 showed that, at 2 and 4 WAS, treatment did not exert any significant difference on maize number of leaves. At 6WAS, plants treated with NPK was at par with those treated with cow dung but had more numbers of leaves significantly (<0.05) than those treated with bio slurry and control. Although plants treated with cow dung and bio-slurry have the same number of leaves statistically with mean values of 6.44 and 6.22 respectively. At 8WAS, plants treated with NPK, had more leaves significantly (<0.05) higher than those treated with bio- slurry and control but was statistically similar with plants treated with cow dung.

Effect of Treatment on Maize Stem girth (cm)

Treatment effect was not significant on the stem girth of maize throughout the period of observation in this study (Table 2).

Effect of treatment on maize Grain Yield (kg/ha)

Effect of treatment on grain yield shown in Table 3 revealed that, maize treated with NPK with mean value 2.43kg/ha was significantly (<0.05) higher than those treated with cow dung (2.20kg/ha) and control (2.02kg/ha) but was statistically the same with those treated with bio-slurry (2.35kg/ha). This result buttress the fact that Bio-slurry can also be used to build up health fertile soil for crop production. It contains easily-available plant nutrients and it contains higher amounts of nutrients and micronutrients than composted manure and FYM (Ishikawa *et al.*, 2006). It can be seen that the effects of bio-slurry application are comparable to the effects of the application of synthetic fertilizers. Hence, digested bio-slurry can be a precious alternative to synthetic fertilizers. Biogas slurry is considered a good source of organic fertilizer as it contains considerable amounts of both macro (N, P, K) and micronutrients (Zn, Mn, B) that are necessary for plant growth (Alam, 2006).

CONCLUSION

Result obtained from this study showed that bio- slurry compete favourably with convectional fertilizer (NPK) to bring about appreciable increase in yield of maize hence bio –slurry at the rate of 90 kg/ N/ha can be used as a substitute for NPK fertilizer to bring about appreciable maize yield of 2.35 kg/ha. Bio slurry at the rate of 90 kg N/ ha which is less bulky and environmental friendly is hereby recommended in this study.

Table 1: Physical and Chemical properties of Pre- cropping soil

Soil properties	Value
pH	6.1
Available Phosphorus (mg/kg)	30.6
Organic Carbon (g/kg)	0.782
Total Nitrogen (g/kg)	0.092
Exchangeable bases (c mol/kg)	
Calcium (Ca^{2+})	0.52
Magnesium (mg^{2+})	1.22
Potassium (K^{+})	0.14
Sodium (Na^{+})	0.21
Exchangeable acidity (H^{+})	0.32
Particle size g/kg	
Sand	852
Silt	68
Clay	80
Textural class	Sandy loam

Chemical Properties of Cow dung and Bio slurry

Properties	Cow dung	Bio slurry
Nitrogen	0.168(%)	0.012 (%)
Phosphorus	0.23 (%)	0.10 (%)
Calcium	2.03 (%)	0.084 (%)
Magnesium	0.75 (%)	0.079 (%)
Potassium	0.90 (%)	0.24 (%)
Sodium	11.96 (%)	0.004 (%)
Manganese	7.10 (mg/kg)	15.85 (mg/kg)
Iron	147.5 (mg/kg)	150.5 (mg/kg)
Copper	69.5 (mg/kg)	0.88 (mg/kg)
Zinc	150.00 (mg/kg)	3.66 (mg/kg)

Table 2: Effect of Treatment on Plant height of Maize (cm), Leaf area (cm^2), number of leaves, Stem girth (cm) and yield of maize (kg/ha)

Treatment	2WAP	4WAP	6WAP	8WAP
NPK	14.73	28.00	42.22	120.67
Slurry	11.11	23.89	41.88	119.56
Cow dung	10.67	23.88	41.89	118.56
Control	9.00	19.66	32.44	82.66
LSD(0.05)	3.68	4.03	3.34	10.77
Leaf Area (cm^2)				
NPK	25.67	83.66	120.78	121.56
Slurry	34.67	85.90	130.44	135.00
Cow dung	33.55	74.00	140.55	141.33
Control	16.67	65.22	106.89	107.78
LSD(0.05)	5.92	15.77	23.75	22.76
Number of leaves				
NPK	4.33	5.45	6.44	7.11
Slurry	4.33	5.45	6.67	7.44
Cow dung	4.00	5.55	6.22	6.78
LSD(0.05)	ns	ns	0.41	0.63
Stem girth (cm)				
NPK	2.01	2.23	2.48	2.89
Slurry	2.10	2.26	2.68	2.94
Cow dung	2.01	2.20	2.65	3.04
Control	2.13	2.31	2.58	3.01
LSD(0.05)	ns	ns	ns	ns

Effect of treatment on maize yield

Treatment	Value (kg/ha)
Cow dung	2.20
NPK	2.43
Bio slurry	2.35
Control	2.02
LSD (0.05)	0.10

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Growth and Yield of Three Varieties of *Vigna unguiculata* (L.) Walp as Influenced by Compost

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ABSTRACT
The need for integrated plant nutrition management and soil fertility maintenance for better performance, and improved crop production. The experiment was conducted to examine the growth and yield of different varieties of Vigna unguiculata as influenced by composted organic fertilizer. The experiment was laid out in a 4 x 3 factorial with four treatments and three varieties replicated four times. The treatments used were: control (no fertilizer), 2.5 t ha^{-1}, 5 t ha^{-1}, and 7.5t ha^{-1} composted organic fertilizer while three varieties used were 97k-499-35, 99k-573-1-1 and 96D-610. The fertilizers was applied 2 weeks before planting. Data collected were plant height (cm), stem girth (cm), number of branches/plant, number of leaves/plant, leave area (cm^2) and yield. The result of the study shows that the application of fertilizer gave no significant ($p<0.05$) difference in plant height, stem girth, number of leaves, number of branches and yield. The yield has an increase of (298 - 455 t ha^{-1}) in varieties 99k-573-1-1, (12 - 38 t ha^{-1}) in varieties 97k-499-35 and (136 - 144 t ha^{-1}) in varieties 96D-610 from the control plot to where 7.5t ha-^{1} organic fertilizer was applied. The result revealed that the three varieties of cowpea assessed were viable and can be recommended to farmers for planting because of its contribution to the sustainabilty of cropping system and soil fertility improvement through provision of cover, plant residue and nitrogen fixation. Farmers could be advised to plant all the varieties with minimal fertilization to start up and reduce cost of production as statistics shows no significant difference in all the parameters measured. However, further research is inevitable with increased composted fertilizer application rate to examine if the production could be increased and at the same time economical to the farmers.
Keywords: Growth, Yield, Compost, Cowpea

INTRODUCTION
Cowpea (*Vigna unguiculata* L Walp) is an annual legume commonly referred to as southern pea, black eye pea, Cowpea in tropics and subtropics (Rajapaske and Vaneniden, 1997). It is a member of the family *Leguminosea* genius *Vigna*. Cowpea is a common food crop throughout Nigeria but particularly in the middle belt and drier northern region (Ojuderie *et al*., 2009). It is an important food grain legume for 200 million people in the dry savanna of tropical African. It is particularly important in West African with over 9.3 million metrics tonnes of annual production (Oritz, 1998). The grain is a source of protein while the haulms are valuabnle source of livestock protein (Fatokun, 2002). It is asource of income for small holders farmers in sub-saharan Africa and contributes to the sustainabilty of cropping system and soil fertility improvement in maginal lands through provision of cover for soils, plant residue, nitrogen fixation and seppressing weed. However despite its great inportance, the grain yield production is low compare to other legumes (Leite *et al*., 1997).

In Nigeria, 80% of cowpea production is mainly in the savanna zone of the country (FAO, 1999). A wide range of yields have been recorded for cowpea, but are generally low. Among factors reponsible for the low yield are low fertility as most tropical soil are defficient inessential nutrient particularly Nitrogen and Phosporus (Haruna, 2011).

Traditionally, soil fertility in West African has been maintain through fallow. However, in Nigeria intensive cropping is gradually replacing the traditional shifting cultivation that is associated with long fallow and hence low yield. The steady decline in food production due to reduce length of fallow on land has prompt farmers to amend the soil with different materials such as organic fertilizer in order to enhance plant growth and increased yield (Adepetu, 1997). Although cowpea fixed nitrogen symbiotically, plant dependent on symbiotically fixed nitrogen may well suffer from temporary nitrogen defficiency during the seedling growth once the cotyledonary reserves are mobilised during hypocoty enlogation in cowpea and cotyledon are usually shed one or two days from emergence. It has thus been recognised and demonstated that the application of organic fertilizer which contain nitrogen enhance the early vegetative growth (Ndakemi and Dakoora, 2007) such plant also had more branches and produce many peduncles resulting in greater number of pods, seeds and lager yields due to the effect of phosphorous application (Owolade *et al*., 2006).

There are some reports indicating that in poor soil, cowpea hardly satisfy nitrogen requirement, but the plants performance is improved by fertilizer application (FAO 2005). Organic fertilizers are fertilizers derived from animal matter human excreta or vegetable matter (Heinrich *et al*., 2009). Organic fertilizer is time tested material for improving the fertility and productivity of soil. Almost every kind of organic matter can be used as manure but some are better than the other. This use of organic manure is to meet the nutrient requirement of crops. Organic fertilizer generally improves the soil physical, chemical and biological properties along with conserving the moisture holding capacity of the soil and thus resulting in enhanced crop productivity, along with maintaining the quality of crops produced (Maheswarappa, *et al*., 1999). The soil structure is improved via the use of organic matter and there is increase in water and air permeability by root developing in soil. (Hassanpanah and Azimi, 2012). The main aim of this study is to determine the growth and yield of three varieties of cowpea as influenced by composted organic fertilizer with a view to increasing its productivity for food sufficiency.

MATERIALS AND METHOD

The experiment was carried out at Federal College of Forestry Ibadan on Crop Production Technology experimental plot situated at Jericho hill Ibadan, Oyo state. The area lies between latitude $7^{0}23^{1}$N and longitude $3^{0}51^{1}$E. The climatic condition of the area is tropically dominated by rainfall pattern from 1400mm – 1500mm. The average temperature is 26^{0}C. The three varieties of cowpea 99K-573-1-1, 97K-499-35 and 96D-610 was gotten from IITA Ibadan Oyo State Nigeria**.** The pre-soil analysis was carried out. Three varieties of cowpea were planted and the procured composted organic fertilizer was applied at three different level which are 2.5t/ha, 5t/ha, 7.5t/ha per experimental unit, in which the treatment without fertilizer serves as the control. The treatment was laid out in a 3x4 factorial in randomized complete block design replicated four times. The experimental unit size was 1 m x 1.5 m and the experimental plot area was 55.25m^2. Fertilizer was applied two weeks before planting and two seeds were planted per hole at a spacing of 50 cm x 30 cm giving a total number of fifteen plants per each experimental unit. The mid-row plants were tagged for data collection. Data was collected on Plant height, Number of leaves, Number of branches, Leaf area and Stem?? girth at 2, 3, 4, 5, 6, 7, weeks after planting (WAP). Analysis of variance (ANOVA) was used to analyse data collected. Means were separated using Least significantly difference (LSD) at 5% level of significance

RESULTS AND DISCUSSION

The soil physical analysis revealed that the bulk density was 1.2 g cm^{-3} with sandy loam texture. Saturated hydraulic conductivity value of 12.64cm hr^{-1} indicated a well-drained soil suitable for the production of the legumes these physical properties were adjudged to be adequate for crop production (Sherifat, 2010). The analysis in Table 1 further confirms the assertion and also reveals that the soils are moderate in zinc, high in potassium and phosphorous. Organic carbon and total nitrogen content of the soil were 16.44 and 1.74g kg^{-1} respectively which is above the critical range (Adeoye and Agboola, 1985), nearly neutral pH. The extractable Mn and Fe contents of the soil are high with 324.00 mg kg^{-1} and 283 mg kg^{-1}, respectively. The effects of compost on the leaf area are as presented in table 2. It shows that there was no significant difference in the first week ($p<0.05$) while the second, third and fourth week shows a significant difference ($p<0.05$) only among the varieties and also there is a significant difference ($p<0.05$) in fifth and sixth week in both the varieties and treatment. The effects of compost on plant height are as presented in table 3. It shows that in the first and second week, there is a significant difference ($p<0.05$) only in the variety, the third week shows a significant difference ($p<0.05$) in the level of interaction between the variety and level, while the fourth, fifth and sixth week shows that there is significant difference ($p<0.05$) only in the variety and their level of interaction. This agrees with the findings of (Ghadge, 2013), which states that the use of organic manure such as compost, vermicompost, dry leaf powder on growth and yield of crops increase productivity.

The numbers of branches as influenced by compost were presented in table 4. This shows that in the first week there is significant difference ($p<0.05$) only in the level of interaction between the variety and level while the second, third and fourth, fifth and sixth shows no significant difference ($p<0.05$). This agrees with the findings of Mugwira (1985), legumes have the ability to absorb and transform nitrogen from whatever source to vegetative yield. The numbers of leave as influence by compost were presented in table 5. The table shows that in the first week there is a significant difference ($p<0.05$) only in the variety while the second, third and fourth, fifth and sixth shows no significant difference ($p<0.05$). This agrees with the findings of (Teboh, 2009), the full potential of the improved varieties can be realized only if essential inputs, particularly organic fertilizers are applied both in requisite quantities and in timely manner. The effects of compost on stem girth as were presented in table 6. It shows that in the first and second week there is a significant difference ($p<0.05$) only in the variety while the third and fourth, fifth and sixth weeks shows no significant difference ($p<0.05$). This agrees with the findings of Teboh, (2009), the full potential of the improved varieties can be realized only if essential inputs, particularly organic fertilizers are applied both in requisite quantities and in timely manner. Yield of three varieties of cowpea as influenced by compost was presented in table 7. It shows there was no significant difference ($p<0.05$) in all the parameters that was taken on number of pod, number of seed, weight of pod and weight of seed in varieties, level of interaction and treatment but the effect was felt due to the increase in yield from the control to 7.5 t ha^{-1} compost that was applied and also varieties 99k – 573 – 1 -1 has the highest number of yield. The view is also corroborated by Swift and Anderson (1993), organic fertilizer supplied nutrient which NPK fertilizer could not supply to crops. This showed the potentials of organic fertilizers in increasing the crop yields.

CONCLUSION

The result showed that composted fertilizer has influence on growth and yield of the three varieties of cowpea. It could be observed from the result that there was an increase in leaf area and stem girth in which highest leaf area were observed in the varieties 99k – 573 – 1 -1 at 7.5 t ha^{-1} compost applied and there was a significant difference ($p<0.05$) in plant height and leaf area. Therefore, it can be concluded that there is a need for further research with increased level of application of compost and also variety 99k – 573 – 1 -1 can be used by farmers who are interested in the vegetative growth of cowpea if the motive is mainly for pasture purposes.

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Table. 1: Pre-planting soil physical and chemical properties of experimental site

Soil parameter	Content in soil
pH (H_2O)	5.2
Organic carbon (g kg^{-1})	6.44
Total Nitrogen (g kg^{-1})	0.6
Available Phosphorous (mg kg^{-1})	4.74
Exchangeable cations (cmol kg^{-1})	
Ca	0.74
Mg	1.37
K	0.26
Na	0.70
Extractable micro nutrients (mg kg^{-1})	
Mn	324.0
Fe	283.0
Cu	1.80
Zn	1.89
Exchangeable Acidity (cmol kg^{-1})	
Particle size distribution	1.5
Sand (g kg^{-1})	800
Silt (g kg^{-1})	54
Clay (g kg^{-1})	146
Textural class	Loamy sand
Bulk density (g cm^{-3})	1.2
Saturated Hydraulic Conductivity (cm hr^{-1}	12.64

*= $P \leq 0.05$, ** = $P \leq 0.01$ ns = not significantly different

Table 2: The Growth and Yield of Cowpea on Leaf Area as Influenced by Compost

Variety	Level t/ha	Weeks After planting (WAP)					
		1	2	3	4	5	6
99k-573-1-1	0	22.4	55.9	83.4	83.3	117	128.7
	2.5	29.8	48.6	84.4	97.4	130	160
	5	30.7	50.4	69.4	93.5	103	113.8
	7.5	30.1	61.3	96.3	112.3	117.1	115.1
97k-499-35	0	14.2	14.5	35.1	46.1	62.1	62.9
	2.5	15.7	21.7	35.3	61.7	94.9	106.1
	5	15	17	42	61.4	75.1	86.2
	7.5	19.7	33.9	66.4	81.7	76.7	106.2
96D-610	0	15.1	38.5	62	65.7	74.4	85.7
	2.5	15.9	37.2	59.6	79.3	93.5	104
	5	37.8	52.2	60.2	73.8	86.2	131.2
	7.5	26.9	40.2	52.2	74.9	88.5	99
Lsd variety		10.55^{ns}	20.56*	14.98**	27.55**	5.50**	8.55*
Lsd Level		12.18^{ns}	23.74^{ns}	17.30^{ns}	20.27^{ns}	17.90*	1.42*
Lsd Variety x Level		21.10^{ns}	41.12^{ns}	29.97^{ns}	35.11^{ns}	31.00^{ns}	37.09^{ns}

Table 3: The Growth and Yield of Cowpea on Plant Height as Influenced by Compost

		Weeks After planting (WAP)					
Variety	Level t/ha	1	2	3	4	5	6
99k-573-1-1	0	9.43	13.13	16.00	19.10	2.63	5.60
	2.5	9.83	12.33	16.17	21.33	8.17	0.43
	5	10.30	11.90	14.83	19.67	3.50	6.50
	7.5	10.20	13.13	16.73	17.67	6.33	9.70
97k-499-35	0	8.83	10.80	13.13	18.33	3.03	5.10
	2.5	6.37	9.10	13.00	17.67	6.00	8.60
	5	9.00	11.23	13.33	16.77	0.00	2.10
	7.5	8.80	11.89	16.17	22.33	1.33	5.00
96D-610	0	11.60	13.97	16.00	23.83	5.43	8.10
	2.5	11.37	15.43	18.00	24.00	2.45	5.57
	5	12.20	15.33	18.83	24.40	7.47	1.50
	7.5	10.67	11.27	12.33	20.33	6.43	0.13
Lsd variety		2.064**	1.892**	2.087 ns	2.069**	.527*	.840*
Lsd Level		2.384 ns	2.183 ns	2.410 ns	2.389 ns	.918 ns	3.279 ns
Lsd Variety x Level		4.129 ns	3.784 ns	4.175*	4.138*	.054*	.680*

*= $P \leq 0.05$, ** = $P \leq 0.01$ ns = not significantly different

Table 4: The Growth and Yield of Cowpea on Number of Branches as Influenced by Compost

		Weeks After planting (WAP)					
Variety	Level t/ha	1	2	3	4	5	6
99k-573-1-1	0	5.33	5.33	8.33	10.61	11.67	13.00
	2.5	2.67	4.69	9.67	14.33	12.00	14.33
	5	2.00	5.67	7.00	9.67	12.00	15.00
	7.5	4.00	5.33	9.33	11.67	13.33	16.00
97k-499-35	0	1.00	3.00	4.67	12.00	12.00	12.67
	2.5	4.33	3.67	11.67	13.00	14.00	15.00
	5	3.00	3.00	5.33	11.33	12.33	13.67
	7.5	2.33	6.33	11.00	13.33	13.67	16.00
96D-610	0	4.67	6.33	10.00	13.00	13.67	16.33
	2.5	4.33	4.33	9.33	13.33	11.67	12.67
	5	5.00	8.33	12.00	13.67	14.33	17.33
	7.5	2.67	6.33	10.00	11.33	17.33	18.33
Lsd variety		1.272 ns	2.421 ns	2.798 ns	2.203 ns	2.030 ns	2.207 ns
Lsd Level		1.468 ns	2.097 ns	3.231 ns	2.543 ns	2.344 ns	2.348 ns
Lsd Variety x Level		2.543*	4.194 ns	5.596 ns	4.405 ns	4.060 ns	4.414 ns

*= $P \leq 0.05$, ** = $P \leq 0.01$ ns = not significantly different

Table 5: The Growth and Yield of Cowpea on Number of Leaves as Influenced by Compost

Variety	**Level t/ha**	**1**	**2**	**3**	**4**	**5**	**6**
99k-573-1-1	0	13.00	26.0	39.3	62.3	72.7	87.3
	2.5	9.67	20.7	30.3	59.7	97.7	108.3
	5	7.67	21.0	40.0	49.3	60.3	66.3
	7.5	8.00	23.0	40.3	81.3	65.3	78.7
97k-499-35	0	5.00	14.7	20.0	46.3	67.2	76.7
	2.5	4.33	13.0	27.3	65.7	104.7	112.7
	5	6.00	12.3	18.0	47.3	73.0	84.3
	7.5	7.67	21.3	50.3	90..7	73.7	87.0
96D-610	0	16.0	20.3	35.7	70.0	75.3	89.7
	2.5	12.33	19.7	33.0	54.7	101.3	114.0
	5	16.67	25.7	58.0	75.7	95.3	114.3
	7.5	13.00	22.0	55.3	84.0	68.0	18.3
Lsd variety		3.431**	9.47 ns	22.05 ns	25.04 ns	25.95 ns	25.62 ns
Lsd Level		3.962 ns	8.20 ns	25.46 ns	28.92 ns	29.96 ns	29.59 ns
Lsd Variety x Level		6.862 ns	16.40 ns	44.10 ns	50.08 ns	51.89 ns	51.25 ns

*= $P \leq 0.05$, ** = $P \leq 0.01$ ns = not significantly different

Table 6: The Growth and Yield of Cowpea on Stem Girth Influenced by Compost

Variety	Level t/ha	Weeks After planting (WAP) 1	2	3	4	5	6
99k-573-1-1	0	1.200	1.400	1.633	1.933	2.255	2.467
	2.5	1.067	1.333	1.733	2.133	2.067	2.300
	5	1.133	1.233	1.533	2.067	2.233	2.333
	7.5	1.67	1.433	1.867	2.033	2.433	2.833
97k-499-35	0	0.867	1.000	1.200	1.433	1.700	1.833
	2.5	0.900	1.000	1.300	1.667	2.800	2.933
	5	0.833	1.067	1.267	1.433	2.000	2.200
	7.5	0.933	1.233	2.067	2.667	1.833	1.967
96D-610	0	0.867	1.067	1.500	1.800	2.033	2.267
	2.5	1.200	1.367	1.633	1.933	2.300	2.367
	5	1.33	1.467	2.067	2.433	2.700	3.000
	7.5	1.133	1.200	1.800	2.233	2.300	2.433
Lsd variety		0.1976*	0.2001*	0.3093^{ns}	0.4561^{ns}	0.4511^{ns}	0.4329^{ns}
Lsd Level		0.2282^{ns}	0.2310^{ns}	0.3571^{ns}	0.5267^{ns}	0.5209^{ns}	0.4993^{ns}
Lsd Variety x Level		0.3952^{ns}	0.4000^{ns}	0.6185^{ns}	0.9123^{ns}	0.9023^{ns}	0.8548^{ns}

*= $P \leq 0.05$, ** = $P \leq 0.01$ ns = not significantly different

Table 7: Yield of Cowpea as Influenced by Compost

Varieties	Level $t\ ha^{-1}$	No of pod	No of seed	Weight of pod	Weight of seed
99k-573-1-1	Control	46	298	90	65
	2.5	100	526	206	146
	5	70	375	184	109
	7.5	80	455	192	111
97k-499-35	Control	12	88	22	12
	2.5	30	175	52	32
	5	34	204	63	38
	7.5	28	175	49	38
96D-610	control	85	425	136	102
	2.5	86	400	118	81
	5	85	400	142	102
	7.5	74	368	144	81
LSD Varieties		73.5^{ns}	362.2^{ns}	166.4^{ns}	110.9^{ns}
LSD Level		84.8^{ns}	418.3^{ns}	192.2^{ns}	128.0^{ns}
LSD varieties and level		146.9^{ns}	724.5^{ns}	332.8^{ns}	421.9^{ns}

*= $P \leq 0.05$, ** = $P \leq 0.01$ ns = not significantly different

Principal Components and Cluster Analyses of Genetic Diversity of Bambara Groundnut Grown in Akure

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ABSTRACT
Bambara groundnut (Vigna subterranea (L.) Verdc.) is a protein rich legume in Africa. It is among the neglected and underutilized crops with high nutritional, medicinal and industrial potentials. Twenty-two accessions of Bambara groundnut were planted in the 2019 cropping season in Akure to determine the genetic diversity among the accessions. The experiment was laid out in a randomized complete block design with three replications. Data were collected on growth and yield parameters. Principal Component Analysis (PCA) and Cluster Analysis (CA) were employed to analyze the magnitude and pattern of diversity among the accessions. The first three PC axes captured 77.72% of the total variance. The PCA identified plant height, number of pods, root length, biomass and number of days to 50% flowering as most important characters in discriminating the 22 Bambara groundnut accessions. The genotypes were grouped into three clusters based on their level of similarity by the CA. These clusters displayed a wide range of diversity for most of the traits. CA proved to be an effective method in grouping the accessions for efficient breeding programmes.

Keywords: Bambara groundnut; Cluster Analysis; Principal Component Analysis; genetic diversity

INTRODUCTION

Bambara groundnut (*Vigna subterranea* (L.) Verdc.) is an important legume in Nigeria. It ranked as the third most important grain legume, after groundnut (*Arachis hypogaea* L.) and cowpea (*Vigna unguiculata*). The high carbohydrate (65%) and relatively high protein 18% contents make it a complete food (Doku, 1995). Bambara groundnut is probably the most drought–tolerant of the grain legumes and may be found growing successfully where annual rainfall is below 500 mm and optimum between 900–1000 mm per year (Ocran *et al*., 1998). Bambara groundnut is tolerant to high temperatures and can be grown on poor marginal soils not suitable for other leguminous crops (Yamaguchi, 1998). Bambara groundnut is not attacked by disease and pests in any of its production regions. However, in damp conditions, it may be susceptible to various fungal diseases (Baudoin and Mergeai, 2001).

Climate change and the changing weather patterns associated heat and drought stress are on the increase. Poor yield potential of traditional Bambara cultivars necessitates the need to develop high yielding cultivars for farmers. Development of high yielding varieties requires a thorough understanding of existing genetic diversity as well as magnitude and direction of genetic association among the yield contributing characters. Various multivariate methods can be applied to gather knowledge on genetic diversity in crop genotypes. The commonly used methods include principal component analysis, cluster analysis, factor analysis, canonical analysis, discriminant analysis and Mahalanobis squared distance (D2 Statistics). These statistical techniques identify plants characters that contribute most to the variation within a group of entries. Often, the methods are extended to genotype groupings to cluster entries similar in one or more characters and thus guide in the choice of parents for hybridization

(Ariyo, 1987, Badu-Apraku *et al*., 1999; Odiyi *et al*., 2014). The choice of the most adequate method is dependent on the objectives of the work, precision desired by the researcher, the ease of the analysis and the manner in which data were obtained. Principal components and cluster analyses have been successfully used in classifying, summarizing and describing variation patterns in populations of crop genotypes (Makinde and Ariyo, 2010; Khatun *et al*., 2010; Odiyi *et al*., 2014). Therefore, this study aimed using principal components and cluster analyses to access the genetic diversity of 22 Bambara groundnut accessions grown in Akure.

MATERIALS AND METHODS

The research was carried out at the Teaching and Research Farm of the Federal University of Technology, Akure, Ondo State, FUTA, on coordinates 7º16'N and 05º12'E, having a clay loam soil with pH of 6.9. The experiment was laid out in randomized complete block design with three replications. Each accession was planted on single row plot of 3 meter length and plant spacing of 75 cm (inter-row) x 30 cm (intra-row) with an alley of 0.5 m created between the replicates, for both experimental sites. The land was cleared, ploughed, harrowed and ridged using tractor with the appropriate implement attached to it at each stage of the operation. Each accession was planted under open field conditions during the late rainy season. Planting was done 5th of September, 2019. One seed was planted per hole. Mixture of Glyphosphate and Paraquat herbicides was used immediately after planting, then, hand weeding was done at three weeks' interval consequently throughout the period on field. Harvesting was done manually using hoe to bring out pods of Bambara groundnut carefully. The following data were collected: emergence count, number of days to 50% flowering, number of lateral roots, root length (cm), plant height (cm), biomass (g), harvest index (%), pod weight (g), 100 grain weight (g), and grain yield (kg/ha). Data collected were subjected to Principal Component and Cluster Analyses using Past 3.0. software. The principal component analysis was performed on the mean values for each trait to identify a group of characters that accounted for most of the variance in the set of data. The PCA reduces the dimensions of a multivariate data to a few principal axes, generates an eigen vector for each axis and produced component scores for the characters (Makinde and Ariyo, 2010). The cluster analysis was performed to obtain a dendrogram and to sort the bambara accessions into clusters based on the pattern of similarity and dissimilarity. The procedure sorted the bambara accessions into a dendrogram at intervals of 5% level of similarity starting from a minimum distance of level of similarity when all the twenty-two bambara occurred in a cluster.

RESULTS AND DISCUSSION

Principal component analysis revealed that the first three principal component axes with eigen values 5.25, 1.45 and 1.07, respectively jointly accounted for 77.72% of the total variation among the 22 bambara groundnut accessions studied (Table 1). The first principal component axis (PC1) accounted for 52.50% of the total variation, while PC2 and PC3 were responsible for 14.52% and 10.70% respectively. The variation in PC1 was mainly associated with grain yield (0.42), plant height (0.39), root length (0.38), emergence count (0.37), biomass (0.36), and number of pods (0.35). In PC2, number of days to 50% flowering (0.60) and harvest index (0.51) were the highest influencers in the axis, while harvest index (0.60) and number of pods (0.50) were the major contributing characters in PC3.

Figure 1 shows the score plot of PC1 and PC2 describing the overall variation among Bambara accessions. Result shows TVSu 1547 had the highest positive interaction on PC1, while TVSu 505 had the highest positive interaction on PC2. On the other hand, AKR 002 and TVSu 1532 were the accessions having the highest negative interaction on PC1 and PC2, respectively. From figure 2 which shows the score plot of PC2 and PC3, TVSu 505 had the highest positive interaction on PC2, while TVSu 1512 had the highest positive interaction on PC3. Conversely, TVSu 1532 had the highest negative interaction on PC2 while TVSu 273 was highest on PC3.

Table 1: Principal Component Analysis of the Bambara Accessions showing the 3 principal components

Characters	PC 1	PC 2	PC 3
Emergence count	0.37	0.17	-0.34
Plant height	0.39	0.17	-0.30
Root length	0.38	0.09	-0.18
Number of days to 50% flowering	-0.05	0.60	-0.12
100 Grain weight	0.24	-0.29	-0.26
Harvest Index	0.15	0.51	0.60
Number of Pods	0.35	-0.17	0.50
Grain yield	0.42	-0.11	0.08
Biomass	0.36	-0.31	0.22
Crude Protein	-0.24	-0.31	0.07
Eigenvalue	5.25	1.45	1.07
% Variance	52.50	14.52	10.70
Cumulative Percentage	52.50	67.02	77.72

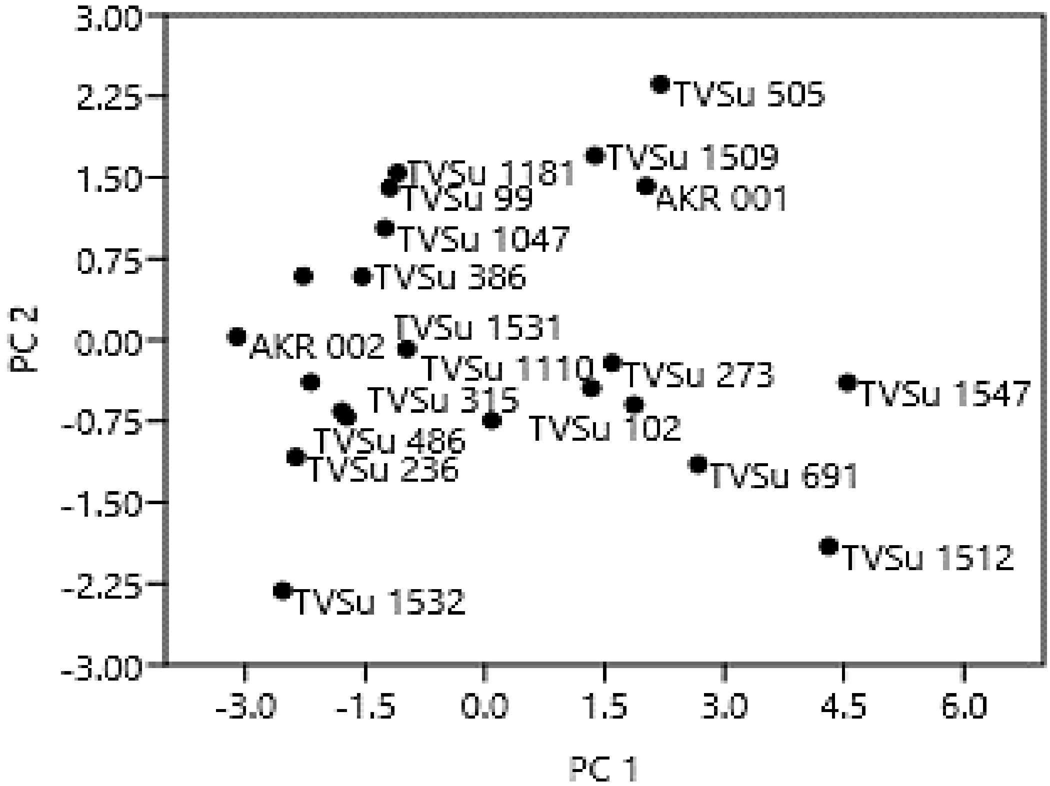

Figure 1: Principal Component score plot of PC1 and PC2 describing the overall variation among Bambara accessions

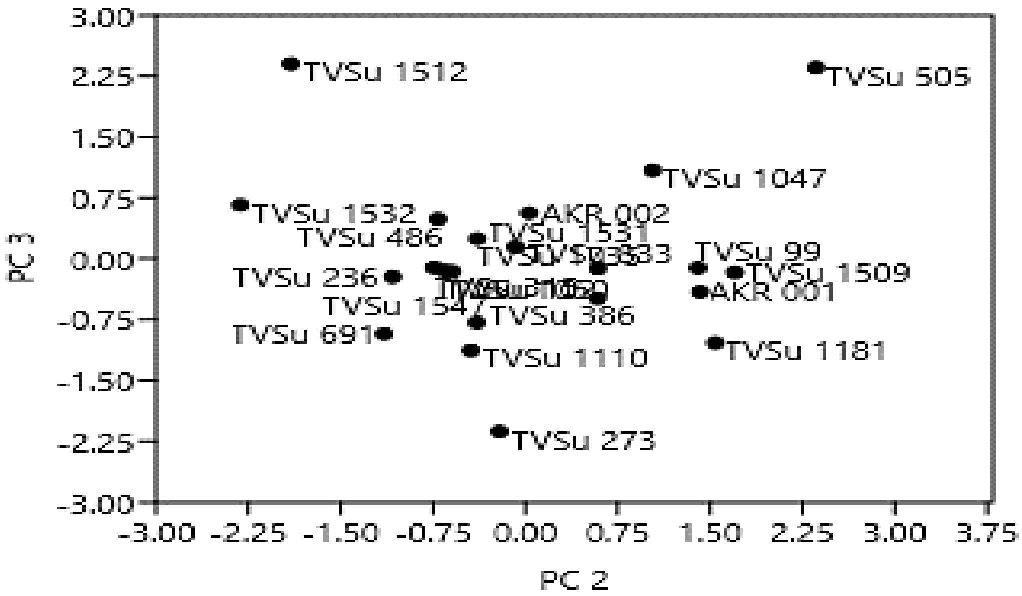

Figure 2: Principal Component score plot of PC2 and PC3 describing the overall variation among Bambara accession

The cluster analysis of the twenty twenty-two bambara accessions presented in Figure 3 and Table 2. The dendrogram grouped the Bambara accessions into three clusters at distance of 250. Cluster I consisted of eleven (11) acsessions including, TVSu 1047, TVSu 833, TVSu 1735, TVSu 1181, AKR 002, TVSu 1050, TVSu 99, TVSu 386, TVSu 236, TVSu 315, and TVSu 486. Cluster II comprised of one (1) accession (TVSu 1512), while cluster III comprised of ten (10) accessions (TVSu 691, TVSu 102, TVSu 273, TVSu 1509, TVSu 1110, AKR 001, TVSu 1531, TVSu 1532, TVSu 1547, and TVSu 505).

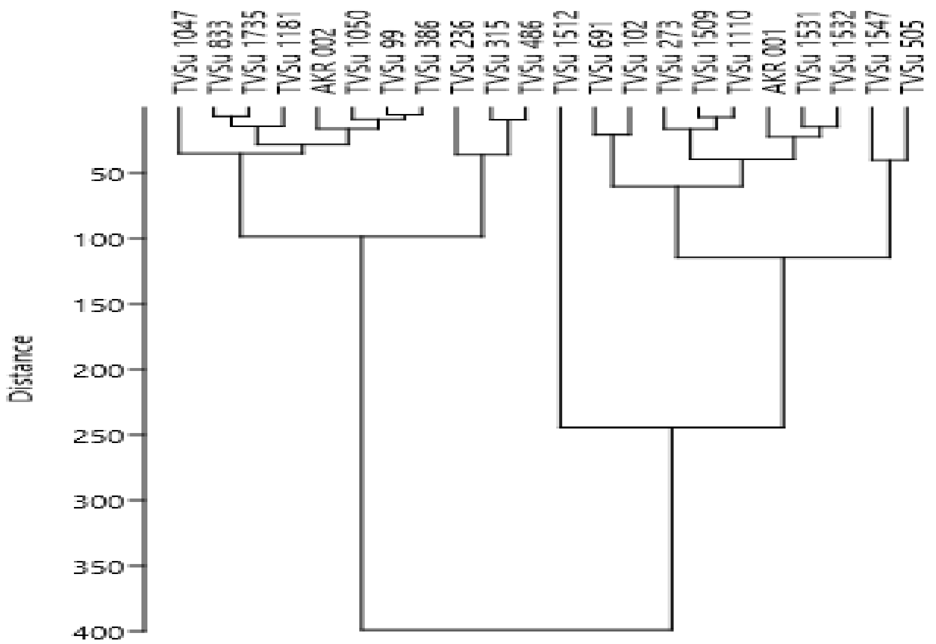

Figure 3: Dendrogram resulting from the Ward Cluster analysis of twenty-two (22) Bambara accessions in Akure.

Table 2: Distribution of the twenty five hybrid sorghum in different cluster

Cluster number	Number of accessions	Accession code
I	11	TVSu 1047, TVSu 833, TVSu 1735, TVSu 1181, AKR 002, TVSu 1050, TVSu 99, TVSu 386, TVSu 236, TVSu 315, and TVSu 486.
II	1	TVSu 1512
III	10	TVSu 691, TVSu 102, TVSu 273, TVSu 1509, TVSu 1110, AKR 001, TVSu 1531, TVSu 1532, TVSu 1547, and TVSu 505.

Genetic diversity among germplasm plays a major role, since it opens the way to determine the most divergent parents based on the contribution of different qualitative and quantitative traits, for further utilization in any hybridization programme (Shukla *et al*., 2009). From the result obtained from PCA, it was clear that though plant height, number of pods, root length, biomass and number of days to 50% flowering contributed significantly to grain yield. From this study, PCA revealed that numbers of pods, grain yield, number of days to 50% flowering, root length, emergence count, plant height, harvest index, and biomass were the most important characters that contributed to the variation that existed among the Bambara groundnut accessions evaluated. Thus, they can be stated as traits of importance. The accessions were grouped into three clusters, each containing Bambara groundnut accessions sharing common attributes and being similar to one another The clusters were grouped according to their morphological differences. This result agreed with Sadia *et al*. (2012) who reported grouping of cultivars based on morphological differences rather than origin.

CONCLUSION

Based on the results obtained, variation existed among the bambara groundnut accessions in a number of characters. These were numbers of pods, grain yield and biomass of Bambara groundnut. The exploitation of these traits provides opportunity to increase bambara groundnut performance in terms of yield.

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PROCEEDINGS

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Rufus Giwa Polytechnic, Owo Ondo State

SUB-THEME 3

Animal Production, Nutrition, Health, Genetic Improvement and Welfare

Performance of Broiler Chickens Fed Air-Dried Bitter kola (*garcinia kola*) Seed Meal at Varying Inclusion Level under Single Phase Isonitrogenous Feeding

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ABSTRACT
The effect of inclusion of air-dried bitter kola (Garcinia kola) seed at varying inclusion levels on the feed intake, body weight, feed conversion ratio and economy of feed efficiency of broiler chickens were studied for the period of 8 weeks of growth, under single phase feeding. Four diets, diet 1 (control diet with 0 % inclusion level of air-dried bitter kola (ADBK)) , diet 2 (5 % inclusion level of air-dried bitter kola), diet 3 ((10 % inclusion level of air-dried bitter kola) and diet 4 (15 % inclusion of air-dried bitter kola) were formulated and fed to a total of 180 day-old broiler chickens that were allotted into four treatments, T1 (control treatment), T2 (treatment 2), T3(treatment 3) and T4 (Treatment 4), with each treatment being replicated thrice with 15 broiler chicks i.e. 15 broiler chickens per replicate making 45 broiler chickens per treatment. There were significant (p<0.05) differences in average daily, weekly and total weight gain, likewise in average daily, weekly and total feed intakes. Also, there were significant differences in feed conversion ratio and economy of feed efficiency.

Keywords: Bitter kola (Garcinia kola), broiler chickens, diet feed, growth period, isonitrogenous

INTRODUCTION
Broiler chickens are farm-reared chickens kept for meaty production. They are bred to be very fast growing in order to gain weight quickly. They provide high quantity and quality meat for household consumption. The production of broilers has increased due to consumers' demand for affordable poultry meat. Nutrition of poultry birds, generally, plays an important role in their productivity, especially in growth and reproduction. The faster a bird grows, the earlier it reaches its maturity. There will be limitation in the productivity of a bird having delayed or poor growth. Broiler chickens are raised specifically for meat, hence, for this purpose, the size and rearing system must be determined with definite ratio of protein and energy. Growth promoters have been used by poultry farmers for increment in growth rate, and overall efficiency and productivity improvement. Various compounds have been used for growth promotion which includes; hormones such as microbial agents. Natural hormones such as estrogen (Oestrodiol) progesterone, testosterone, or synthetic hormones such as Zeranol, melengestrol acetate are widely used as growth promoters in animals (Al-Dobaib and Mousa, 2009). Indiscriminate and inappropriate use of antibiotics as feed additives in animal feed has resulted in diseases such as cancer, kidney and other organ failure in Nigeria (NAFDAC, 2018. There is complete ban, as reported by livestock and aquaculture (2018), on the use of antibiotics (growth promoter and mould inhibitors) in livestock industry. However, phytobiotics have been growing as feed additives to their beneficial effects on growth performance. Phytobiotics are the plant-derive products, added to feed in order to improve performance. These phytobiotics may be available in solids, dried and ground forms, or as extract (essential oils) (Arun, 2009). Bitter Kola (*Garcinia Kola*) is a phytobiotics product, beneficial in improving performance of broiler chickens and rabbits (Arun, 2009). It is a

flowering plant found mostly in tropical rain forest region of Central and West Africa. It is a perennial crop growing attaining a height of 35- 40 m (Adedeji *et al*., 2009). It is an evergreen flowering tree with a heavy, spreading crown. The trunk is straight with brown bark. The leaves are leathery. The flowers are greenish-white. The seed is characterized physically with brown colour, bitter astringent, aromatic flavor: somewhat resembling that of a raw coffee bean (Ajayi and Eyong, 2008).

MATERIALS AND METHODS

***Ethical approval*:** The protocol and procedures for this study received approval from the review committee of Animal care and Use of the Department of Animal Production, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Nigeria.

Study Location

The study was conducted at the Poultry Unit of the Teaching and Research Farm, School of Agriculture and Agricultural Technology, Minna, Nigeria. It is located within latitude 09^0 30 and 09^0 45' and longitude 06^0 30' and 06^0 45E with an altitude of 1475m above sea level. its vegetation is mainly of Southern Guinea Savannah grassland. The mean annual rainfall is 1200mm-1300mm (www. Nigisservices.com)

Experimental Materials Sources

A total of 180 broilers were sourced from chikun farm sales agent within Minna. The bitter kola seeds were purchased in a local market called Owena in Ondo State. Other feed ingredients (i.e. maize, maize offal, GNC, bone meal, fish meal, oil, lysine, methionine and premix were sourced for from Kure market.

Experimental Diets

The bitter kola seeds were sliced in their fresh state, air dried at room temperature for several days after which the thin layer covering were removed. It was grounded into powder form using an hammer mill, the method used by Uko *et al*., (2001) and adopted by Iwuji and Hebert (2012). The bitter kola powder was thoroughly mixed

RESULTS AND DISCUSSION

Table 1 shows the gross composition of the proximate analysis of the experimental diet with the Crude protein ranging from 23.98% in D1 to the 23.72% in D2, while Crude fiber range from 6.05% in D3 to 6.84% in T1, Fat ranges from 5.02% in T2 and 4.78% in T3. Ash has the highest value of 13.42% in T1 and the lowest value of 13.05% in T3 while NFE has the highest value of 47.69% in T4 and the lowest value of 45.27% in T1.

Performance characteristics: Table 2 shows the average treatment means of the initial and final weights, total weight gain, weekly weight gains. Also average daily and weekly feed intake, feed conversion, protein efficiency and energy efficiency ratio are shown. The final weight, average daily, weekly and total weight gain were highest in T1(control treatment fed diet of 0.00 % ADBK inclusion level) followed by T4 broilers (fed diet of 15 % ADBK inclusion level). T2 (fed diet of 5 % ADBK inclusion level) birds has the lowest final body weight. The final weight trend was T1>T4>T3>T2. Average daily, weekly and total feed intake were highest in T4 and higher in T3, lower in T2 and lowest in T1. The trend in the average daily, weekly and total feed intake was T4>T3>T2>T1. The progression in the feed intake indicates the tolerance level of the broiler chickens to bitterness at higher inclusion level, but depressed at lower inclusion level. This is in contrary to the conclusion of Adedeji *et al*. (2008), who concluded that progressive feed intake of the broiler chicks fed bitter kola dry seed powder, as a natural growth promoting agent showed ability of the birds to tolerate the bitterness levels, but depression in the intake at the highest level of 10% inclusion level. Broilers of T2 and T3 had the lowest feed conversion ratio, protein efficiency ratio and energy efficiency ratio i.e. significantly lower than that of broilers of T1(the control treatment). Table 3 shows the economy of feed conversion efficiency of broiler chickens fed diet containing different levels of air dried bitter kola. Feed cost per kilogram ranges from ₦127 in T1 to ₦198.02 in T4. T1 had a lower cost of feed per Kg of price (127). T2 had a higher cost of feed per Kg than T1 (₦183.64) but was lower than T3 (₦192.78). T4 had the highest cost of feed per kilogram of price (₦198.02). With regards to cost of feed consumed per bird, T4 had a higher cost of feed consumed per bird, having ₦922.51, then T3 with ₦867.11, followed by T2 with ₦820.79 while T1 had ₦524.55. T3 had a higher feed cost per body weight gain, having ₦626.54/kg, followed by T4 and T2 with 619.80/kg and ₦602.34/kg respectively while T1 had a feed cost per weight gain of ₦372.11/kg.

CONCLUSION

The result obtained showed that there were significant differences in the weight gain, with the birds in the control treatment(T1) fed with the control diet (D1 of 0 % inclusion level of ADBK) having highest value of weight gain, despite having lowest average feed intake compared to others fed diet containing ADBK (D2, D3 and D4) at varying levels. Also, the control treatment (T1) fed D1(diet of 0 % ADBK inclusion level). had the lowest cost of feed per Kg and good feed conversion ratio. Thus, it can be concluded that feeding broiler chickens with diet containing bitter kola grounded seeds affect the performance of the birds, leading to non-profitability because of the highest cost of the feed, low feed conversion and low weight gain.

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Table 1: Proximate Analysis of the Experimental Diets Containing Different Air Dried Bitter Kola Levels Fed to the Broiler chicken

Treatment%	D1	D2	D3	D4
Dry matter	94.40	94.21	94.27	95.48
Crude protein	23.98	23.72	23.83	23.68
Crude fibre	6.84	6.36	6.05	6.14
Fat	4.89	5.02	4.78	4.86
Ash	13.42	13.39	13.05	13.11
NFE	45.27	45.72	47.56	47.69
Metabolizable Energy	2902.34	2958.70	2928.78	2941.73

D1 =0% inclusion level of Air dried Bitter Kola, D2 =5% inclusion level of Air dried Bitter Kola, D3 =10% inclusion level of Air dried Bitter Kola, T4=15% inclusion level of Air dried Bitter Kola, NFE=Nitrogen free extract

Table 2: Growth Performance of Broiler Chickens Fed Varying Inclusion Levels of Air Dried Bitter Kola

Parameters	T1	T2	T3	T4	SEM	P-value
Initial Weight (g)	20.42	20.43	20.42	20.44	0.00	0.58
Final Weight(g)	1747.20^{a}	1385.03^{d}	1405.41^{c}	1511.03^{b}	43.38	0.00
Total Weight Gain (g)	1726.78^{a}	1364.59^{d}	1384.99^{c}	1490.59^{b}	43.36	0.00
Av. weekly weightgain(g)	215.85^{a}	170.58^{d}	173.12^{c}	186.32^{b}	5.40	0.00
Av. Daily weight gain (g)	30.84^{a}	24.37^{d}	24.73^{c}	26.62^{b}	0.77	0.00
Total Feed Intake	4130.30^{d}	4469.55^{c}	4497.93^{b}	4658.65^{a}	57.98	0.00
Av. weekly feed intake(g)	516.29^{d}	558.69^{c}	562.24^{b}	582.33^{a}	14.49	0.00
Av. Daily Feed Intake (g)	73.76^{d}	79.81^{c}	80.32^{b}	83.19^{a}	1.03	0.00
Feed Conversion Ratio	2.39^{a}	3.28^{c}	3.25^{c}	3.13^{b}	0.10	0.00
Protein Efficiency Ratio	1.76^{a}	1.27^{c}	1.28^{c}	1.33^{b}	0.06	0.00
Energy Efficiency Ratio	0.0136^{a}	0.0100^{c}	0.0106^{c}	0.0106^{b}	0.00	0.00

Means with the same superscripts in the same row are not significantly different (p>0.05) while means in the same row not followed by the same superscripts are significantly different (p<0.05) T1 (control treatment) - fed D1 (diet 1 of 0 % ADBK inclusion level), T2 (treatment 2) – fed D2 (i.e. diet 2) of 5 % ADBK inclusion level, T3 (treatment 3) – fed D3 (diet 3) of 10% ADBK inclusion level, T4 (treatment 4) - fed 15% ADBK inclusion level, SEM – Standard error of mean

Table 3: Economy of Feed Conversion Efficiency for Broiler Chicken

Parameters	T1	T2	T3	T4	SEM	P-value
Total feed consumed (g)	4130.30^{d}	4469.55^{c}	4497.93^{b}	4658.65^{a}	57.98	0.00
Feed cost/kg (₦ /kg)	127^{d}	183.64^{c}	192.78^{b}	198.02^{a}	28.39	0.00
Total cost of feed intake (₦ /kg)	524.55^{d}	820.79^{c}	867.11^{b}	922.51^{a}	40.56	0.00
Final Body Weight (g)	1747.20^{a}	1385.02^{d}	1405.41^{c}	1511.03^{b}	43.38	0.00
Feed Conversion Ratio	2.39^{a}	3.28^{c}	3.25^{c}	3.13^{b}	0.10	0.00
Feed cost/weight gain (₦/kg)	372.11^{d}	602.34^{c}	626.54^{b}	619.80^{a}	6.08	0.00

Means with the same superscripts in the same row are not significantly different (p>0.05) while means in the same row not followed by the same superscripts are significantly different (p<0.05). T1 (control treatment) - fed D1 (diet 1 of 0 % ADBK inclusion level), T2 (treatment 2) –fed D2 (i.e. diet 2) of 5% ADBK inclusion level, T3 (treatment 3)– fed D3(diet 3) of 10% ADBK inclusion level, T4 (treatment 4) - fed 15% ADBK inclusion level. SEM – Standard error of mean

Apparent Nutrient Digestibility of Growing Japanese Quail Birds (*coturnix coturnix japanica)* Fed Diets Containing Graded Level of Ginger *(zingiber officinale*) Waste Meal

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ABSTRACT
The experiment was carried out to investigate the effect of graded levels of ginger (Zingiber officinale) waste meal on the nutrients digestibility of Japanese quails (Coturnix coturnix japanica). The experiment lasted for four (4) weeks and a total of two hundred and eighty-eight (288) Japanese quails of two (2) weeks old of mixed sexes were used. The birds were randomly allocated into four (4) dietary treatments with four (4) replicates. T_1: (diet contained 0 % ginger waste meal), T_2: (diet contained 35% ginger waste meal), T_3: (diet contained 40 % ginger waste meal) and T_4: (diet contained 45 % ginger waste meal). The parameters measured during the experiment were daily feed intake and daily feaces voided. All data were subjected to one-way analysis of variance (ANOVA) using SPSS and where differences occurred, Duncan Multiple Range Test was used to separate the means. The results showed that there were significant (P<0.05) differences in all parameters measured. It was observed that birds on 35 % replacement level of ginger waste meal had the highest digestibility value for crude protein, crude fibre, Ash, Ether extract and Nitrogen free extract than other treatments. In conclusion, ginger waste meal could be used to replace maize up to 35 % in the diets of growing Japanese quails without any negative effect on apparent nutrient digestibility.
Keywords: Japanese quail, ginger waste meal, apparent nutrient digestibility

INTRODUCTION
Nigeria is the largest economy in Africa with a population of over 174 million persons. This amazing data calls for a sustained approach to provide its citizens with quality food especially safe and affordable animal protein. Unfortunately, the level of animal protein intake is absolutely low at 4.5g/day per caput (USDA, 2013). This level of animal protein intake is not befitting of a nation that is the largest economy in Africa and the 26th in the world. One way of increasing the protein supply is to diversify poultry production, as well as increasing the production of other micro-livestock species with a short generation interval (Usman *et al.*, 2008). Japanese quail (*Coturnix coturnix japonica*) is among such micro-livestock animal which is described as an excellent and cheap source of animal protein for Nigerians (Babangida and Ubosi, 2006). Japanese quail are hardy birds that thrive in small cages and are inexpensive to keep. Japanese quail has high prolific tendencies; short generation interval, fast growth rate and can survive in small cages (Odunsi *et al.*, 2007). Feed cost for intensive poultry production is said to be the highest between (60 - 80 %) of the total production cost (Oruseibio and Smile, 2001). The increasing cost of feed ingredients in livestock production have been identified as a serious constraint to meeting the demand for animal protein especially in developing countries (Adejinmi *et al.*, 2010). Maize is a major ingredient used in livestock feed, but competition between man and livestock for maize has resulted in high cost of the cereal. The high cost of maize has necessitated a search for alternative energy-rich feed ingredients for compounding livestock feed. In Nigeria, large quantities of agricultural and agro industrial by-products are

produced and most of them are regarded as waste and classified as non-conventional feed stuffs. The competition between human beings and livestock for available cereal has resulted in high cost of feed production, and consequently higher cost of such livestock. It has therefore become necessary to search for cheaper, but equally effective means of making such feed. Ginger is a plant rich in many phenolic compounds, hence the spicy aroma, taste, fragrance. In the root rhizome are naturally high plant based chemicals known as phytochemicals believed to possess antibacterial and anti-viral agents that protect the plant from natural flora. The rhizome ginger is a plant extensively cultivated in Nigeria and many other countries of the world; it is processed into various products for human consumption. The by-product here is referred to as ginger waste meal (Onimisi *et al.*, 2006).

MATERIALS AND METHODS

Experimental Site

The research work was conducted at the Quail unit of the old Teaching and Research Farm of the Department of Animal Production, Federal University of Technology, Bosso Campus, Minna, Niger State, Nigeria. Minna lies between latitude 9° 28' N and 9° 37' N and longitude 6° 23' E and 6° 33' E with annual rainfall of 1000 - 1500 mm, and temperature range of 28 °C – 42 °C. The vegetation is Southern Guinea Savanna. (Climate-data.org, 2019).

Experimental Materials

The materials and ingredients used for the experiment includes deep litter pen, wooden cages, feeders and drinkers, charcoal, rechargeable lamps, clean water, weighing balance, Japanese quails, sun - dried cassava peel meal, molasses, groundnut cake, maize offal, fish meal, bone meal, limestone, premix salt, synthetic methionine, lysine and vitalyte®.

Source of Experimental Birds and Other Ingredients

Two hundred and seventy-two (272) two weeks old Japanese quails were purchased from National Veterinary Research Institute, Vom Plateau State Nigeria, for the purpose of this study. All the ingredients used for the diet formulation were purchased locally from Gwadabe Market, along Western by-pass, Minna. Groundnut cake, vitamin mineral premix, lysine, methionine, fish meal and bone meal were purchased at Farida shop in Gidan Matasa, Bosso, Minna, while ginger waste meal were purchased from Kafanchan in Giwa Local Government Area of Kaduna State.

Preparation of Experimental Diets

Diets were formulated such that treatment 1 (T_1) had no ginger waste meal (control), while treatments 2, 3 and 4 (T_2, T_3 and T_4) contained 35 %, 40 % and 45 % ginger waste meal respectively.

Management of Experimental birds

Clean drinking water was supplied ad-libitum throughout the experimental period. Routine observations of bird's behaviour and cleaning of the pen, drinkers, feeders, provision of clean drinking water and feed were carried out daily, to prevent any form of infection. Anti-stress (Vitalite®) was administered in drinking water throughout the experiment due to weather changes. At two weeks of age, antibiotic was administered (Tetracycline) for 5 days, through drinking water as prevention against bacterial infection.

Digestibility Trial

Digestibility study was carried out at the end of the growing phase of the experiment (fourth week). The birds in each of the treatment groups were weighed and sacks were placed in each of the replicate pens for seven days for the total collection of excreta samples, with an adjustment period of two days. The total sample collection lasted for five days. Each day's collection was oven-dried for five days and sealed in a foil paper in a desiccator jar for laboratory analysis. Clean drinking water was supplied daily and feed was given to all the birds in each treatment measured equally and the total droppings were collected, for proximate analysis using (Association of Analytical Chemist AOAC, 2000) methods. The formula used to calculate the digestibility is shown below:

$$\text{Nutrient digestibility} = \frac{Nutrient\ intake\ in\ feed - Nutrient\ voided\ in\ feaces}{Nutrient\ intake\ in\ feed} X\ 100$$

RESULTS AND DISCUSSION

The apparent nutrient digestibility of Japanese quails feed diets containing graded levels of ginger waste is shown in Table 1. All treatments had digestibility values of over 50 %, which means they utilized the nutrient beyond average and they have high nutrient digestibility. The results showed that crude protein, Crude fibre, Ash, Ether extract, Dry matter and nitrogen free extract were significantly affected ($P<0.05$). Birds fed diets 2 and 3 (35 % and 40 % ginger waste) recorded significantly ($P<0.05$) higher digestibility value in Crude protein, Crude fibre, Ash and Nitrogen free extract over the control group (0 % ginger waste meal). There were significant differences ($p<0.05$) among the (CP, CF, Ash, EE and DM). This could be attributed to stimulation of digestive enzymes by bioactive compound of ginger and thus overall improvement of digestion. According to Windish *et al.* (2008), ginger has favorable influence on gut function, which is the primary mode of action for growth promoting feed additives. Platel and Srinivasan, (2000) stated that spices enhance the activity of pancreatic lipase, amylase, trypsin and chymotrypsin by 22-27 %, 32-51 %, 63-81% and 12- 38 % respectively. The high digestibility effect may be linked to phenolic compound present in ginger extract which enhance digestion, by stimulating the endogenous enzyme in the guts of broiler chickens (Duwa *et al.,* 2020). Karangiya *et al.* (2016) also reported that incorporation of garlic powder or extract influenced ash and crude fibre digestibility in broilers chickens.

CONCLUSION

From this study it can be concluded that ginger waste meal can be included in Quails diet without any adverse effect. However, birds fed with diet containing 35 % and 40 % ginger waste meal inclusion level were found to have performed better in terms of nutrient digestibility compared to other inclusion level (45 %) and the control (0 %) ginger waste meal inclusion level.

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Table 1: Apparent nutrient digestibility of Japanese quail birds fed diets containing graded level of ginger waste meal

Parameter	T_1 (0 %)	T_2 (35 %)	T_3 (40 %)	T_4(45 %)	SEM
Crude protein (%)	88.37^{b}	92.38^{a}	90.93^{ab}	88.28^{b}	0.63
Crude fibre (%)	92.37^{a}	94.11^{a}	92.43^{a}	88.39^{b}	0.73
Ash (%)	80.94^{b}	87.91^{a}	85.74^{ab}	81.85^{ab}	0.57
Ether extract (%)	74.69^{b}	85.55^{a}	83.08^{ab}	77.79^{ab}	1.63
Dry matter (%)	86.26^{ab}	90.89^{a}	88.90^{ab}	85.64^{b}	0.77
NFE (%)	87.00^{ab}	90.19^{a}	87.83^{ab}	84.91^{b}	0.75

abc; Means on the same row with different superscript are significantly ($p<0.05$) different, T_1– 0 % ginger waste meal, T_2–35 % ginger waste meal, T_3–40 % ginger waste meal, T_4 – 45 % ginger waste meal, SEM – Standard error of means, NFE – Nitrogen free extract

Effects of Different Cooking Periods of Kenaf Seed (*Hibiscus cannabinus*) Meal on Growth Response and Carcass Characteristics of Broiler Chickens

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ABSTRACT
An eight weeks feeding trial was conducted to evaluate the effect of different cooking periods of kenaf seed (Hibiscus cannibinus) on growth response and carcass characteristics of broiler chickens. One hundred and eighty (180) day old broiler chicks were randomly allotted to 5 treatments of 36 birds with three (3) replicated each. T1 served as control, T2 contained raw kenaf seed meal, T3 contained kenaf seed meal cooked for 20mins. T4 contained kenaf seed meal cooked for 30mins while T5 contained cooked kenaf seed meal for 40mins. The cooked kenaf seed meals were used to replace full fat soya bean at 15% inclusion rate in a completely randomized design. Data were collected on feed intake and weight gain. At the end of the experiment two (2) birds per replicate were randomly selected and sacrificed for carcass evaluation. The results revealed significant difference (p<0.05) in all growth response parameters evaluated. However, results of carcass characteristic showed significant difference (p<0.05) in the values of live weight, drumstick, back, wings and abdominal fat, while all other parameters were not significant (p>0.05). It can be concluded that cooked kenaf seed meal can replace full fat soya in broiler feed.
Keywords: Broiler, chickens, carcass characteristics, Hibiscus cannibinus, seed meal

INTRODUCTION
In intensive poultry production systems, feed is the most important input and accounts for 60–80% of total production costs. Protein is one of the main composition of poultry feed and is one of the major contributors to the finished feed cost. However, the rapidly growing poultry industry and the increasing demand for poultry feeds have led to a considerable increase in feedstuff prices (Odetola *et al.*, 2012a). Furthermore, beside the rising prices of feedstuff, the traditional and conventional protein sources in poultry feed such as oil seed meals (SBM and canola meal) and fishmeal are failing to meet the increasing demand due to both sector and human population growth. With these present trends of rising prices and shortage of supply, it seems inevitable to consider alternative protein supplements to fully or partially replace the conventional protein sources in poultry feed (Odetola *et al.*, 2012a). A possible way to reduce poultry feed costs is finding alternatives to conventional protein sources that are inexpensive, efficient and locally available. Kenaf is traditionally known as fiber crop (Webber *et al.,* 2002), but research has highlighted the potential of the seed as a protein sources (Arora *et al.,* 1983; Rajashekher *et al.,* 1993). Kenaf seeds range from 24 - 23% on DM basis (Rajashekher *et al.,* 1993). Analysis of the leafy materials showed values of 8.5% ADF, and 34.0% CP. While the total plant composition levels of NDF, ADF and CPM were 42.2%, 32.6% and 1`7.1% respectively. While seeds have a crude protein content of 33.88% and ether extract 18.55% (Odetola *et al.*, 2012a). Despite the rich nutritional composition of kenaf seed, there are reports of the presence of a number of antinutritional (toxic) factors. Hansawasdi and Kawabatta (2000) reported low levels of tannin, amylase and protease inhibitors, phytic acid and gossypol

in kenaf seeds. Cooking generally inactivates heat-sensitive anti-nutritive factors such as trypsin and chymotrypsin inhibitors and volatile compounds. Omeje (1999) reported that cooking legume seeds for about 30 minutes resulted in the destruction of ANF such as trypsin inhibitors, haemagglutinins, phytic acid, lectin and goitrogen. In soybeans, there were 52.3% reduction in raffinose and 20.7% reduction in stachyose contents after cooking (Mulimani *et al*., 1997). Armour *et al*. (1998) reported complete inactivation of soya lectin and protease inhibitory activity by aqueous heat treatment of fully imbibed soya seeds at 100°C for 10 minutes.

MATERIALS AND METHODS

Source and processing of test ingredient

The kenaf was precisely obtained from Institute of Agricultural Research and Training and full fat soya was obtained from a commercial feed mill in Ibadan. The seeds were cleaned to remove extraneous material; after which they were divided into four equal portions of 25kg each. Hundred (100) liters of cold clean water were first brought to boiling point of 100^{0}C in a solution drum. A batch of 25kg raw kenaf seed was poured into the boiling water and cooking time was taken from moment the kenaf seed was poured into the boiling water, at the end of 20min cooking, water was drained off and the cooked seeds were sun dried for 4days. The same procedure was repeated for 30 and 40mins boiling periods respectively. The dried seeds were ground to pass through 2mm sieve size and stored at room temperature until required.

Experimental diets

Five experimental diets were formulated. Diet 1 contained no kenaf seed meal, Diet 2 contained raw kenaf seed meal which was made of full fat soybean meal at 15% levels, Diet 3,4 and 5 contained 15% inclusion levels of kenaf seed meal of 20, 30 and 40mins cooking period respectively both at starter and finisher stages as presented in Tables 1 and 2.

Experimental animals and design

A total number of 180 broiler chicks were randomly allotted to 5 treatments of 36 birds per treatment which were further divided into 3 replicates of 12 birds per replicate in a completely randomized design (CRD). The birds were brooded together for 7 days before the commencement of the experiment. The brooding pen was washed, cleaned and disinfected with morigad two weeks before the arrival of the birds. Wood shaving served as bedding materials, charcoal and coal pot as heat source were provided before the experiment commenced. Artificial light was also provided to enable the birds to eat at night. On the arrival of the birds, the chicks were provided with glucose solution as anti-stress, vitamins and antibiotics were added to the water for 7 days.

Experimental feed and water were supplied *ad-libitim*. All the routine management procedures were strictly followed. The initial weights of the birds were recorded as they were being assigned to the various treatments groups. Feed intake was monitored daily while the body weight of the birds was recorded on weekly basis. Data generated were subjected to analysis of variance using SAS (2003). The means were separated using Duncans Multiple range procedure of the same software.

RESULTS AND DISCUSSION

The results of different cooking periods of kenaf seed meal on the growth response and carcass characteristics of broiler chicken are presented on Table 1 and 2. All parameters evaluated were significantly ($p<0.05$) influenced by the dietary treatments. Birds on control diets had the highest values for final weight and weight gain, while those fed with raw kenaf seeds had the least values. However, birds on control and those on cooked kenaf seed meal had significantly similar feed conversion ratio which was significantly ($p<0.05$) higher than those on raw kenaf seed meal. Final live weight and weight gain of broilers fed the control diet was highest with value higher than those obtained for cooked kenaf seed meal (CKSM). This implies that inclusion of CKSM in the diets added no positive improvement on the final live weight and weight gain of broiler chickens. This agreed with the work of Maikano, (2013) who reported that feeding differently processed Roselle seeds to broiler chicken did not produce any effect on the weight gain. It also corroborates the work of Mukhtar, (2012) who found out that feeding Roselle seeds with or without enzyme to broiler chickens has no significant (p>0.05) effect on final weight, weight gain and feed conversion ratio. Higher final weight and weight gain recorded for the control diet in this study could be as a result of the relatively low crude fibre of control compared to the CKSM based diets, since increasing the fibre content in diets has negative linear effects on the body weight (Zaczek *et al.,* 2003). Previous literatures also confirm that processing of oil seeds resulted in improved growth performance (Yagoub *et al*., 2008; Kwari *et al*., 2011; Odetola, *et al*., 2012a; Odetola, *et al*., 2014). The same trend was also recorded for the protein efficiency ratio. Live weight, drumstick, wings and abdominal fat were significantly influence by the dietary treatment, while all other carcass parameters measured were not significantly (p>0.05) influenced.

CONCLUSION

It can therefore be concluded that CKSM in the diets of broiler chickens will not have produce any deleterious effect on their growth response and carcass characteristics.

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Table 1: Growth response of broiler chickens fed cooked kenaf seed meal

Parameters	T1	T2	T3	T4	T5	SEM±
Initial weight (g/b)	113.28	113.91	112.00	113.91	113.77	2.10
Final weight (g/b)	2677.33^{a}	1735.67^{c}	2222.67^{b}	2380.67^{ab}	2171.00^{b}	90.04
Weight gain (g/b)	2564.06^{a}	1621.76^{c}	2110.67^{b}	2266.75^{ab}	2057.23^{b}	89.64
Feed intake (g/b)	5868.25^{a}	5761.39^{ab}	5761.61^{ab}	5882.42^{a}	5692.67^{b}	23.95
Feed conversion ratio	2.29^{b}	3.61^{a}	2.75^{b}	2.60^{b}	2.77^{b}	0.18
Protein efficient ratio	0.44^{a}	0.28^{c}	0.37^{b}	0.39^{ab}	0.36^{b}	0.02

FCR: *Feed Conversion Ratio* ***PER:*** *Protein Efficiency Ratio*

^{a,b,c}***:*** *Means with the same superscript on the same row are not significantly different (P>0.05)*

Table 2: Carcass characteristics of broiler chickens fed cooked kenaf seed meal (% of live weight).

Parameter (gm)	T1 0	T2 Raw	T3 20	T4 30	T5 40	SEM±
Live weight (g)	2677.33^{a}	1735.67^{c}	2222.67^{b}	2380.67^{ab}	2171.00^{b}	90.04
Defeather weight	87.05	93.54	94.07	91.37	94.13	1.29
Eviscerated weight	80.08	78.88	76.34	75.61	81.66	1.72
Dress weight	68.12	67.71	69.85	71.47	70.47	1.04
Breast	2.36	2.45	2.32	2.37	2.08	0.07
Thigh	4.61	4.60	5.48	5.46	5.46	0.18
Drumstick	4.35^{a}	3.92^{ab}	3.89^{ab}	4.13^{a}	3.54^{b}	0.10
Back	20.53	20.49	23.85	22.01	24.39	0.70
Wing	11.63^{b}	12.55^{a}	11.57^{b}	12.35^{a}	12.73^{a}	0.15
Head	10.68	10.12	11.00	10.71	10.55	0.16
Neck	14.25	14.57	14.64	13.21	12.54	0.42
Abdomen fat	0.26^{b}	0.69^{ab}	1.14^{a}	1.00^{a}	1.11^{a}	0.11

$\pm$ SEM – Standard error mean

^{a,b,c}***:*** *Means with the same superscript on the same row are not significantly different (P>0.05)*

Growing attributes of Noiler in Comparison with Isa brown and Nera black Pullets

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ABSTRACT

The most common strains keep in Nigeria for egg production are Isa Brown and Nera Black, Noilers are just being introduced. This study evaluated performance attributes of grower Noiler pullets strain as compared to isa brown and Nera black. Eight (8) weeks old pullet growers were allotted into three treatments with four replicates of 22 birds each, each strain represented a treatment. Results obtained revealed that the weight gain and feed intake value of Noiler (12.52g/bird/day and 85.68g/bird/day, respectively) were the highest and significant (p<0.05) to values recorded for Nera black (8.95g/bird/day and 63.73g/bird/day, respectively) and Isa brown (8.84g/bird/day and 61.09g/bird/day, respectively). The values obtained for Isa brown and Nera black were similar (p>0.05). Initial weight and final weight also followed the same trend, Noiler, Isa brown and Nera black had 1213.04g/bird and 2089.25g/bird; 605.25 and 1531.25g/bird; l 574.81 and 1493.33g/bird, respectively, However, the feed conversion ratio, mortality and economy of gain were not significantly (P>0.05) affected by strain. The values ranged respectively as follows 6.87 - 7.23; 0.00 – 1.00% and ₦687.44 - ₦723.72. Noiler proved superior in growth performance compared to Isa brown and near black.

Keywords: Isa brown, Nera black Noiler, weight gain

INTRODUCTION

Various interventions enhancing indigenous chicken productivity have been attempted in the past including breed substitution, crossbreeding/upgrading, and selection within population. Crossbreeding or upgrading of indigenous chicken with commercial exotic chickens through cockerels or pullets exchange was a genetic intervention implemented in the past in several African countries. The intervention started in 1950s in Nigeria where Indegenous chickens were crossed with Rhode Island Red, Light Sussex and Black Australorp chicken (Tiamiyu, 1999). Crossbreds demonstrated superiority in performance (Fayeye *et al*., 2005), but their survival rates were low and the intervention was categorized as unsuccessful (Magothe, 2012). Kuroilers are derived from crossing either colored broiler males with Rhode Island Red females, or, White Leghorn males crossed with female Rhode Island Reds (Sandilands and Hocking, 2012). Kuroilers, a dual-purpose breed producing meat and eggs, can live on a diet of kitchen and agricultural waste, and produce around 150 eggs per year, males weigh approximately 3.5kg and females about 2.5kg, the Kuroiler is also resistant to diseases (www.kuroiler.com/en). Kuroiler is known as Noiler in Nigeria and it is being bred in Nigeria by a commercial hatchery. The Isa - layer strain is of reference for more than 30 years and adapts herself to all climates and environments of the world (Nwankwo and Omeje, 2009). They are excellent layers with a quiet temperament able to produce between 300-350 eggs per hen in the first year of laying. Kabir *et al*. (2013) reported the weight of 1978.00±21.05g for 26 weeks old. Isa brown plumage bird and it is also a brown egger birds as reported by Olawumi (2009). The nera black on the other hand is a black plumage bird with high resistant to heat, 94% livability, 94% at peak production, with low temperament. Kabir *et al.* (2013)) reported Nera black weight of 1887.33±13.11g with feed intake of 2733.33±227.96g at 26 weeks of age and Olawumi (2009) reported egg production of 273.12±36.9 eggs/week.

MATERIALS AND METHODS

A total of 300 pullets consisting of noiler, isa brown and nera black strains (100 chicks each), purchased from two reputable commercial farms and raised to eight (8) weeks on commercial chick mash. At 8th week the birds were allotted into three treatments with four replicates of

22 birds each. Each strain represented a treatment and the birds were fed commercial grower feed, supplied with cool and drinkable water all through. All management practices were observed during the experimental period and all necessary vaccination and medication were applied. The experimental design was Complete Randomized Design (CRD). Data collection included initial weight, weight gain, feed intake, feed conversion ratio, final weight, mortality and economy of production. Data obtained from the study were subjected to Analysis of Variance (ANOVA) and where difference exists between means, Duncan Multiple Range Test was used to separate the means at 5% probability level.

RESULTS AND DISCUSSION

Performance characteristics and economy of gain of three strains of growing pullets were presented in Table 1. Initial weight, final weight, weight gain, and feed intake were affected by strain and the values obtained were significantly different ($p<0.05$). The initial weight of Noiler was the highest (1213.04g/bird) and was significantly higher ($p<0.05$) than those of Isa brown and Nera black. The final weight was also affected by strain. Noiler had (2089.25g/bird) which was significantly higher ($p<0.05$) than Nera black (1531.25g/bird) and Isa brown (1493.33g/bird). The weight gains and feed intake value of Noiler (12.52g/bird/day and 85.68g/bird/day, respectively) were the highest and significant ($p<0.05$) to values recorded for Nera black (8.95g/bird/day and 63.73g/bird/day, respectively) and Isa brown (8.84g/bird/day and 61.09g/bird/day, respectively). The values obtained for Isa brown and Nera black were similar ($p>0.05$) for all the above parameters. However, the feed conversion ratio, mortality and economy of gain were not significantly ($P>0.05$) affected by strain. The values ranged respectively as follows 6.87 - 7.23; 0.00 – 1.00% and ₦687.44 - ₦723.72. The results obtained on performance of growing pullets revealed initial weight, final weight, weight gain and feed intake as they were significantly affected by the strain. The initial body weight values of the three strains were affected by strain. The result showed that Noiler had the highest value than the other two strains had similar values. The final weight of isa brown and Nera black was higher than the mean mature body weight value presented by Ajayi and Agaviezor (2009) for Nigerian local chicken. These two strains values contradicted the study of Olawumi (2009) and Ayorinde and Oke (2009) who presented the weight of 1449.6 ± 17.24g in Nera black and 1445.45g in 20-week hen respectively. Meanwhile, the final weight attained by Noiler goes in line with the study of Lozhikan (1987) who presented the weight of 1.8kg in 20-week white leghorn. The mean feed intake (g/bird/day) of Noiler was significant to that of Nera black and Isa brown. Feed consumption of Nera black was higher than that of Isa brown and this confirmed the work of Imouokhome (2012) and Yakubu *et al*., (2007) who issued the statement that Bovan Nera consume more feed. The feed conversion ratio of Isa brown and Nera black contradicted the value presented by Imouokhome (2012). The values were higher to that of Noiler despite the high feed consumption. Noiler strain of pullets are the most efficient in feed conversion to body weight, and thus cost less to produce the weight. However, feed conversion ratio increased with age at different growing period for the different strain but with Noiler having the largest increase on average. This is an indication of more unit of feed consumption per unit weight gain for Noiler. Noiler appears to be the best among the strain in terms of the feed conversion ratio. Noiler also had the least value for economy of gain and this is as a result of the high rate of converting the high feed to weight. This indicated that Noiler require less unit of feed to gain unit of weight, this could be attributed to the fact that Noiler was bred from heavy breed (Harth, 2011) and broiler are known higher feed conversion (Leeson and Summer, 2013). The result of the mortality showed that Nera black are more rugged than Noiler and Isa brown and this confirmed the conclusion of Olawumi (2009) who reported that parents of black layer strain had lower mortality rate and more adaptable to the hot weather than parents of brown layer strain.

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Table 1; Performance characteristics and economy of gain result of the three experimental strains

Parameters	Treatment 1 Isa brown	Treatment 2 Nera black	Treatment 3 Noiler	SEM
Initial weight (g/bird)	574.81^{b}	605.25^{b}	1013.04^{a}	17.28
Final weight (g/bird)	1193.33^{b}	1231.25^{b}	1889.25^{a}	48.58
Weight gain (g/bird/day)	8.84^{b}	8.95^{b}	12.52^{a}	0.71
Feed intake (g/bird/day)	61.09^{b}	63.73^{b}	85.86^{a}	1.86
Feed conversion ratio	7.10	7.23	6.87	0.60
Mortality (%)	1.00	0.00	1.00	1.16
Economy of gain (#)	700.45	723.72	687.44	59.99

^{ab} means differently subscripted along the same row are significantly different from one another ($p<0.05$)

Immunological Response of Cattle to Gastro-S Intestinal Helminth Burden and Treatment Choice in A Semi-Intensive Management System

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ABSTRACT
The study was conducted to determine the relationship and effect of sex, on the immunological response of 40 cattle to helminth infection over twelve weeks' period in a longitudinal study. The cattle were managed in a semi intensive system and are made up of 29 cows and 11 bulls. Blood and fecal samples were collected at the beginning of the study and taken to the laboratory of the state Veterinary Hospital, Minna for Haematology immunology and parasitogical examination. The cattle were divided into four groups A, B, C and D. Group A was control while group B, C and D were administered Albendazole, Levamisole, Baminth F dewormers respectively. Thereafter, Blood and fecal samples were collected weekly for twelve weeks and analysed in the laboratory. The Results shows that there is significance (p<0.05) difference in weight changes, haemoglobin, packed cell volume(PCV) and white blood cell (WBC) with treatment 4 having highest value compared to other treatments. However, the control treatment (T1) and T3 show similarity. There was also no significant difference (p>0.05) in the immunoglobulin G and immunoglobulin D but immunoglobulin A, E, and M differs significantly (p<0.05) with the control cattle group having the highest titre. It was concluded that administration of antihelminthic drugs lower immunoglobulin titer in cattle. It is recommended that routine deworming exercise be carried out on cattle to minimize the helminth infection.
Keywords: Albendazole, Antihelminthic, Haemoglobin, Immunoglobulin

INTRODUCTION
Livestock are essential agricultural commodity in developing countries of the world. They are reared under a wide variety of production systems ranging from large-scale intensive commercial enterprises to traditional small-holder and village production systems. (Jorgen, 1998). Livestock production is therefore an invaluable component of pastoral and agro-pastoral farming, with human populations largely depending on it for meat, milk, fat, dung and farm energy (Wilson, 1991). In Nigeria, ruminants comprising cattle, sheep and goats constitute the livestock farm animals and about 13.9 million cattle, 22.1 million sheep, 34.5 million goats are currently been reared by farm families in the country as reported by Lawal-Adebowale (2012). These livestock animals are mostly managed on free range/ extensive system and semi-intensive system, where the animals are allowed to roam the streets and neighborhood to feed for themselves with little or no special provision of supplements for the animals (Lawal-Adebowale, 2012). The growth and development of healthy ruminants have not been maximally exploited due to obstacles such as diseases, malnutrition and mismanagement (Adzitey, 2013). Parasitism diseases contribute to the lower rate of animal production in different countries, specifically in the tropic like Nigeria (Ibrahim *et al.*,2014). Ruminants managed in extensive systems and semi intensive system of management are very susceptible to various parasitic helminths (Ibrahim *et al.*,2014). The gastro-intestinal tracts (GITs) of these livestock frequently shelter a variety of helminths, which cause clinical and subclinical

parasitism (Regassa *et al*., 2006). Gastrointestinal helminth infection is one of the most health problems limiting the productivity of livestock such as cattle (Dimaner *et al*., 2000 and Johannes *et al*., 2009), with infected animals having reduced weight gains, reduced food conversion rates, abortion, infertility and reduced meat and milk production, and sometimes leading to high mortality rates (Ogunrinade, 1984; Tisdell *et al*., 1999). Some important predisposing factors that might promote helminth infections are carelessly handled by the farmers keeping these animals. Such predisposing factors include grazing or feeding habits, pasture management, immunological status, nutritional deficiency, presence of intermediate hosts and vectors, number of infective larvae and eggs released into the environment, and a conducive weather condition for the development of the helminth's eggs to infective stages reported by Odoi *et al*. (2007). However, the treatment of gastrointestinal helminthes to improve the productivity of livestock is paramount since animals managed on extensive and semi intensive system are exposed always to helminthic infection. This study therefore investigates the sex, immunological response of cattle on gastrointestinal helminth burden and treatment choice in semi intensive management system in Minna, Niger State, North-Central Nigeria.

MATERIALS AND METHODS

Study Site

This study was conducted in Waji Farm, Nigeria Limited. The Farm is located at Kante village along Tagwe Dam road, Tungangoro, Chanchaga, Minna. Niger State, Nigeria. Minna lies within latitude $9^{0}30^{1}$, North and longitude $6^{0}33^{1}$, East. The annual rainfall ranges between 110mm -1600mm and a mean temperature of 21^{0}C and 36.5^{0}C (Usman, 2011).

Sample Collection

The experiment was carried out to analyse faecal and blood sample of 40 cattle of different sex, various ages and body weight.

Faecal Sample Collection

Faecal samples for the study were collected from the experimental cattle. Samples were collected per rectum to obtain 5g of the sample using hand gloves into sterile bottles. All the specimens were identified clearly, labeled and kept in an ice box and transported for examination at Niger State Veterinary Hospital, Minna Niger State and processed immediately. The study lasted for twelve weeks.

Faecal Sample Processing

Faecal samples were processed and examined for the presence of helminth eggs and larvae using simple faecal centrifugation floatation technique as described by Foryet (2001). 2g of the samples (faeces) were mixed with 60 ml of sugar solution; the samples were then strained through a tea strainer into test tubes and single-step centrifugation was carried out for 10 minutes at 300 rpm (Weber992). A plastic pipette was used to pick few drops of the samples from the top layer for a wet mount smear on a microscope slide using X10 and X40 objectives lens and observed under a microscope for eggs and larvae as reported by Kassai (1999). In each case, the parasite stage was photographed using Celestron LCD digital microscope model 44340. Faecal samples were also examined by direct smear and concentration method using Formol-ether concentration technique and saturated salt floatation for adult parasites as described by Urquahart *et al*. (1996).

Blood Collection and Analysis

Blood samples were collected via the jugular vein puncture from each animal on weekly basis. For each animal, 7mls of blood sample were collected between 7:00 am and 10:00 am for haematology, blood biochemistry and immunogloblin's test. 5ml of the collected blood sample was emptied into labelled ethylene diamine tetraacetate (EDTA) bottle (heparinized test tube) and reserved for haematological studies while the remainder was decanted into labelled plastic test tubes for serum metabolites determination. Packed cell volume (PCV), White Blood Cell (WBC), differential counts of WBC (Neutrophils, Lymphocytes, monocytes, Eosinophils, and Basophilis) and immunoglobulin (IgA, IgG, IgE, IgD and IgM) were determined according to the methods described by Coles (1986). Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) and platelet were calculated as: MCV (fl) = Haematocrit (PCV) × 10 RBC mm-3 MCH (pg) = Hb in g/100ml blood × 10 RBC mm-3 MCHC % = Hb in g/100ml blood × 10 Haematocrit (PCV) Total protein, albumin and other serum metabolites were determined using commercially available diagnostic kits according to the methods described by Ogunsanmi *et al*., 2002 and Ahamefule *et al*., 2008.

Statistical Analysis

Data generated were subjected to Chi-Square test used for association using the SPSS software version 20. The level of significance was defined as $p < 0.05$.

RESULTS AND DISCUSSION

Elevation in immunoglobulin A in cattle not administered antihelminth drugs could be as a result of the fact that helminth parasite load in cattle lowers immunity of the animals which gives way to other secondary infections (Tisdel *et. al*., 1999). Immunoglobulin A is usually the body first line of defence especially against bacterial and viral infections mostly recure in animals that are already stressed or on a low plane of nutrition. Helminth load in animals does not allow the animal's body access to nutrient consumed in the feed because their nutrients are equally fed upon and utilized by these parasitic organisms. Certain helminth parasites are responsible for some allergic reactions in animals, thereby, causing elevation in immunoglobulin E. This may explain the elevation of immunoglobulin E titer observed in cattle not administered any antihelminth drug in this study. Elevated immunoglobulin M in the cattle in the control group is probably due to the its immunoregulatoty role in immunology and also likely because of its function as the first and immediate role in responding to threats to the animal's body.

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Table 1: Haematology Parameters on Sex, Immunological Response of Cattle in A Semi-Intensive Management System

Parameter[Units]	Control	T2	T3	T4	Standard Error
Weight	281.4286^{ab}	313.5714^{b}	270.7143^{ab}	260.0000^{a}	7.976
Heamoglobin	11.5238^{a}	13.0673^{b}	13.3796^{b}	13.2653^{b}	0.1149
PVC	34.5238^{a}	39.4122^{b}	39.5388^{b}	39.9531^{b}	0.3087
RBC	10.4952	6.5082	9.2	7.751	0.746
WBC	3.7048^{a}	4.5286^{b}	4.6592^{b}	4.5694^{b}	0.0364

a,b,c means denote by different superscripts are significantly difference (p<0.05)
PVC = Packed cell volume, RBC = Red blood cell, WBC = White blood cell

Table 2: Immunoglobulin Parameters On Sex, Immunologibulin Response of Cattle in Semi-Intensive System

Parameters(Unit)	Control	T2	T3	T4	Standard Error
IgA	11.8571^{a}	12.4898^{ab}	12.2857^{ab}	12.5918^{b}	0.1057
IgG	71.7619	72.6735	71.7347	73.0408	0.5396
IgE	0.0571^{a}	0.1429^{b}	0.1408^{b}	0.1490^{b}	0.007
IgD	0.1286	0.1184	0.1245	0.1286	0.006
IgM	2.0952^{a}	3.6531^{b}	3.7755^{b}	3.7551^{b}	0.0869

a,b,c means denote by different superscripts are significantly difference (p<0.05)

Hypolipidemic effect of Taurine on Lipid Profile of West Africa Dwarf Sheep

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ABSTRACT
The study was conducted to study the hypolipidemic effect of taurine on lipid profile of thirty-two mixed sex West Africa Dwarf (WAD) sheep with an average weight of 12kg in a Completely Randomized Design involving four dietary treatments (T1, T2, T3 and T4) containing 0, 0.5, 1 and 1.5% levels of inclusion of taurine respectively. Blood sample was collected from each animal and were investigated to determine the lipid profile; glucose, high density lipoprotein (HDL), low density lipoprotein (LDL), total cholesterol (TCHO), and triglycerides were analyzed. The result reveals that all the lipid parameters investigated showed significant (P<0.05) differences with the exception of HDL. Serum glucose decreases as supplementation increases, it varied from 46.25mg/dl (T4) to 62.11(T1). Dietary taurine had no significant (P>0.05) effect on HDL, however, it ranged from 41.67mg/ dl (T1) – 42.89mg/dl (T4). LDL, TCHO, triglycerides decreased significantly (P<0.05) from T1 - T4 (13.69 – 22.46mg/dl, 83.28mg/dl – 48.67mg/dl and 29.41mg/dl – 37.13mg/dl) respectively. The lipid profiles of sheep fed dietary taurine supplemented diets were well improved over those fed the control diets. This result indicated that taurine is a hypolipidemic agent and can be incorporated into the diets of sheep for their optimal performance and lean meat production.
Key Words: Hypolipidemic, Taurine, Lipid, West African Dwarf, Sheep

INTRODUCTION
Lipids, represented by phospholipids, cholesterol, triglycerides (TG) and fatty acids, are considered essential to the body, both by making up of the basic structure of cell membranes (phospholipids), and by acting as precursor to steroid hormones, bile acids and vitamin D, as well as being a constituent of cell membranes and in the activation of enzymes (Bionaz *et al*., 2020). Glucose, Low-density lipoproteins (LDL) are known to contribute to the formation of plaque in the arterial wall; oxidized LDL can further exacerbate plaque formation. In hypercholesterolemia, however, lipid abnormalities significantly contribute to the increased risk of cardiovascular disease and other morbidity (Musa *et al*. 2018). Fat accumulation also affects feed conversion, meat quality and any significant alteration in their plasma levels could lead to a variety of clinical disorders (Sinedino *et al*., 2017). The most well-established function of taurine is the conjugation of bile acids in the liver, resulting in the formation of water-soluble bile salts which are crucial to lipids digestion and thereby affecting an overall increase in fat absorption within the small intestine (Jong *et al.,* 2012). Supplementation of dietary taurine has been found to improve the serum lipid profile, heart function and reduced mortality (Hariprasath *et al*., 2012). In Nigeria, the West African Dwarf (WAD) sheep are essentially raised for meat, they are reared extensively in the rainforest belt and derived savanna zone where they are mostly found (Aderinola *et al*., 2008). If the WAD sheep are adequately harnessed they can be used to reduce the wide gap between the animal protein need ($35gd^{-1}$) and supply ($8gd^{-1}$) in the diet of Nigerians (Ani and Okorie, 2003). The objective of this study was to evaluate the effect of taurine on the lipid profile of WAD sheep

MATERIALS AND METHODS

A total of thirty-two West Africa Dwarf (WAD) sheep of both sexes with an average body weight of 12kg were used for this study. On arrival they were given prophylactic treatment and quarantined for two weeks during which they were treated against ecto-parasite using Diasentol and dewormed with Albendazole (2.5% oral suspension) per kg body weight. Four diets were formulated with graded levels of supplemental taurine at 0, 0.5, 1.0 and 1.5 respectively (Table1). Sheep were divided into four treatments groups with four replicates and were fed at 3% of their body weight in a completely randomized design that lasted for ninety days. The determination of serum levels of cholesterol was carried out using colorimetric enzymatic end point method. Serum triglyceride was analyzed using colorimetric method after enzymatic hydrolysis with lipases. High density lipoprotein (HDL) and cholesterol were determined using precipitant method and glucose was also determined. All these analyses were carried out using standard commercial test kits (RANDOX Laboratories Ltd., Ardmore, Diamond Road, Crumlin, Co. Antrim, United Kingdom), following strictly the instructions provided by the manufacturers. Low density lipoprotein measured in mg/dl, was calculated from the values of total cholesterol, triglycerides and HDL-cholesterol using the formula described by Friedewald *et al*. (1972). LDL-Cholesterol = Total Cholesterol – Triglycerides /2.2 – HDL-Cholesterol. All data obtained were statistically analyzed using the analysis of variance (ANOVA) procedure of SAS (2002) while the significant differences in means were separated using pairwise-difference

RESULTS AND DISCUSSION

The lipid profile of WAD sheep fed graded levels of dietary taurine were as presented in Table 2. Dietary taurine supplementation significantly ($P<0.05$) influences all the parameters considered in this study except HDL. Serum glucose decreases as supplementation increases, it varied from 46.25mg/dl (T4) to 62.11(T1). This finding is in agreement with (Zeweil *et al*., 2012) who reported a decrease in glucose level of mouse administered with taurine supplemented diet. Dietary taurine had no significant ($P>0.05$) effect on HDL, however, it ranged from 41.67mg/ dl (T1) – 42.89mg/dl (T4). This support the report of Musa *et al*. (2018), that administration of selenium and vitamin E had no significant effect on the serum concentration of HDL. LDL, decreased significantly ($P<0.05$) from T1 - T4 (13.69 – 22.46mg/dl. Earlier workers (Lee *et al*., 2004 and Hariprasath *et al*., 2011) also reported a consistent reduction in LDL as levels of taurine increases in rats and mice. TCHO decreased significantly ($P<0.05$) with increasing supplementation from 0% dietary taurine (83.28mg/dl) to 1.5% dietary supplementation (48.67mg/dl). This observation is in agreement with earlier reports of Park *et al* (2007) Foda *et al* (2016), they reported that plasma cholesterol decreased progressively in rat as the inclusion level increases. Serum triglyceride decreases progressively from 37.13mg/dl (T1) to 29.41mg/dl (T4). This corroborates the observation of Foda *et al* (2016). They observed a total decrease in triglycerides of post taurine treatment of diabetic rats.

CONCLUSION

It can be concluded that taurine can be added to diet of sheep for optimal performance and lean meat up to 1.0% level of inclusion

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Table 1: Experimental Diets

Ingredients	Levels of inclusion (%)
Maize offal	78.0
Soya bean cake	6.5
Groundnut cake	8.6
Oil	5.0
Limestone	1.5
Salt	0.4
Metabolizable Energy (Kcal/kg)	2800

Table 2: Lipids Profile of WAD Sheep Fed Graded Dietary Levels of Taurine

	Levels of taurine (%)				
Parameters	**0**	**0.5**	**1.0**	**1.5**	**SEM**
Glucose (mg/dl)	62.11^{a}	57.84^{b}	49.63^{c}	46.25^{d}	7.77
HDL (mg/dL)	41.67	42.57	42.69	42.89	0.84
LDL (mg/dL)	22.46^{a}	20.73^{b}	14.83^{c}	13.69^{c}	3.48
Total cholesterol (mg/dL)	80.28^{a}	64.75^{b}	58.36^{c}	48.67^{d}	7.99
Triglycerides (mg/dL)	37.13^{a}	32.66^{b}	29.76^{c}	29.41^{c}	2.74

High density lipoprotein (HDL), low density lipoprotein (LDL). a, b, c Means with different superscript along the row are significantly different (P>0.05)

Carcass Yield of Broilers Fed Diet Supplemented with Cocoa Seed Powder as Anti-Oxidant

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ABSTRACT
Cocoa's polyphenols contents are bioactive compounds with antioxidant properties. This study investigated the ameliorating properties of cocoa powder as an anti-oxidant supplement on carcass yield of broilers fed commercial diet. 192 broiler chicks were randomly allotted into four (4) treatments of varying levels of cocoa powder with three (3) replicates of sixteen (16) birds each. Cocoa powder was supplemented on commercial feed at 0g, 5g, 10g and 15g constituting the four experimental diets, respectively. At 8th week, two (2) birds per replicate were slaughtered for carcass analysis. The birds were plucked, eviscerated and cut to various parts. The following part were carefully weighed using sensitive electronic scale, live weight, plugged weight, while neck, wing, back, breast muscle, thigh muscle, drum stick, shank, crop and leg were measured as percentage of the plucked weight. The live and dressed weight were significantly affected. Birds fed diet containing 15gramme supplementation with cocoa powder had the higher significant values (p<0.05) for the average live weight and dress weight (3283.00 and 3018.00g/bird, respectively). However, head, shank, neck, wing, drum stick, thigh and breast as percentages of plucked weight were similar (p>0.05) and the ranges were 2.40 – 2.96, 3.69 – 4.62, 3.47 – 4.53, 8.87 – 9.34, 11.67 – 12.47, 12.34 – 14.67 and 28.54 – 31.68, respectively. In conclusion, cocoa seed powder as anti-oxidant supplement in the diets of broilers significantly affected live and plucked weight but had no effect on the carcass yield.

Keywords: Cocoa seed powder, Broilers, Carcass yield, Plucked weight

INTRODUCTION
Cocoa has recently become a matter of interest as a therapeutic natural product due to its flavonoid content. Cocoa polyphenols have been reported in many studies as bioactive compounds, with antioxidant, antiradical and anticarcinogenic properties (Abbe Maleyki, and Amin, 2008; Ren *et al.,* 2003). Oligomeric procyanidins isolated from cocoa have been shown to possess biological activities potentially relevant to oxidant defenses and immune function (Arteel and Sies, 1999). Also, it is well-known that methylxanthines have physiological effects on various body systems, including the central nervous, cardiovascular, gastrointestinal, respiratory and renal systems (Spiller, 1998). Heat stress is one of the major problems facing poultry production in the tropical and subtropical regions, it inflicts heavy economic losses on poultry production as a result of stunted growth (Sahin *et al.,* 2001), decrease in hen-day production (Eid *et al.*, 2008) increased cost of production, high rate of mortality due to depressed immunity, and reproductive failure (Obidi *et al*., 2008). Heat exposure also impairs survival rate (Deaton *et al*., 1986), weight gain, and feed conversion ratio of broiler flocks (Faria Filho, 2006). Heat stress lowers breast yield and enhances higher fat deposition (Ain Baziz *et al*., 1996; Geraert *et al*., 1993), which are undesirable, considering the economic value of breast meat and that excessive amount of fat in broiler carcasses is not well accepted by customers.

This study was aimed at investigating the ameliorating properties of cocoa powder as an anti-oxidant supplement on carcass yield of broilers fed commercial diet.

MATERIALS AND METHODS

The experiment was carried out at the Poultry Unit of Teaching and Research farm of Oyo State College of Agriculture and Technology, Igbo-ora. The experiment lasted eight (8) weeks between October 4 and November 29. Two hundred broilers (Cobb 500) were purchased from a reputable hatchery in Ibadan. After two weeks of brooding and acclimatization, 192 birds were randomly allotted into four (4) treatments of varying levels of cocoa powder with three (3) replicates of sixteen (16) birds each in a Completely Randomized Design (CRD). All management practices, necessary vaccination and medication were observed. The birds were fed with commercially prepared feed (Broiler starter and finisher feed) throughout the period of the experiment. Cocoa powder used for the experiment was purchased from a reliable store in Ibadan and supplemented on commercial feed at 0g, 5g, 10g and 15g constituting the four experimental diets, respectively. At 8th week, two (2) birds per replicate were slaughtered for carcass analysis the birds were inserted into the hot water for about 1minute for the removal of the feather. The abdomen of the birds was opened and the internal organ were carefully removed after weighed, the various parts were dismembered. The following part were carefully cut and weighed using sensitive electronic scale; live weight, plugged weight, while head, shank, neck, wing, drum stick, thigh and breast were measured as percentage of the plucked weight. All data obtained in the study were analyzed by general linear model according to the procedure of Statistical Analysis System (SAS). Differences among the means were subjected to Duncan Multiple Range Test of the statistical package.

RESULTS AND DISCUSSION

Effect of supplementation of cocoa powder on carcass yield of broiler chicken is shown in table 1. The live and dressed weight were significantly affected. Birds fed diet containing 15gramme supplementation with cocoa powder had the higher significant values ($p<0.05$) for the average live weight and dress weight (3283.00 and 3018.00g/bird, respectively). These values were however similar ($p>0.05$) to values for those fed 10g cocoa powder (3200.00 and 2964.00g/bird, respectively), but significantly higher ($p<0.05$) than those on treatment 2 and the control diet (3100.00g/bird and 2906.33g/bird; 2917g/bird and 2749g/bird, respectively). However, dress percentage was similar for all the treatments. Also, head, shank, neck, wing, drum stick, thigh and breast as percentages of plucked weight were similar ($p>0.05$) and the ranges were 2.40 – 2.96, 3.69 – 4.62, 3.47 – 4.53, 8.87 – 9.34, 11.67 – 12.47, 12.34 – 14.67 and 28.54 – 31.68, respectively. The growth promoting properties of cocoa seed powder (DRI, 2003) was implicated in the significantly increased live weight of broiler with increase in cocoa powder in the diet. This agreed with finding of Olayemi et al. (2020) who reported increased in weight gain when broiler chickens were fed diet containing biologically upgraded cocoa pod husk at 10% inclusion level. The carcass yield was not significantly affected and showed that inclusion of cocoa powder did not affects carcass yield of fed broilers. This contradicted Ain Baziz *et al*. (1996) and Geraert *et al*. (1996) who stated that heat stress lowers breast yield and enhances higher fat deposition.

CONCLUSION

Inclusion of cocoa seed powder as anti-oxidant supplement in the diets of broilers significantly affected live and plucked weight but had no effect on carcass yield.

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Table 1: Carcass yield of broiler fed Cocoa seed powder

	Inclusion level of cocoa seed powder/kg				
Carcass yield	**0 g/kg**	**5 g /kg**	**10 g/kg**	**15 g/kg**	**SEM**
Live weight (g/bird)	2917^{c}	3100.00^{bc}	3200.00^{ab}	3283.00^{a}	4.44
Dressed weight (g/bird)	2749^{c}	2906.33^{bc}	2964.00^{ab}	3018.00^{a}	7.14
Dressed weight %	94.22	92.28	92.56	91.84	0.39
Head (%)	2.96	2.74	2.40	2.70	0.14
Shank (%)	4.62	4.49	4.49	3.69	0.39
Neck (%)	3.90	4.53	3.47	3.98	0.17
Wing (%)	9.18	8.87	9.32	9.34	0.1
Drum stick (%)	11.91	12.08	12.47	11.67	0.21
Thigh (%)	14.67	12.75	12.40	12.34	0.44
Breast (%)	28.54	28.65	28.65	31.68	0.44

^{abc} *means in the same row with different superscripts differed significantly (P<0.05)*

Nutritional Value of Rumen Ingesta Treated Rice Husk

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ABSTRACT

Improvement in the nutritional value of rice (*Oryza sativa*) husk by the use of rumen ingesta as a source of microbes (fungi) was studied over a period of seven (7) days. The proximate composition showed significant ($P<0.05$) improvement in the nutritional value with the crude protein (CP) rising from 5.20 % to 6.80 % in the raw and treated rice (*Oryza sativa*) husk respectively.it also shows an increase Mineral/ ash content and nitrogen free extract (NFE) from 15.90 to 16.50 % and 42.80 to 44.20% respectively. Significant reduction in crude fibre (CF) and lipid was observed during biodegradation of rice (*Oryza sativa*) husk with CF and lipid values from 26.00 to 25.00% and 4.50 to 2.50 % respectively. Biological treatment of rice (*Oryza sativa)* husk has improved it nutritive value hence it can be used in feeding livestock.

INTRODUCTION

Rice (*Oryza sativa)* husk is one of the crop residue currently produce in large quantity in Nigeria due to the increasing level of rice production in the country. The annual rice production in Nigeria has increase from 5.5 million tons in 2015 and 5.8 million tons in 2017 (RIFAN, 2017) and for every 1000 kg of paddy milled about 220 kg (23 %) of rice husk is produced (Koteswara *et al*., 2012; Moraes *et al*., 2014; Benassi *et al*., 2015). Recently in most milling locations, heaps of rice husk have continued to accumulate and are either burnt for heat or dumped as waste in majority of rice producing communities (Nwofoke, 2016). Disposal and evacuation of the accumulated rice husk is necessary as its impending environmental hazards such as degradation and pollution it poses to the people and the environs (Koteswara *et al.,* 2012; Haryana, 2018). It was revealed by Oyenuga (1968) that rice husk composed of 2.9-3.6 % crude protein, 8-12 % oil, 39-42 % crude fibre and 15-22 % ash. Biological treatment of crop residue to produce extra cellular enzymes to degrade large molecules of carbonhydrate such as starch, cellulose, hemicellulose, lignin and pectin of plant cell wall as well as improving the nutrient value of rice husk in term of it protein content and reduction in fibre composition had been carried out (Priest, 1984). This brought about environmental waste reduction as well as cost reduction in feeding livestock with conventional feed material. Improving the nutritional value of rice husk through biological method, is the aim of the study.

MATERIAL AND METHODS

Purchase and treatment of feed-stuffs

Rice husk was obtained from commercial rice milling stands surrounding the Federal University of Technology, main campus (Gidan Kwano) Minna Nigeria. Enough quantity was purchased at the commencement of the experiment to safeguard fluctuations in quality of the ingredient with different batches because of the inconsistency in processing techniques. 6kg of the rice husk was poured into a polythene bag, autoclaved at 121°C for 15 minutes.

Source of inoculum's and culture methods

The microbes (fungi) utilized in this study was obtained from rumen ingesta source from Minna modern Abattoir which was use in the preparation of Agar culture in the Department of Animal Production laboratory, School of Agriculture and Agricultural Technology Federal University of technology Minna, Nigeria. It was maintained on Molten Agar (sabouroud Dextrose Agar (SDA) and sub cultured fortnightly.

Inoculation and Fermentation of Sample

Rumen ingesta was sourced from the Minna modern abbatoir in a sterilize test tube, for the preparation of agar culture. One (1) gram of rumen ingesta was transfer into 9 ml of already autoclave water in a test tube and allowed to stand for 10 minutes. 1 ml of this sample was taken from the test tube and transfer into sterile petri dish and added with 20 ml of molten agar (sabouroud dextrous agar) and allow to solidify. The petri dish was cultured for 48 – 72 hours; the resultant colonies/growth were identified. The resultant colony was isolated and further cultured on agar slant and use as stock culture and the fungi was transferred into an agar broth and incubate for 48 – 72 hour for development of spores (AOAC, 2005). Three strains of fungi (*Aspergilus Niger*, *Aspergilus Flavus* and *Aspergilus penicilium*) was obtained from agar culture which were used to inoculate the substrate (rice husk) that was initially soaked for 24 hours under solid state condition. The soak rice (*Oryza sativa)* husk was autoclaved for about 15 minutes at the temperature of 121^{0}C, the inoculated rice husk was allowed to cool and 10 ml of each prepared fungi solution was added onto 6 kg of autoclaved rice husk. 5 g of salt and molasses were added to the 6 kg rice husk autoclaved for inoculation. It was mixed for uniformity to obtain homogenous mixture. The biofermentation of rice husk was carried out according to the procedure described by Fasuyi and Olumuyiwa (2012). The mixed sample was allowed to ferment under anaerobic condition for about 5-7 days, after which the fermented mixture was oven dried to a dry condition to stop the fungi growth.

Chemical Analysis of the Samples

Proximate analysis

The samples were analysed for their proximate composition according to the standard methods of A.O.A.C. (1990).

Statistical Analysis

Result obtained were analysed using independent sample t-Test.

RESULTS AND DISCUSSION

The result of the proximate analysis of the untreated and treated rumen ingesta rice husk is presented in the table 1. The result shows that the treated rice husk contains 95.00 % dry matter, 6.80 % crude protein, 25.00 % crude fibre, 16.50 %ash content, 2.50 % lipid and 44.20 % calculated nitrogen free extract. It also shows that the untreated rice husk contains 94.40 % dry matter, 5.20 % crude protein, 26.00 % crude fibre, 15.90 % ash content, 4.50 % lipid and 42.80 % nitrogen free extract. The increase in crude protein and the ash content of the treated rice husk might have resulted from the fermentation microbe in the study their growth lead to loss of nutrient accounting for the increase in crude protein in our result. Increase in crude protein as a result of microbial treatment of rice husk has been previously reported by (Aderolu *et al*., 2007; Belewu and Okhwere, 1997 and Smith *et al.*, 1996) and the ash content increase might also be as a result enzymatic activity of the microbe in the degrading of phytic resulting in increase in mineral content. The decrease in crude fibre and lipid values obtained were probably due to degraded of non-cellulosic wall polysaccharides by the fungi. Similar result was reported by Smith et al., (1996) when wheat bran was degraded with *Trichoderma reesei* and the reduction in lipid value might be as a result of energy conversion of ether extract to energy to provide necessary nutrient needed for solid state fermentation (Nishimura and Beevers, 1979).

CONCLUSION

This study shown that nutritional value of rice husk using rumen ingesta has been improved and its inclusion in livestock diet can be said to have better utilization.

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Table 1: Comparison of the proximate composition of untreated and treated rumen ingesta rice (*Oryza Sativa*) husk (%)

Parameters	UTR	RITRH	SEM
Dry Matter	94.40	95.00	0.58
Crude Protein	5.20	6.80	1.00
Crude Fibre	26.00	25.00	1.30
Ash	15.90	16.50	1.06
Lipid	4.50	2.50	0.26
Moisture Content	5.60	5.00	0.14
Nitrogen Free Extracts	42.80	44.20	0.16

Key: UTR: Untreated rice husk
RITRH: Rumen Ingesta Treated Rice Husk

Distribution of Genetic Markers in Local Chickens Sold in Some Markets of Zangon Kataf and Kauru Local Government Areas of Kaduna State, Nigeria

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ABSTRACT
This survey was conducted to investigate the frequency of thermoregulatory gene carries amongst local chickens sold in major markets of Zangon Kataf and Kauru Local Government Areas of Kaduna State, North Western Nigeria. One thousand five hundred birds (996 males and 504 females) obtained from Samaru Kataf, Zonkwa, Fadan Kamatan and Kamuru Ikulu all in Zangon Kataf Local Government and Bakin Kogi, Damaka suwa, Mariri and Kauru Markets in Kauru Local Government. Among the investigated markers were Naked neck (Na/na), Frizzle(F/f), polydactyly (Po/po) and ptylopody (Fsh/fsh). Obtained frequencies of investigated genes were generally lower than the expected Mendelian Value of 0.75 for dominant alleles and higher for the recessive (0.004, 0.006 and 0.0000 for Na. F, Po and Fsh respectively). Naked neck shows superiority in body weight than normal feathered birds. Ptylopods were superior in all metric traits except for shank length, however, these superiorities were statistically insignificant (P>0.05). The present research showed that ptylopody birds can be used to improve on body weight and body size parameters in local chickens and naked neck can also be used to improve body weight. Deliberate effort should be made to further reduce the abundance to zero level (as the case is with polydactyl birds) in the market place as this will preserve the already endangered carriers.

Keywords: Frequency, gene carriers, local chickens, markets

INTRODUCTION
Nigerian Local Chickens are characterized by small body size and low body weight. This may be due in part to the hot tropical environment (which is also characterized by heat stress) and also to weak genetic improvement of the local chickens. The effect of heat has been generally reported by many researchers and it has been confirmed to strongly and negatively affect growth and meat yield in chickens (Adams and Rogler, 1968 and Leenstra and Cahaner, 1992). Management of heat in poultry houses is very expensive in the tropics; therefore, raising high performing birds that are adaptable to the tropical environment will go a long way in improving the local chicken population. Some genetic markers have been associated with heat resistance and tolerance, and it is in view of these that researchers have suggested the need to breed birds with more natural resistance (Eberhart and Washburn, 1998). Some of these genes of interest include those that are related with feather distribution such as naked neck (Na), feather structure (Frizzle) these have been associated with decrease in feather coverage on chickens to about 20 and 40% in the heterozygous and homozygous states respectively of Naked neck gene (Adeyinka *et al.,* 2006). This allows for good dissipation of body heat than the normal feather and such protein is now used for meat tissues (Cahaner *et al*., 1993 and Ajang *et al.,* 1993). In view of this important aspect of these genes, several studies have been carried out in different households of different geographical locations in Nigeria, with reported low

frequencies of these genes at all locations (Akinokun, 1990; Sonaiya and Olori, 1990; Ikeobi *et al.,* 1997; Feyeye and Oketoyin, 2006 and Feyeye *et al*., 2006). Most of these researches have all indicated that these genes are at the brink of extinction, and attributed this to negative selection against carriers of these genes through culling for sales, ritual sacrifices and occult practices in most parts of the country (Sonaiya, 2003 and Fayeye and Oketoyin, 2006). Till now no study has been done to determine the proportion at which these major gene carriers are being sold in the local markets. The present study investigated the proportion of the carriers of these genes being sold, the frequencies of these genes in the market place and their (genes) effects on body weight and other body parameters.

MATERIALS AND METHODS

One thousand five hundred (1,500) local chickens were used for this work. These birds were obtained from eight randomly selected markets of two local governments (Zango Kataf and Kauru) of Kaduna State, North-Western Nigeria. The birds were observed for all phenotypic features such as feathered shank (ptylopods-Fsh), Naked neck (Na), 5 toes (Polydactyly-Po) and feather structure (Frizzele-F). The total in each category were recorded. Body parameters measured were bodyweight, toe length, shanks length, body length, wing length, body girth, keel length and shank diameter, as described by Solomon (1996). These were recorded in centimeters except for shank diameter which was measured in millimeters. Body weight was obtained using a top weighting scale, upon which is a container tarred, whose weight had been adjusted to zero. All birds were confined in this container and their weights recorded. Mean values of body weight and body size parameters were calculated, but were however not subjected to any statistical analysis for test of significance between the values of the major gene carriers and the normal feathered birds. Frequencies of these genes under review were calculated using the Hardy-Weinberg equilibrium approach as described by Falconer (1998) as follows:

q = root m/t

Where q = frequency of the recessive allele.

m = observed number of birds with recessive phenotype.

t = total number of birds considered.

Dominant allele (p) frequencies were calculated as p = 1 – q.

Frequencies observed were tested against the expected Mendelian ratios using chi-square test as described by Thompson (1941).

RESULTS AND DISCUSSION

The proportion and frequencies of these dominant genes and their recessive counter parts are found in Table 1. From table 1, it shows that birds carrying these genes of interest supplied to these markets were generally few and constituted the following percentages and proportional of the total birds in the market: 0.0087% or 0.0087, 1.13% or 0.0113, 1.128% or 0.0128 and 0% or 0.00 for Na, F, Fsh and Po respectively, this in agreement with the work of Feyeye and Oketoyin (2006) who reported almost similar values for Fulani-ecotype chickens. The implication is that the rate at which these gene carriers are sold in these markets, may as well be true random sample of their abundance in the Nigerian local chicken population. This also suggest that these birds are really not sold out, but their low frequencies both in the households and markets could be attributed to other reasons; such as sacrifices during festive periods, rituals and cult practices in one hand (Ikeobi *et al.,* 1997; Fayeye and Oketoyin,2006 and Fayeye *et al*., 2006). Their frequencies also failed to agree with the expected mendelian frequencies of a population. From the frequencies obtained in this present study (0.4% 0.6%, 0.6 and 0.0% for Na, F, Fsh and Po) and the 0.5% and 0.3% for Na and F obtained by Fayeye and Oketoyin (2006), it is clear that these gene frequencies are continuously decreasing when compared to earlier frequencies reported; such as the 10 and 8 percent report for polydactyl by Akinnokun (1990), and Ikeobi *et al.* (1997) respectively. Ptylopods in this work shows mean values that were higher than normal feathered birds in al metrics measured except for shank length, however, these were not tested for level of significant. It does appear that this trait can be exploited to improve on the local chicken population. This is confirmed earlier findings that polydatyly and ptylopody were significantly higher in body weight than their recessive counterparts at matured age (Shoffner *et al*., 1993 and Fayeye *et al.*, 2006).

CONCLUSION

Considering the continuous decrease in frequencies of these important genes in the local chicken population, it is recommended that deliberate efforts be geared towards the preservation of these genetic resources by use of rural extension service. Again, proper breeding programs should be put in place with a view of increasing the proportion of these gene careers in the local chickens especially those that carry the gene for ptylopody. Trials using these genes should be conducted in controlled environment and management to detect the real superiority or otherwise of these genes over their recessive counterparts.

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Table 1: Frequency of occurrence and proportion of major dominant gene carriers in Zango-Kataf Local Government markets

Condition	Major gene	Expected	Observed	Proportion of phenotypic frequencies	Proportion%	Gene frequency	Expected
Naked neck	Na	1125	13	0.0087	0.87	0.004*	0.75
Normal	na	375	1487	0.9913	99.13	0.996	0.25
Frizzle	F	1005	17	0.0113	1.13	0.006*	0.67
Normal	F	495	1487	0.9887	98.87	0.994	0.33
Ptylopody	Fsh	1125	19	0.1270	1.28	0.006*	0.75
Normal	fsh	375	1481	0.9873	98.73	0.994	0.25
Polydactyly	Po	1125	0	0.0000	0.0000	0.00*	0.75
Normal	po	375	1500	1.0000	1.0000	1.00	0.25

**Significant difference (P<0.05) from the expected Mendelian value*

The effect of genotype on body girth and shank length is found in Table 2

Table 2: The effect of major gene carriers on body weight and body size parameters

Body parameter	Naked neck	Frizzle	Polydactyly	Ptylopldy	Normal
Body weight (kg)	1.46	13	--	1.58	1.3
Body length (cm)	35.16	35.12	--	36.11	35.07
Body girth (cm)	30.48	31.10	--	31.51	30.55
Shank length (cm)	7.62	7.66	--	7.16	7.64
Wing length (cm)	20.32	20.30	--	20.35	20.30
Toe length (cm)	5.08	5.05	--	5.11	5.02
Shank diameter (mm)	14.3	15.42	--	15.42	14.40
Keel length (cm)	0.26	0.25	--	0.28	0.25

Effect of Probiotic Mix Supplementation on Growth Performance and Nutrient Utilization of Growing Yankasa Sheep

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ABSTRACT

The experiment was conducted to evaluate the effects of probiotic mixture (Saccharomyces cerevisiae 2 × 10^8 cfu/g + Lactobacillus acidophilus 6 × 10^8 cfu/g) on feed intake, and rumen fermentation parameters of growing Yankasa. Lambs of about 6-8 months' age and an initial average live body weight of 12.3 ± 0.68 kg were used. The lambs were divided into three groups (5 lambs/group) and the experiment lasted for 70 days. The control group T_1 received concentrates feed mixture without probiotic mixture supplementation; group T_2 and T_3 received 0.2 and 0.3 g/kg mixture supplementation with concentrate respectively. Dry matter and nutrient intake were taken, digestibility trial was conducted at the end of the experiment. Results showed improvement ($P<0.05$), in dry matter, crude protein and non-fiber carbohydrate and neutral detergent fiber intakes by probiotic supplementation. Higher ($P<0.05$) digestibility and nutritive values for organic matter, crude protein and non fibre carbohydrate observed in T_2 and T_3 when compared to control (T_1). The obtained results indicated that probiotic mixture supplementation improved lambs dry matter, nutrient intake and digestibility. However, 0.3 g/kg supplementation proved to be superior in enhancing feed intake and nutrient utilization in growing Yankasa sheep.

Keywords: Feed additive, probiotic, nutrient utilization, growth performance, Yankasa sheep

INTRODUCTION

The exponential growth of human population in the world resulted to growing demand for food of plant and animal origin. According to the report of Van Bavel (2013) the number of people in the world is estimated to reach 9 billion by 2050. For this reason, scientists are looking for solutions allowing intensification of food production, with simultaneous reduction of production costs, and in compliance with high standards of quality and safety (for both people and the environment). Many scientists and nutrition specialists believe that animal production can play a role in increasing food production. In the past, antibiotics and other medicinal products had been broadly used, mainly in order to modify the alimentary microbiota and to boost productivity and animal growth. Long-term use of those substances has led to development of drug-resistant microorganisms, posing a threat to consumers' health and exerting a negative effect on the environment. As a result, the European Union ban the use of antibiotic-based growth stimulators (Sarker *et al*., 2010). Therefore, alternative natural substances such as probiotics ensuring similar effects have been sought. Probiotics are characterized as dietary supplements containing most likely a live microorganism, which exhibit a beneficial effect on the host animal performance and health by stimulating appetite (Nahashon *et al*., 1994), improving the balance of the intestinal microorganisms and digestion (Arowolo and He, 2018). Addition of probiotics has been proved to improve feed intake, average daily gain, digestibility with high economic returns in kids in growing lambs (Soren *et al*., 2013). Probiotic products may contain one or more selected microbial strain. Studies showed that yeast additives such as *Saccharomyces cerevisiae* lead to an increase in the concentration of ruminal bacteria, especially *Fibrobacter spp*., due to the equilibrium in rumen pH (Beauchemin *et al*., 2006). Bacterial additives such as lactate producing bacteria (LAB) (*Lactobacillus, B ifidobacterium, Enterococcus, Streptococcus*, and *Bacillus*) and lactate utilizing bacteria (LUB) (*Megasphaera elsdenii, Selenomonas ruminantium*, and *Propioni bacterium*) are used as microbial additives. This current study is aimed at effect of probiotic mixture supplementation on the feed intake and nutrient utilization of Yankasa lamb.

METHODOLOGY

Experimental site

The study was carried out at Small Ruminant Unit of Teaching and Research Farm, Federal College of Wildlife Management, New Bussa. Nigeria (9° 53 N, 4° 31 E) located in the Guinea Savannah vegetation zone, with a humid tropical climate, mean annual rainfall of about 1,040 mm and mean temperature of 34 °C.

Experimental animals' management and design

Fifteen growing intact Yankasa rams (12.3 ± 0.68 kg; LW) was procured from local markets, quarantined for 14 days during which they were being treated against internal and external parasites and antibiotics. The lambs were housed in individual rammed floor with bedding materials. The experiment was conducted in a completely randomized design with four treatments and five replications. The sheep were balanced for their initial BW. Each animal within each of the treatments was randomly assigned to one of the three dietary treatments to study the effect of feeding of threshed sorghum top based complete feed without or with supplementation of probiotic. A complete feed was prepared containing threshed sorghum tops 50 parts and concentrate mixture 50 parts on DM basis to meet the nutrient requirement of animals as per ICAR (2013). The parts of concentrate mixture contained TST = 50.0%, maize = 8.0%, wheat bran = 10.0%, cowpea husk = 8.0%, groundnut cake = 18.0%, urea = 1.0%, Dicalcium phosphate = 1.0%, premix = 1.0% and salt 1.0% (Table 1). Probiotic (*Saccharomyces cerevisiae* 2×10^{10} cfu/g + *Lactobacillus acidophilus* 6×10^{9} cfu/g) in equal ratio was incorporated in complete threshed sorghum tops based complete feed at 1, 2 and 3 % of DM respectively, for efficient utilization in ruminant system, while complete feed without probiotics served as control. The experiment lasted for 84 days (63-day feeding trial and 21-day adjustment period). Feeding was done twice daily, at 08:00 and 16:00 h, and water was made available *ad libitum*. Feed intake was calculated as Feed intake (g/d) = Feed offered – feed refusal.

Digestibility trial

At the end of the growth experiment, the growing sheep from each group was transferred individually into metabolic crates to determine apparent digestibility. Lambs were allowed a period of 7 days to adapt to the crates followed by a collection period of 7 days when feed intakes and orts was recorded and sampled. Daily faecal of each animal was collected, weighed, and recorded, and then 10% each was kept prior to chemical analysis. At the end of the experiment, samples from each sheep were pooled and a subsampled for faeces analysis obtained. Feed samples and faeces were taken separately, thoroughly mixed together, sub-sampled, milled through a 1-mm sieve in a hammer mill and preserved for their proximate composition.

Chemical analyses

The dry matter (DM), crude protein (CP), ether extracts (EE) and ash contents of diets and faeces were analyzed according to the AOAC (2000). The neutral detergent fibre (NDF), acid detergent fibre (ADF) and lignin were according to Van Soest *et al.* (1991). Non-fibre carbohydrate (NFC) was estimated using the equations of Sniffen *et al.* (1992).

Statistical analysis
Data collected was subjected to a one-way ANOVA using version 9.1 of SAS software (SAS Institute, 2003). Significant difference between individual means was separated by Duncan's procedure:

RESULTS AND DISCUSSION
Similar amount of dry matter (DM) and all the nutrients except for neutral detergent fibre (NDF) ware obtained in the feed components of the treatment diets (Table 1). Higher NDF content was recorded in T_3 than T_2 and $T_{1.}$ The diets tested were formulated to meet the nutrient requirement of growing sheep. The supplementary concentrates were formulated to contained CP (17.0 % DM) recommended for growing sheep (MLA, 2007) with NDF content far below the 65 % DM threshold level at which cell wall inhibits feed intake, digestibility and animal performance. The NFC content of the concentrates was adequate to stimulate NH_3–N utilization in the rumen (Tylutki *et al*., 2008). The optimal concentration of NFC is important in ruminant diets to avoid acidosis and other metabolic problems. Supplementation generally did not significant effect on the chemical composition of the experimental diets because the probiotic mixture used is non-nutritive feed additive and therefore did not add any nutrient to the diets as level of inclusion increases. There was a significant difference ($P < 0.05$) between T_1 and T_2, while T_2 and T_3 were similar in terms of total DM (Table 2). The intakes of OMI, CP, NFC and ADF increased ($P < 0.05$) as level of probiotic mixture increased and it was highest in animals placed on T_3. However, a non-significant difference ($P > 0.05$) was observed in dry matter intake (% BW), EE and ADF intakes among treatments. Feed intake in terms of dry matter intake and nutrient intake was affected by the probiotic supplementation and consistent with results of Lesmeister *et al*. (2004). This may be due to the increased digestibility of the NDF and the DM in their experiment, and also, may be correlated with rumen development (Lesmeister *et al*., 2004). The progressive increases in nutrients intakes may be a response to progressive decline in fibre fractions (ADF and ADF) and probably induced by level of probiotic supplementation, in consonance with earlier reports. With the exception of NDF and ADF digestibility, addition of probiotic mixture in the diets result in improved nutrients digestibility of DM, OM, CP, NFC, and ADL (Table 3). In the present study, lambs were fed a highly digestible concentrate diet, which may have resulted in positive effects of probiotic mixture supplementation on digestibility. Another possibility could be that probiotic supplementation might have increased ruminal cellulolytic microbial populations and improved rumen pH (Ghazanfar *et al*., 2015). The present results are agreement with other studies (Haddad and Goussous 2005, Mukhtar *et al*., 2010). On the other hand, supplementing the diet of weaned lambs (Ding 2008) with probiotic did not affect the digestibility of DM, OM, and CP compared to control group. Differences in the results of these experiments may be because of differences in the animal models used, environment, method of administration, level and type of addition of probiotic, or supplementation timelines (Whitley *et al*., 2009).

CONCLUSION
In conclusion, the study demonstrated that probiotic mixture no influence on the growth and blood profile of growing sheep. The study demonstrated the need for varying or increasing the levels of the probiotics to ascertain the optimum inclusion levels that would further improve animal performance.

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Table 1: Chemical composition of experimental diets (% DM)

	Level of probiotic supplementation (%)			
Nutrient	**T_1**	**T_2**	**T_3**	**SEM**
Dry matter	92.38	92.12	92.00	0.37
Organic matter	92.16	90.83	97.51	5.34
Crude protein	16.87	17.44	17.63	0.18
Ether extract	4.67	3.30	3.23	1.43
Non fibre carbohydrate	14.98	14.96	12.91	2.06
Neutral detergent fibre	41.00[c]	44.45[b]	58.31[a]	3.44
Acid detergent fibre	31.19	30.40	23.40	5.76

[abc] *Means in the same row with different superscripts differ significantly (P<0.05)*

Table 2: Nutrient intake of growing Yankasa rams supplemented with probiotic mix (g/day)

Nutrient	Level of probiotic supplementation (%)			SEM
	T_1	T_2	T_3	
Dry matter	787.55^{c}	924.15^{ab}	1067.98^{a}	120.00
Dry matter (% BW)	4.32	4.83	4.91	0.58
Organic matter	773.70^{b}	841.81^{b}	1049.30^{a}	61.26
Crude protein	131.69^{c}	154.12^{b}	181.12^{a}	2.44
Ether extract	28.22	30.56	34.57	6.35
Non fibre carbohydrate	116.61^{b}	137.48^{b}	252.47^{a}	43.00
Neutral detergent fibre	430.22^{c}	596.74^{b}	633.46^{a}	67.92
Acid detergent fibre	324.42	357.44	373.44	33.01

^{abc}*Means in the same row with different superscripts differ significantly (P<0.05)*

Table 3: Digestibility of growing Yankasa rams supplemented with probiotic mix (% DM)

Nutrient	Level of probiotic supplementation (%)			SEM
	T_1	T_2	T_3	
Dry matter	58.68^{b}	64.59^{b}	78.39^{a}	9.06
Organic matter	59.18^{b}	63.37^{b}	70.30^{a}	4.12
Crude protein	60.00^{b}	68.32^{ab}	72.69^{a}	5.54
Non fibre carbohydrate	76.69^{b}	77.09^{b}	94.00^{a}	8.09
Neutral detergent fibre	57.60	68.92	71.21	13.67
Acid detergent fibre	50.26	53.29	55.88	5.62
Acid detergent lignin	46.74^{a}	25.76^{b}	20.19^{b}	5.57

^{abc}*Means in the same row with different superscripts differ significantly (P<0.05)*

Evaluation of Semen Characteristics of White and Black Plumage Improved Nigerian Local Chicken (FUNAAB Alpha)

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ABSTRACT
This study was carried out to evaluate the semen characteristics including semen pH, volume, normal and abnormal morphology, actively and sluggishly motile, sperm count and viability, using data obtained from 15 birds originating from improved Nigerian local chickens (8 white plumage and 7 black plumage) of 28 – 36 weeks of age. The result indicates that significant difference (P<0.05) exist between normal and abnormal morphology – 74.16 and 67.85; 26.25 and 32.85 for white and black plumage colour cocks respectively. The semen pH and volume between the white and black plumage cocks recorded no significant difference (P<0.05). Both sperm count and percentage dead were significantly higher in the black plumage strain. The percentage motility for actively and sluggishly motile were 79.37 and 66.19; 13.12 and 16.90 for white and black plumage respectively. All the traits evaluated were significantly influenced by the age of the cocks. Semen pH, concentration and volume, normal morphology, actively motile, and percentage live increased with age, though variation was found in sperm percentage dead and sperm count at 32 and 36 weeks of age, indicating that some of these traits could be used to ascertain semen condition at various age.
Keywords: Semen quality, Morphology, local chicken, motility, plumage colour

INTRODUCTION
Fertility and hatchability determine the major part of profit in the hatching industry. Good and improved poultry breeding management practices such as semen evaluation is recommended in genetic improvement of poultry species because it allows favourable selection for desired trait to be made when breeding cocks with very low motile sperm but has certain needed characters, by application of Artificial Insemination to keep those specific traits (Islam *et al*., 2002). Semen evaluation helps the breeder make a choice on which male to use and which male to cull when expecting specific results. In domesticated poultry, certain factors or issues have been noticed to affect the rate of fertility and hatchability of eggs, one of which is the quality of the semen used to inseminate the hen. Rapid development of breeding technologies such as artificial insemination has resulted in enormous progress in the global poultry since it contributes to increased poultry production through the use of cockerels with high reproductive potentials (Jie and Liu, 2011). Though artificial insemination has not been widely applied when it involves chicken it is however repeatedly used for special purpose breeding programmes (Bakst *et al*, 2010). The reproductive efficiency of poultry birds to a large extent is determined by the quality of semen produced by the cock (Islam *et al*., 2002). Semen quality characteristics assessment of poultry birds gives a perfect indicator of their reproductive potential and it is a major fertility determinant and subsequent hatchability of eggs (Peters *et al*., 2004). In poultry breeding, the primary concern of a breeder is production of hatchable eggs and this can be realized by the evaluation of semen with excellent quality traits that can yield good fertility (Peters *et al.,* 2004).Several factors are known to affect semen quality in cocks, such as breeds, diseases, age and time of collection, plumage colour, body weight and

degree of development of the secondary sexual characters (Zuk *et al.,* 1995). Waseem *et al.* (2017) reported discrepancies in the semen characteristics of brown, black and white plumage colour cocks whereas Udeh *et al.* (2011) cited differences in exotic and local cocks with the latter producing more semen. The reliance on the evaluation of semen by use of colour and volume parameters in the past, gave estimates of sperm quantity (Tarif *et al.,* 2013). The objective of this study was to evaluate the semen characteristics of white and black plumage improved Nigerian local chickens (FUNAAB Alpha).

MATERIALS AND METHODS

The experiment was carried out at the Poultry Unit of the Teaching and Research Farm of the Department of Animal Science, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, South-South of Nigeria. A total of 15 cocks comprising 8 cocks with white plumage colour (strain 1) and 7 cocks with black plumage colour (strain 2) were used for the experiment. The two improved local chicken strains were procured from the Poultry Breeding Unit of the Federal University of Agriculture (FUNAAB) Abeokuta, Ogun State. These breeds were offspring of a research project that started over 15years ago in Abeokuta.

Semen collection

The collection of semen from the white and black plumage colour Nigerian local cocks of ages 28, 32 and 36 weeks was achieved by the abdominal massage technique (Lierz, 2008). The cocks were trained three weeks before collection commenced and during the collection process they were massaged and in response there was partial aversion of the cloaca thereafter semen was collected from the ventral lip of the vent in a tube maintained at 38-40^{0}C. The semen was subjected to microscopic examination. The following semen parameters: semen pH, volume, normal and abnormal morphology, sperm motility (actively and sluggishly motile), viability, (% dead and live) were evaluated.

Semen pH

This is the degree of acidity or alkalinity of semen. It was determined with the aid of a calibrated pH paper as described by Peters *et al*. (2008).

Semen volume

The semen volume specimen from individual cock strain was measured and recorded using collection tube graduated in *ml*. (Oguike *et al.,* 2000).

Semen motility

A drop of semen with the aid of micropipette was placed on a microscope slide, covered with a glass cover slip to have a uniform thickness and was viewed under the microscope (Peters *et al.*, 2008). A magnification of ×400 was used. Motility of the semen sample was expressed as a percentages of cells that are motile under their own power, proportion of normal forward movement of sperm (Mothibedi *et al*., 2016).

Sperm morphology

The size and shape of sperm is one factor that is examined as part of semen analysis to evaluate male infertility. Sperm morphology results are reported as the percentage of sperm that appear normal when semen is viewed under microscope. Normal sperm have an oval head with a long tail while abnormal sperm have head or tail defects such as large or misshapen head or a crooked or double tail.

Data analysis

Data on the semen traits from the two strains at three age periods (28, 32, and 36 weeks) were analyzed by applying multivariate analysis of the General Linear Model procedure using strain and age as fixed factors. Means were considered significant at 5 %; such means were separated using Duncan's Multiple Range Test. Pearson's correlation coefficients were estimated between strain, age and other semen traits studied. All statistical analyses were carried out using SPSS (2016).

RESULTS AND DISCUSSION

The strain effect on semen characteristics of white and black plumage improved Nigerian local chicken (FUNAAB Alpha) is shown in Table 1. The result indicates that significant difference (P<0.05) exist between normal and abnormal morphology: 74.16 and 67.85; 26.25 and 32.85for white and black plumage respectively. The present findings is in line with the report of Tarif *et al.* (2013) who demonstrated that variation existed between normal and abnormal morphology when he worked on semen quality among four chicken lines. The semen pH and volume between the white and black plumage cocks recorded no significant difference (P<0.05), whereas viability was significantly higher (P<0.05) in white strain. Both dead sperm and sperm count were significantly (P<0.05) higher in the black strain. The percentage motility for actively and sluggishly motile sperm were 79.37 and 66.19; 13.12 and 16.90 for white and black plumage respectively. The result for dead sperm, normal and abnormal morphology is in agreement with the report of Ngu *et al.* (2014). Brillard (1992), reported that oviductal storage of sperm has strain effect issues. Sperm concentration of 50 $x10^6$ was reported to be appropriate for good fertility both in cocks and toms. Some of the factors that affect hatchability include, embryonic mortality and egg fertility. Embryonic mortality (Failure of fertile eggs to hatch) could be a product of elongated egg storage, conditions of abnormal egg storage, breeder bird's age and problems associated with incubation (Fasenko *et al.,* 2003). Islam *et al* (2002), identified the varieties, genetic effects and individuals within breeds on fertility and hatchability.

Trainings linking the ratio of mating are important for the optimization of breeding efficiency of breeder flocks. Semen that are preserved can become unusable in circumstances where cocks do not produce semen after 10 days of handling or in situations where the semen colour changes from the normal colour (Banjoko and Adeseolu, 2013). The quality characteristics of a semen can be affected by the age of the cock in terms of concentration and motility, body weight, genetic factors and the environmental condition such as ambient temperature (Gebriel *et al*., 2009). Table 2 indicates disparities observed on the semen traits at different ages, semen pH, normal morphology, actively and sluggishly motile recorded significant difference (P<0.05) for week 28 in contrast with weeks 32 and 36 which had no significant disparity (P<0.05) but numerical difference existed in the later. Waseem *et al.* (2017) found significantly higher semen volume in black and brown plumage. Apart from these, significant difference (P<0.05) existed in all other traits, the values for semen volume were 0.19, 0.79 and 0.55 for weeks 28, 32 and 36 respectively, with week 32 having the highest significance (P<0.05). The results showed that there were differences in age and strain with respect to viability, abnormal morphology, dead sperm and sperm count. These observations were in harmony with the reports of Peters *et al.* (2008), and Egbunike and Oluyemi (1979). Table 3 indicates that all the traits evaluated were significantly influenced by the age of the cocks. Semen pH, concentration and volume, normal morphology, actively motile, and percentage live increased with age, though variation was found in sperm percentage dead and sperm count at 32 and 36 weeks of age. Studies show that metabolic rate and motility of sperm tends to be affected by pH and this consequently alters the sperm vitality. It was found that higher quantities of live normal sperm were observed in a neutral and alkaline (a pH of 7.2 and 8.2) environment (Alavi *et al*., 2004).

CONCLUSION

There are differences in the semen traits of the white and black plumage improved Nigerian local chicken. Such differences were more obvious during 32 and 36 weeks of age with white plumage having greater values in most of the traits, signifying that they could be of more relevance. The results of this study also show that viable semen can be achieved at 32 weeks of age in both white and black plumage. The ejaculate volume was higher in black at 32 and 36 weeks respectively. The age and strain is an essential predictor of semen viability in local chickens.

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Table 1: Effect of strain on Semen characteristics of FUNAAB Alpha Chickens

Parameter	Strain	
	White	Black
Semen pH	8.20 ± 0.044	8.19 ± 0.047
Volume	0.52 ± 0.061	0.51 ± 0.065
Viability	80.62 ± 3.217^{a}	68.81 ± 3.439^{b}
Normal morphology	74.16 ± 3.236^{a}	67.85 ± 3.460^{b}
Abnormal morphology	26.25 ± 3.590^{b}	32.85 ± 3.838^{a}
Actively motile	79.37 ± 2.818^{a}	66.19 ± 3.013^{b}
Sluggishly motile	13.12 ± 1.882^{b}	16.90 ± 2.012^{a}
Dead	16.45 ± 2.952^{b}	27.38 ± 3.156^{a}
Sperm count	61.25 ± 3.477^{b}	69.28 ± 3.717^{a}

^{ab} *Means on the same row with different superscript are significantly different (P<0.05)*

Table 2: Age effect on Semen characteristics of FUNAAB Alpha breeds of white and black plumage colour

Parameter	Age			
	28 Wks	**32 Wks**	**36 Wks**	**SEM**
Semen pH	8.00^{b}	8.29^{a}	8.29^{a}	0.056
Volume	0.19^{c}	0.79^{a}	0.55^{b}	0.077
Viability	53.21^{b}	85.98^{a}	84.95^{a}	4.079
Normal morphology	47.50^{b}	82.09^{a}	83.43^{a}	4.103
Abnormal morphology	52.54^{a}	16.65^{c}	19.46^{a}	4.551
Actively motile	52.81^{b}	82.41^{a}	83.12^{a}	3.572
Sluggishly motile	18.08^{a}	13.34^{b}	13.61^{b}	2.386
Dead	42.81^{a}	10.93^{c}	12.00^{b}	3.743
Sperm count	59.68^{c}	66.20^{b}	69.91^{a}	4.407

^{a,b,c}*Means on the same row with different superscript are significantly different (P<0.05)*

Table 3: Interaction of strain and age effect on semen characteristics

Strain	Age (Wks)	N	Parameter								
			pH	Vol.	Viability	Normal Morph	Abnormal Morph	Active	Sluggish	Dead	Sperm count
White	28	8	8.00^{b}	0.29^{c}	70.00^{b}	60.00^{c}	39.37^{a}	75.62^{b}	11.87^{b}	25.62^{a}	54.37^{c}
	32	8	8.31^{a}	0.73^{a}	86.25^{a}	80.62^{b}	16.87^{c}	81.25^{a}	13.12^{a}	11.87^{b}	63.12^{b}
	36	8	8.31^{a}	0.54^{b}	85.62^{a}	81.87^{a}	22.50^{b}	81.25^{a}	14.37^{a}	11.87^{b}	66.25^{a}
	SEM		0.076	0.105	5.572	5.606	6.218	4.881	3.260	5.114	6.022
Black	28	7	8.00^{b}	0.09^{c}	36.42^{b}	35.00^{c}	65.71^{a}	30.00^{c}	24.28^{a}	60.00^{a}	65.00^{c}
	32	7	8.28^{a}	0.86^{a}	85.71^{a}	83.57^{b}	16.42^{b}	83.57^{b}	13.57^{b}	10.00^{c}	69.28^{b}
	36	7	8.28^{a}	0.56^{b}	84.28^{a}	85.00^{a}	16.42^{b}	85.00^{a}	12.85^{b}	12.14^{b}	73.57^{a}
	SEM		0.081	0.112	5.957	5.993	6.647	5.218	3.485	5.467	6.437

^{a,b,c}*Means on the same column with different superscript are significantly different (P<0.05), N = number of cocks used.*

Potential of Mixed Forages (*Calopogonium mucuniodes and Pannicum maximum*) as Feed Resources in Gut Microbial Population of Pig

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ABSTRACT
A trial was conducted to determine the potential of fresh forages combination (Calopogonium mucuniodes and Pannicum maximum) as feed resources for pigs. A total of 30 grower pigs at average weight of 18kg were used for 63-day feeding regime. Five diets were formulated which contained 0, 10, 15, 20 and 25% levels of fresh forage respectively. Each diet formed a treatment which was fed to the pigs. Pigs were fed 4% of their body weight, and water given ad- libitum. Treatments were replicated thrice and each contained two pigs in a completely randomised design. The parameters taken were the gut contents from the stomach, caecum and colon which were collected by dissecting the segments. The digesta from the segments were collected into a plane sterile tube and taken to the laboratory for microbial gut population count. Result from the treatments show that the numerical values of these beneficial microbes significantly (p < 0.05) increased in the forage treated diets when compared with the control except for the stomach which had little fluctuation in the trend of increase. The study therefore, concludes the dietary inclusion of forage in pigs can improve the gut status thereby benefiting the animal through the production of digestive enzymes.
Keywords: Forage, Gut, microbes, Diet, Pig

INTRODUCTION
The gut of pig is the fundamental organ which plays important role in digestion of fibre and host defence (Agboola, *et al.,* 2015). The microbial population in the gastro-intestinal tract of monogastric animals play key roles in the normal digestion process and also maintaining animal health (Falaki, *et al.,* 2011). Zigger (2000) reported that the population of beneficial bacteria in the gut of monogastrics increase the pH of gastro-intestinal tract (GIT) due to increase production of volatile fatty acid (VFA), but the use of probiotics has addressed this problem through the use of digestive enzymes, synthesis of vitamin B and immune stimulation (Buba *et al.,* 2018). The use of forage in growing pigs has significantly improved the caecum and colon beneficial gut microbial population count (Jorgensen *et al.,* 1996). Introducing high forage diet in pigs, initially reduced microbial gut population on the colon, but later in few days a number of cellulotic bacteria increased (Varel, 1987). Other findings have shown that the introduction of forage in the diet of pigs caused much increase volume of caecal digesta. This trial therefore, is aimed at investigating the gut microbial population as affected by dietary combination forages in growing pigs.

MATERIALS AND METHODS

Site of study

The experiment was conducted at the department of Animal Nutrition and Forage Science, College of Animal Science and Animal production, Michael Okpara University of Agriculture, Umudike

Procuring and processing of experimental materials

The forages used for the study were obtained from the university environment. The fresh forages cut at their bloom stage were chopped into small sizes and incorporated into the concentrate feed at 0, 10, 15, 20 and 25% supplementary levels respectively as shown in Table 1.

Experimental design and management of pigs

Completely randomised design was used. 30 grower pigs of Large white and Landrace strain cross were used. They were divided into five dietary treatments (T_1 -T_5). Each treatment was replicated three times and each replicate had two pigs. Five different diets were formulated as shown in Table 1. The pigs were stabilised with the concentrate diet for two weeks before the commencement of the trial. Within this period, broad spectrum antibiotic, multivitamin and de-wormer were administered to keep the animals fit for the trial, after this, they were randomly allocated to five different treatment groups after taking initial weights. Feeding was daily at 8.00hours and 16.00 hours at 4% of their body weight. Water was also provided *ad-libitum* both in the wallow and drinking trough respectively.

Data collection and analysis

Two pigs were randomly selected from each of the treatment groups for gut microbial population count. The pigs were slaughtered and the intestine was removed, then using a surgical blade, the gut content from the stomach, caecum and colon were collected by dissecting the segments. The gut content was then placed in a plane sterile tube and taken to the laboratory for microbial population count. The data collected were subjected to analysis of variance (ANOVA) using (SAS. 2004) and significant means were separated using Duncan Multiple Range Test (DMRT) obtained in the same statistical package.

RESULTS AND DISCUSSION

Table 2 shows the effect of grass + legume forage combination on microbial gut population of pigs. Observation showed that the numerical values of beneficial microbes significantly ($p < 0.05$) increased in the forage treated diets when compared to the control, except for stomach which had little fluctuation in the trend of increase. This could explain the reason for microbial increase from the stomach to distal small intestine and further to colon as reported by Aro *et al.* (2009). It could also be that the fermentation occurred with the increase in the forage. The low population of the microbes in the stomach and trend of significance could be traced to the acidity of stomach as well as the bile secretion from the duodenum which hinder the proliferation of gut microbes as has been similarly reported by Hara and Shanaha (2006).

CONCLUSION

The study shows that dietary inclusion of fresh combined forages affected the gut microbial population of benefit in stomach caecum and colon of pigs, with the forage containing diets having higher population of microbes in different segments of the GIT.

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Table 1: Composition of experimental diets

Ingredients	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
Concentrates (%)	100.00	90.00	85.00	80.00	75.00
Grass + Legume (%)	0.00	10.00	15.00	20.00	25.00
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Analysed Composition					
Dry Matter (%)	85.44	86.53	85.94	87.23	85.58
Crude Protein (%)	20.18	19.49	19.15	18.81	17.96
Ether Extract (%)	3.76	3.93	4.02	4.04	4.19
Crude Fibre (%)	11.13	12.81	13.66	14.49	15.34
Ash (%)	9.50	9.81	9.79	10.12	10.28
Nitrogen Free Extract (%)	45.74	43.99	43.09	42.29	41.84
Gross Energy ((kcal/kg)	4.00	3.94	3.92	3.90	3.88

T1 = Grass + Legume + (0 % concentrate), T2 = Grass + Legume + (10 % concentrate), T3 = Grass + Legume + (15 % concentrate), T4 = Grass + Legume + (20 % concentrate), T5 = Grass + Legume + (25 % concentrat

Table 2: Effects of Grass + Legume Forage Combination on the Microbial Gut population of Pig

Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**SEM**
Caecum (x10^4cfu/ml)	5.50^c	7.80^b	7.70^b	9.50^a	10.25^a	
Colon (x10^4cfu/ml)	6.60^b	10.40^a	10.60^a	10.70^a	10.80^a	
Stomach (x10^3cfu/ml)	4.30^{ab}	3.80^b	3.90^{ab}	4.20^{ab}	4.40^a	

a-b means along the same row with different superscripts are significantly (P<0.05) different. SEM = Standard Error of Mean. T1 = Grass + Legume + (0 % concentrate), T2 = Grass + Legume + (10 % concentrate), T3 = Grass + Legume + (15 % concentrate), T4 = Grass + Legume + (20 % concentrate), T5 = Grass + Legume + (25 % concentrate)

Haemato-Serum and Antioxidant Indices of Broiler Chickens Fed Dites Containing Graded Supplementations of Gliricidia-Avocado Composite Leaf Mix

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ABSTRACT

Haematological parameters, serum biochemistry and antioxidant capacity of 128 broilers (42 days of age) were assessed in other to study the effect of composite leaf mix of Gliricidia sepium and Persea americana (Avocado) as feed additive in their diet. Air dried leaves of G. sepium and Persea americana were mixed in ratio 1:1 to produce the composite leaf mix (CLM). This was then supplemented in a basal diet at 0g/kg, 4g/kg, 8g/kg, 12g/kg and hence designated Diets I, II, III and IV respectively. The day old chicks were randomly allotted to the four (4) dietary treatments of 32 birds per treatment in four replicates with eight birds per replicate in a completely randomized design. Feed and water were supplied ad-libitum. Other standard practices were put in place. At the end of the feeding trial, two (2) birds were selected from each replicate and blood was collected for haematology, serum biochemistry and antioxidant properties. The results revealed that for all the parameters measured, packed cell volume, mean cell volume and haemoglobin were significantly ($p<0.05$) influenced by the dietary treatments. The results for biochemical indices revealed that the supplementation of composite leaf mix did not significantly affect the serum biochemical indices with the exception of cholesterol and globulin. The cholesterol value decreased as the level of supplementation increased. For the antioxidant properties, all parameters measured were not significantly ($p > 0.05$) influenced by the dietary treatments. The study concluded that dietary supplementation of CLM of Gliricidia and Avocado in broiler chickens could improve the birds' haematological status and decrease the cholesterol, hence improve meat quality.

Keywords: ad-libitum, antioxidant, composite leaf mix, haemoglobin, serum biochemical

INTRODUCTION

Poultry plays a major role in filling the gap for animal protein needs of people in many developing countries. In particular, eggs from poultry have been reported to contribute over 20% of the total animal protein supply (FAO, 2004). However, poultry production is being seriously affected by feed availability in the developing countries (Girma *et al*., 2011) as feed cost accounts for 60-70% of the total intensive production cost (Oloruntola *et al*., 2016). This problem of feed unavailability in developing countries has been attributed to high cost of the common conventional feed ingredients used in formulations. This has necessitated the search for alternative non-conventional feed stuffs that are locally available, cheaper and also their processing methods could be easily adopted. Leaves of the tropical legumes and browse plants are possible plant protein sources that can be exploited due to their nutritive values, availability, relatively low cost and the nonexistence of competition in their consumption between livestock and man (Agbede and Aletor, 2003). The leaf meals are also known as a good source of minerals, vitamins and oxycarotenoids. It has been known that some particular foliage contains a number of bioactive compounds that are beneficial for the health of chickens (Rama Rao *et al.,* 2019). These compounds include vitamins, phenolic acids, flavonoids, isothiocyanates, tannins as well as saponins (Vergara-Jimenez *et al.,* 2017). In this regard, the use of leaf meal in rations may not only reduce the cost of feeds, but also elicit the health-promoting effect on broiler chickens (Ubua *et al* 2019) and one major parameter/response criteria to measure the animal health status is the blood indices (Haematology and Serum indices). *Gliricidia sepium* is a leguminous plant used for browse plants, live fencing, green manure and shade for plantation crops among others (Kayga-Agyemang *et al*., 2007). Leaves of *G. sepium* contain high quality protein and minerals in adequate concentrations (Oloruntola *et al*., 2016). It has been established that response of birds to feed depends on the physiological life stage of the birds. This explains why different nutrient requirements have been established for birds of different physiological age (Oloruntola *et al*., 2016). *Persea americana,* generally known as avocado or alligator pear is one of the fruits with known excellent nutritional, as well as medicinal qualities. It contains high amount of fats and oils, protein and fibre. It is also a rich source of vitamins such as vitamins C, E, K, B, B2, B6, B9 and minerals such as phosphorus, sodium, magnesium, potassium, iron and zinc (Orhevba and Jinadu, 2011). The exploitation of non-edible parts of avocado can concentrate high levels of valuable bioactive compounds, particularly natural antioxidants (Vinha *et al*., 2013). Therefore, the focus of this study is to evaluate the influence of graded levels of composite leaf mix of gliricidia and avocado leaves on blood, serum and antioxidant properties of arbor-acre broiler chickens.

MATERIALS AND METHODS

Experimental Site

The feeding trial of this study was carried out at the Poultry Section of the Teaching and Research Farm, while the hematology, serum and antioxidant characteristics were done at the Nutritional laboratory of Animal Production and Health Department of the Federal University of technology, Akure, Nigeria. (Latitude $7^0 18^u$N and Longitude $5^0 10^u$E) (Aro *et al*., 2008).

Composite Leaf Mix Production and Diet Preparation

The leaves were spread lightly on clean tarpaulin and air-dried to prevent loss of some vital nutrients. The air-dried leaves were milled separately using hammer mill to produce Gliricidia leaf meal (GLM) and Avocado leaf meal, respectively. They were stored in plastic containers under room temperature prior to laboratory analysis and usage. Thereafter, the two leaves were mixed in a ratio 1:1 weight to produce a composite leaf mix (CLM). A basal diet was formulated to contain 21% crude protein and 3000kcal/kg metabolizable energy and used as straight diet from day-old to 42 days. The basal diet was further sub-divided into four portions such that the first portion was without CLM (control) and the remaining three (3) portions were supplemented with varying levels of composite leaves meal (CLM) at 4g/kg, 8g/kg and 12g/kg. The birds were randomly distributed into the four (4) treatments arranged in Completely Randomized Design. Each treatment had four (4) replicates with eight (8) birds per replicate. One hundred and twenty-eight (128) Abor acre broiler chicken were used for the experiment. During the period, the chicks were fed their respective experimental diets *ad libitum* for 42days. At the end of the feeding trial, the chicks were starved overnight so as to empty the crop and the chicks weighed and sacrificed first by stunning followed by severing the jugular vein. The blood was then allowed to flow freely into labeled EDTA bottles which contained a speck of EDTA (processed for haematology) while the others were collected into Liteum Heparin bottles (processed for serum). The serum was kept deep frozen prior to analysis. All data collected during the experiment were subjected to analysis of variance using SPSS version 25 while means were separated with Duncan's multiple range test from the same software package.

RESULTS AND DISCUSSION

Table 2 presents the hematological parameters of broiler chickens fed diets containing varying levels of composite leaf meal. For all the parameters measured, packed cell volume, mean cell volume and hemoglobin were significantly ($p<0.05$) influenced by the dietary treatments.

Highest packed cell volume (43.33%), highest mean cell volume (160.57μ^3) and highest hemoglobin (14.43g/100ml) were recorded in birds fed Diet III, while lowest packed cell volume (35.83%), and lowest hemoglobin (11.97±0.27g/100ml) were recorded in birds fed Diet IV, and lowest mean cell volume (115.93μ^3) was recorded in bird fed Diet I. All serum biochemical parameters measured were not significantly influenced by phytogenic leaf meals addictive with the exception of cholesterol and globulin. The highest cholesterol (4.39mg/dl) was observed in birds fed Diet III while the highest globulin (51.66g/dl) and lowest globulin (45.93g/dl) were observed in birds fed Diets II and IV respectively. All antioxidant parameters measured were also not significantly ($P > 0.05$) influenced by the dietary treatments (Table 4).

Haematological parameters are important indices of the physiological and pathological status for both animals and humans (Adeneye *et al.,* 2006). In particular, the haematological indices such as red blood count, white blood count, packed cell volume and haemoglobin concentration are usually used for disease diagnosis and feed stress monitoring (Togun and Oseni, 2005). Administration of diets containing composite leaf mix of the test leaves did not alter haematological parameters, such as white blood cell, lymphocyte, monocyte, granulocyte, mean cell volume, red blood cell and mean corpuscular haemoglobin count which means all the diets (both control and test diets) did not affect the blood components of the birds. However, a significant difference was observed in packed cell volume (PCV) and haemoglobin concentration (HBC).

The values for PCV and haemoglobin (35.82 – 43.33 and 11.97 - 14.43 obtained, respectively) in this experiment all falls within the normal range (7.00 – 13.00 and 25.00 - 45.00 respectively) as reported by Wikihow (2013). The increase in the supplementation of the composite leaf mix which precipitated a decrease in red blood count of the bird, did not signal any possible health hazard (relative polycythaemia or absolute polycythaemia) as the red blood count range (2.73 -3.28 x10^{6}mm^3) falls within the normal range (2.0 - 4.0 x10^{6}mm^{-3}) reported for broiler chicken by Oloruntola *et al.,* (2016). Mean cell haemoglobin and mean corpuscular haemoglobin concentration are useful in feed toxicity monitoring (Oyawoye and Ogunkunle, 1998). The abnormal increase in the mean cell haemoglobin value could not be attached to the presence of toxin or anti-nutrients in the feed because the value for mean cell haemoglobin at 0% composite leaf meal inclusion rate (38.63fl) is also outside the normal range. This suggests that the abnormal high value of MCH may be as a result of other factor different from the composite leaf meal inclusion rate. The values obtained for white blood count (5.08 – 6.57x10^{-3}/ml) in this study is higher than 4.07 – 4.32x10^{-3}/ml as reported for normal range by Wikivet (2012). A high white blood cell count in animals could be due to increased white blood production to fight an infection, reaction to a drug and immunomodulatory effect of phytogenic feed supplements (Sultana, 2011; Oloruntola *et al*., 2016). Biochemical markers are useful tools in diagnosis.

The results revealed that the inclusion of composite leaf meal did not significantly affect the serum biochemical indices of the birds (aspartate aminotransferase, alanine aminotransferase, cholesterol, creatinine, total protein, albumin and globulin) but cholesterol and globulin were significantly influenced by the dietary treatments. The composite leaf meal may also be a factor in cholesterol levels' reduction. Increased levels of Globulins are often associated with infectious diseases, immune-mediated disease and some types of cancer (Ivan *et al*., 2008). The normal Serum total protein contents were similar among birds fed control diet and 8% composite leaf meal, but significantly reduced in those fed 12% composite leaf meal. Antioxidant enzymes such as catalase, glutathione and superoxide, which are synthesized and endogenously regulated antioxidant mechanisms, are an important index of the antioxidant capacity of animal tissue (Oloruntola, 2018).

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Table 1: Percentage Composition of Experimental Diets

Ingredients	Quantity (kg)
Maize	55.00
Soybean Meal	20.00
Groundnut cake	12.20
Fish meal	5.00
DCP	2.50
Limestone	1.00
Lysine	0.12
Methionine	0.16
Salt	0.30
Premix	0.50
Oil	3.22
Total	100
Composition	
Crude Protein (%)	21
Metabolizable Energy (KCal)	3000
Calcium	1.64
Available Phosphorus	0.83
Lysine	1.23
Methionine	0.52

Table 2: Hematology parameters of broiler chickens fed varying level of composite leaf meal of Gliricidia and Avocado

DIETS	PCV	RBC	MCHC	MCV	MCH	HB	WBC	GRA%	LYMPH %	MON %
I	36.5 ± 0.72^{b}	3.3 ± 0.28	33.3 ± 0.00	115.9 ± 11.49^{b}	38.6 ± 3.82^{b}	12.2 ± 0.24^{b}	6.1 ± 0.72	17.8 ± 2.06	79.2 ± 1.90	3.0 ± 1.32
II	38.3 ± 2.65^{b}	3.0 ± 0.25	33.3 ± 0.00	130.9 ± 13.89^{ab}	43.6 ± 4.63^{ab}	12.8 ± 0.88^{b}	6.6 ± 0.80	23.7 ± 3.00	74.7 ± 3.14	1.8 ± 0.48
III	43.3 ± 1.54^{a}	2.8 ± 0.26	33.3 ± 0.00	160.6 ± 14.97^{a}	53.5 ± 5.00^{a}	14.4 ± 0.51^{a}	5.1 ± 0.17	21.7 ± 3.51	76.2 ± 3.63	2.2 ± 0.48
IV	35.8 ± 0.79^{b}	2.7 ± 0.26	33.3 ± 0.00	137.6 ± 14.21^{ab}	45.9 ± 4.73^{ab}	12.0 ± 0.27^{b}	6.1 ± 0.10	22.0 ± 3.02	75.8 ± 3.49	2.2 ± 0.60
P-value	0.016	0.477	-	0.173	0.172	0.017	0.549	0.562	0.769	0.762

*PCV = Packed Cell Volume; RBC = Red Blood Cell, MCHC = Mean Cell Haemoglobin Concentration; MCV - Mean Cell Volume; MCH = Mean Cell Hemoglobin, HB = Hemoglobin, WBC = White Blood Cell, LYMP = Lymphocyte, MONO = Monocyte, GRAN = Granulocyte; NS= Not Significant, * = Significant at 0.05%*

Table 3: Serum biochemical indices of broiler chickens fed varying level of composite leaf meal of Gliricidia and Avocado

Diets	AST	ALT	Cholesterol	Creatinine	Total Protein	Albumin	Globulin
I	91.4±0.72	34.8±0.53	4.3±0.65^{a}	39.2±6.32	54.6±3.07	6.6±1.01	48.0±2.25^{ab}
II	85.1±2.65	35.5±0.88	3.6±0.51^{ab}	26.2±2.94	57.7±2.85	5.4±1.02	51.7±2.47^{a}
III	97.8±1.54	34.6±0.95	2.8±0.24^{b}	26.1±2.31	54.8±3.40	6.0±0.81	48.8±0.94^{ab}
IV	98.9±0.79	34.6±0.49	3.2±0.44^{ab}	47.7±6.36	50.6±3.25	4.7±0.71	45.9±0.76^{b}
P-Value	0.21	0.63	0.01	0.59	0.29	0.50	0.01

AST = Aspartate Aminotransferase; ALT = Alanine Aminotransferase

$^{a-b}$ Means along the same column with different superscripts are significantly ($p<0.05$) different

Table 4: Antioxidant properties of broiler chickens fed composite leaf meal of Gliricidia and Avocado

DIETS	SUPEROXIDE	GLUTATHIONE	CATALASE
I	0.83±0.50	0.27±0.31	8.27±1.63
II	2.34±1.12	0.26±0.21	10.45±6.29
III	7.01±6.79	0.28±0.02	3.49±0.09
IV	2.01±1.61	0.24±0.47	3.77±0.12
P=Value	0.63	0.74	0.37

Growth and Hepato-protective Response of Broilers Fed Aqueous Moringa Leaf Extract

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ABSTRACT
This study investigated the growth and hepato-protective response of broilers fed moringa leaf extract. The 8 –weeks study was conducted in a completely randomized design (CRD) with four (4) treatments and three (3) replicates at the Teaching and Research Farm, Department of Agriculture Ndele Campus. Aqueous moringa leaf extract (AMOLE) at four concentrations served as four (4) levels of treatments 0gl^{-1}, 5gl^{-1}, 10gl^{-1} and 15gl^{-1}. The birds were kept for 42 days. 120 Dahmas chicks (trade name) were purchased from Pixy Farm, Port Harcourt and brooded for two weeks before placing them on the experimental units. Ten (10) chicks per replicate, AMOLE were orally administered to the birds and readings taken for feed intakes and growth performance. Feeds were also supplied to the bird's ad-libitum; at 42 days, two birds were slaughtered for blood and digesta collection into EDT bottle and non-EDT bottle for hematology and serum analysis in the laboratory. The data collected were subjected to analysis of variance (ANOVA) using SPSS version 21 and mean separated using Duncan's multiple range test. The results indicated that, AMOLE has protein, carbohydrate, lipids, moisture, vitamins and minerals and the composition of these substances in aqueous extract depend on the concentration (gl^{-1} of water or solvent). AMOLE showed positive effect ($p< 0.05$) on the feed intake and body weight of the birds at the range of 10gl^{-1} and 15gl^{-1} treatments. The immune stimulation and the hepato-protection improved, as the oral administrations of AMOLE increases. The study clearly shows that, AMOLE has a fourfold function to improve feed intake, growth performance, immune stimulation and hepato-protection of broiler birds. Thus recommended that AMOLE should be used to fortify and supplement broiler feed instead Moringa oleifera leaf meal (MOLM) due its high fibre content, which ultimately reduces feed intake. AMOLE at 10 –15gl^{-1} should be used for immune stimulation, hepato-protection, stimulate feed intake and growth of the broilers.

Keywords: Digesta, hepato-protection, feed intake, immune stimulation, serum analysis

INTRODUCTION
Protein insecurity is generic problem as it leads to poor growth, poor immune and general disease conditions. The protein in security is influenced by factors, kind of farm animal kept, farming systems, climate change, government policies, culture, pests, diseases, cost and availability of feeds. The simplest farm animal to rear by a poor family to meet its protein needs is poultry. The poultry production industry has many business opportunities including rearing of broilers, the main source of meat. Rearing of broilers is growing in different parts of the world including Nigeria; though the method of production and flock size differ but the goal remains the same – food production for humans and other animals. Intensive poultry production requires feeding and medication, where feeding is relatively poor a decline in production occurs. The feed cost, according to many researchers has contributed more than

half of cost of production. Ukachukwu (2000) and Ukachukwu and Obioha 1997) reported that feeding accounts for 70 – 80% of the cost of production in poultry, and that there is direct correlation between feeding and health of a livestock. Poor feeding leads to poor health, while good feeding enhances healthy growth and performance in livestock. Nutrients in feed promotes normal metabolic activities in the animals, the state of the feed either solid or liquid notwithstanding. Thus, the high cost of feed and diseases incidence have led to excessive and extensive use of drugs and vaccines in poultry production in many countries all over the world (Verzosa, 2012). Most of those drugs and vaccines are inorganic chemical substances and majority of them are antimicrobial agents. They also have pronounced residual effects on the end users (consumers) of poultry products and many a times build antimicrobial resistance. These two factors in association with others may lead to emergence of zoonoses. These problems led to the exploration of feedstuffs from plant family that could be used as both feedstuff and phyto-medicine, most of these plants are being researched on for their possible incorporation as feedstuffs by animal nutritionists and other animal scientists.

These plants currently constitute non-conventional or novel feed sources, some of these plants that have been used include: Lyon bean in poultry diet (Ukachukwu, 2000), vegetable in poultry diets (Al-Harthi *et al*., 2001; Onu, 2012), Herb and spices in poultry diets (Windish *et al*; 2008; Okoye *et al*; 2006), Moringa Leaf Meal in weaner rabbit diet (Nuch, 2010), Moringa leaves in a Sirohi goat kid goat (Meel *et al*; 2018), Moringa leaves meal based diet in rabbit (Vidjanna *et al*; 2018) and Moringa leaves supplements in rats for Alzeheimer's disease. These plants have been reported as having positive effects on the trials in livestock and are recommended for use. Every part of the plant has one or more particular usefulness or the other to humans, animals and the environment. Thus the plant has been described using the following terms; Miracle Tree" (Fugile, 2003; Meel *et al*; 2018). *Moringa oleifera* recently became more popular so that animal scientists are interested in exploring various strategies in which it can be used in animal nutrition and as antibiotics due to its multifarious nutritional and medicinal advantages in addition to its abundance, availability, fast growth and the propensity for frequent harvesting and good forage yield has prompted this study. Therefore, this study was designed to examine growth and hepato-protective responses of broilers fed on aqueous moringa leaves extract.

MATERIALS AND METHODS

This study was carried out at the Department of Agriculture, Teaching and Research Farm, Ignatius Ajuru University of Education, Rivers State. The area is located at latitude $4^0 58^1$N of the equator and is characterized by two main seasons; namely rainy and dry seasons. The study was conducted in a completely randomized design (CRD) with four (4) treatments only. The treatments were labelled A_1, A_2, A_3 and A_4 respectively, each treatment was replicated three (3) times. The birds were fed two kinds of feeds depending on their ages, from 0 to 4 weeks; they were fed starter diet whereas from 5 weeks and above, they fed finisher diet respectively. Fresh plucked moringa leaves were air dried, grounded and graded 0, 5, 10, and 15g and were used to prepared one litre of aqeous moringa leave extract (AMOLE) from each. One hundred and twenty (120) day old broiler birds purchased from reputable farm, brooded for three (3) weeks and randomly allotted to 4 aqueous moringa leaves treatments. Each treatment had three (3) replicates and 10 birds per replicate. Four (4) treatments were administered, labelled A_1, A_2, A_3, and A_4 respectively. The birds were reared in a deep litter system, warmth was provided using electricity and lantern and birds were fed *ad-libitum* through-out experimental period. Clean water was always administered as treatment solution finishes and feed was served *ad-libitum*. The litter materials were regularly changed every 3 weeks and the litter materials. Data were collected on body weight, feed take and feed conversion ratio (FCR) for growth induces. Two birds were slaughtered for blood and digesta collection into ethyldiamine tetra acetic acid (EDTA) bottle and non-EDT bottle for hematology and serum analysis. About 4 ml of the blood sample was used for heamatological studies according to the method of Cole (1986). Heamatological parameters measured included packed cell volume (PCV), white blood cell (WBC) count, red blood cell (RBC) count and heamoglobin (Hb) count. Also measured were total protein, albumin, globulin, Serum glutamic pyruvic transaminases (SGPT), Serum glutamic oxalo-acetic transaminase (SGOT) (Reitman and Frankel (1957) and alkaline phosphatase (AP or ALP) (Wright *et al.* (1972). Two birds were randomly selected from each replicate and slaughtered amounted to eight (8) birds per treatment. The digesta samples were collected from the crop; gizzard, small intestine and droppings and taken laboratory to determine the microbial content (gram positive and negative) in each part. All data collected were subjected to analysis of variance (ANOVA) procedures at $p = 0.05$ level of probability and means separated using Duncan's Multiple Range test. The analysis was done using SPSS version 21.

RESULTS AND DISCUSSION

From the data in Table 1b, the total feed intake indicates 1862.50, 2045.43, 2165.19 and 2215.10g per bird (gb^{+1}) for treatments A_1, A_2, A_3 and A_4 respectively. Treatment A_1 ($0gl^{-1}$) aqueous moringa leaves extract differs significantly from treatments A_2 ($5gl^{-1}$), A_3 (10g ($^{-1}$) and A_4 ($15gl^{-1}$) respectively. The feed intake increases as the quantity of aqueous moringa leaves extracts increases. The average feed intake shows 34.50, 37.87, 40.10 and 41.02 gb^{-1} for treatment A_1, A_2, A_3 and A_4 respectively. There is significant difference among treatments mean. This proof that aqueous moringa leaves extract has ability to induce digestion of feed and stimulate appetite coupled with favourable environment and climatic factors. Treatments A_3 and A_4 differ significantly but within the range of 2000 gb^{-1} (2kgb) which is excellent result for profit making by farmers. The feed conversion indicates 1.10, 2.59, 2.73 and 2.59 for treatments A_1, A_2, A_3 and A_4 respectively. There is significant difference among treatments. Treatment A_1 ($0gl^{-1}$) differ significantly from A_2 ($5gl^{-1}$), A_3 ($10gl^{-1}$) and A_4 (15 gl^{-1}). The birds by generation composition have good feed conversion potentials but the application of aqueous moringa leaves extract enhances this potential the more. Kobo spent on feed is well accounted for by the growth performance of the birds. At the onset of the experiment, initial body weight per bird indicates 60, 60, 60 and 60g for treatments A_1, A_2, A_2 and A_4 respectively. There is no significant difference among treatments. The final body weight indicates 1690.33, 1841.58, 1895 .19 and 1948.11 for A_1, A_2, A_2 and A_4 respectively. There is significant difference among treatments mean. The control ($0gl^{-1}$) aqueous moringa leaves extract differs significantly from aqueous moringa leaves extract treated birds. Treatment A_2 also differs significantly from treatments A_3 and A_4 respectively.

The weight gain shows 1630.33, 1781.58, 1895.19 and 1888.11 glb (gl^{-1}), for treatments A_1, A_2, A_3 and A_4 respectively. There is significant ($p<0.05$) difference among treatments mean. Bird fed with $0gl^{-1}$ aqueous moringa leaves extract differs significantly ($P \geq 0.05$) from treatments A_2, A_3 and A_4 respectively. Treatments A_2 and A_3 do not differ significantly ($P \geq 0.05$) from each other but differ significantly from treatment A_4. This implies that aqueous moringa leaves extract has ability to stimulate cell division thereby enhances growth, shape or minimizing factors that diminished growth and development such as heat or cold stress and disease causing agent such as bacteria, fungi, viruses and protozoans proliferating on their targets. The feed intake and body weight increase as the oral dose increases. The results are in consonant with David *et a*l. (2012) that administration of *Moringa oleifera* leaf improve growth performance of the broiler birds. The results are also in tandem with Khan *et al* (2017) reported the moringa leaf meal induces higher body weight. It is also in consonant with Ahialawi *et al* (2016) that moringa leaves at higher levels (15 and 20%) in broiler diets resulted in a higher growth rate and better health status.The total unit count of gram positive bacteria is 8.67, 5.90, 4.10 and 1.25 for A1, A2, A3 and A4 respectively (Table 2). There is significant difference among treatments mean. Control ($0gl^{-1}$) aqueous moringa leaves extract differs significantly from $5gl^{-1}$, $10gl^{-1}$ and $15gl^{-1}$ of aqueous moringa leaves extracts, in similar manner $5gl^{-1}$ differs significantly ($P \geq 0.05$) from $10gl^{-1}$ and $15gl^{-1}$ respectively. This shows that the higher the administrated dosage of aqueous moringa leaves extracts, the lesser the total unit count of gram positive. It could be deduced that aqueous moringa leaves extract has the ability to kill or denature gram positive bacteria thereby rendering them unable to cause harmful effect on the birds. The total unit count (TUC) of gram negative bacteria is 22.87, 17.43, 9.11 and 3.33 for treatments A1, A_2, A_3 and A_4 respectively. Numerically the total unit count decreases from the control (Ogl^{-1}) as the dosage of aqueous Moringa leaves extract increases. There is significant difference ($P \leq 0.05$) among treatments, the control (Ogl^{-1}) differs significantly from treatments A_1, A_2, A_3 and A_4 respectively. Treatment A_2 ($5gl^{-1}$) differs significantly from A_3 ($10gl^{-1}$) and A_4 15($15gl^{-1}$) respectively. It could be deduced that administration of aqueous moringa leaves extract has the potency to kill or render gram negative bacteria inactive to proliferate and cause harm to the birds. The decrease was significant ($P \leq 0.05$) among treatments. This implies that AMOLE has potency to inhibit or de-nature gram positive and gram negative bacteria in the gut of birds. The result is in consonant with the report by Jaheen *et al.* (2008) that moringa inhibit bacteria by attacking the cell wall due to its lipophilic compounds. The results are also in tandem with Faluyi and Agbede (2018) that moringa leave extract caused significant ($P \leq 0.05$) increase in the number of white blood cells and leucocytes to subdue bacteria.

The result in Table 3 shows mean of serum characteristic of the broiler birds as indicators of hepto-protective ability of aqueous moringa leaves extract. The total protein (TP) indicates 33.21, 34.08, 35.19 and 34.31 gdl^{-1} per bird for A_1, A_2, A_3 and A_4 respectively. The total protein increases as the dose of the aqueous moringa leaves extract increases and also there is significant difference among treatments mean. This could be due to the protein mobilized from the feed and other sources. The albumin (Alb) indicates 14.10, 13.27 13.14 and 11.64 gdl^{-1} a bid for A_1, A_2, A_3 and A_4 respectively. Administration of the extract shows gradual progressive increases in albumin as the dose of treatment increases. There is significant difference among treatment mean. The control ($0gl^{-1}$) differs significantly from treatment $15gl^{-1}$ of aqueous moringa leaves extract but treatment control did not significantly differ from treatments A_2 ($5gl^{-1}$) and A_3($10gl^{-1}$) respectively. It shows that aqueous moriga extract aided the formation of albumin which helps in protection of organs against diseases. The globulin shows 16.2, 21.58, 22.07 and 23.67gdl^{-1} for A_1, A_2, A_3 and A_4 respectively. There are numerical increases in quantity of globulin in the blood which increases as the dose of aqueous moringa leaves extract increased. There is significant difference among treatments mean. Control ($0gl^{-1}$) differs significantly from $5gl^{-1}$, $10gl^{-1}$ and $15gl^{-1}$ aqueous moringa leaves extract. Treatments $5gl^{-1}$ and $10gl^{-1}$ do not differ significantly from each other. Globulin and albumin act in combination to prevent diseases and build immune system of the bird. The serum glutamic pyruvic transminases (SGPT) indicate 73.12, 75.04, 77.21 and 79.35 ul^{-1} for treatments A_1, A_2, A_3 and A_4 respectively. The application of aqueous Moringa leaves extract increases in quantity of SGPT content of the blood. Broilers fed with $0gl^{-1}$ aqueous moringa leaves extract differs significantly ($P \geq 0.05$) from treatments A1, A2 and A3 respectively. The serum glutamic oxalo-acetate transaminases (SGOT) indicate 128.68, 123.04, 113.64 and 112.60ul^{-1} bird for treatments A_1, A_2, A_3 and A_4 respectively. The administration of aqueous moringa leaves extract differs significantly ($P \leq 0.05$) from the treatments A1, A2 and A3 respectively. The serum glutamic oxalo-acetate transaminase (SGOT) indicates 109.7, 114.23, 116.92 and 116.58 $ul^{[-1}$ bird for treatments A_1, A_2, A_3 and A_4 respectively. The administration of aqueous moringa leaves extract of aqueous moringa leaves extract increases the quantity of (SGOT) in the blood. There is significant difference among treatments mean. The control ($0gl^{-1}$) differs significantly from $5gl^{-1}$, $10gl^{-1}$ and $15gl^{-1}$ respectively. The control ($0gl^{-1}$) does not differ significantly ($P \geq 0.05$) from A_2 ($5gl^{-1+)}$ respectively. Alkaline phosphatase (Alp) indicates 109.7, 114.23, 118.04 and 116.92gdl^{-1} a bird for treatments A_1, A_2, A_3 and A_4 respectively. Administration of aqueous moringa leaves extract induces increases in the amount of ALP in the blood of the broilers. There was significant difference in the mean amount of ALP among treatments. The control ($0gl^{-1}$) differs significantly from treatments A_2 ($5gl^{-1}$), A_3 ($10gl^{-1}$) and A_4 ($15gl^{-1}$) do not differ significantly ($P \geq 0.05$). It could be deduced that $10l^{-1}$ aqueous moringa leaves extract is likely to perform same as $15gl^{-1}$. These blood chemistry characteristics (assays) are indicators of hepto-protection. Higher in globulin and SGOT and ALP indicates that aqueous Moringa leaves extract has hepto-protective potency, also the low concentration of albumin and serum glutamic pyruvic transaminase indicate healthy status of the broiler birds particularly the liver. These results are in line with the report of Shad and Xiang (2019) who stated that *M. oleifera* is immune enhancer, anti-oxidant and hypo-cholesterol substance. The findings is in consonant with the work of Faluyi and Agbede (2018) that aqueous leaf extract of *M. oleifera* stimulates immune response of broilers challenged new castle disease (ND), pathogens and blood chemistry of the birds were slightly proved and the growth performance improved. The experiment has two parts, farm and laboratory sections.

CONCLUSION

AMOLE showed positive effect on the feed intake and body weight of the birds at the range of $10gl^{-1}$ and $15gl^{-1}$ treatments, also stimulate the bird's immune stimulation and improve hapto-protection. It could be concluded that AMOLE has a fourfold function, improve feed intake, growth performance, immune stimulation and hapto-protection of broiler birds

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Table 1a: Composition of the experimental diets for 0– 4 weeks old (broiler starter) and 5 and above weeks old (broiler finisher)

100 % Ingredients	Starter Diet	Finisher Diet
Maize	52.15	56.00
Wheat offal	11.00	11.00
Soya bean	20.20	18.00
Fish meal	7.00	7.00
PKC	2.5	2.5
Bone meal	3.0	3.00
Common salt	1.00	1.00
Calcium phosphate	0.25	0.25
Lysine	0.25	0.25
Methionine	0.25	
Total	100.00	100.00
Calculated		
Energy kgCal^{-1}	3225.00	3125.00
Protein %	23.5	18

Feed formulation table (% composition)

Table 1b: Growth performance of broiler birds administered aqueous moringa leaf exract

Parameter/ Treatment	A_1 (0gl^{-1})	A_2 (5gl^{-2})	A_3(10gl^{-1})	A_4(15gl^{-1})
Total feed intake (glb)	1862.50^a	2045.43^b	2165.15^c	2215.10^d
Average feed intake (glb)	34.50^a	37.87^b	40.10^c	41.02^d
Feed conversion ratio	1.10^a	2.59^b	2.73^c	2.59^b
Initial body weight (glb)	60^a	60^a	60^a	60^a
Final body weight (glb)	1690.33^a	1841.58^b	1895.19^c	1948.11^d
Weight gain (glb)	1630.33^a	1781.58^b	1835.19^b	1888.11^c

a,b,c,d Means with same superscript are not significantly different at $p \geq 0.05$; A_1,A_2,A_3,A_4 means 0,5,10&15^{g}rames;gl means grammes per litre; g/b mean grammes per bird.

Table 2 Mean total unit gram count of positive and negative bacteria due to administration of aqueous moringa leaves extract

Parameter/ Treatment	A_1 (0gl^{-1})	A_2 (5gl^{-1})	A_3(10gl^{-1})	A_4(15gl^{-1})
Gram positive (TUC)	8.67^d	5.90^c	4.10^b	1.25^a
Gram negative (TUC)	22.87^d	17.43^c	9.11^b	3.33^a

a,b,c,d means with same superscript are significantly different at $p \geq 0.05$; A_1,A_2,A_3,&A_4 means 0,5,10&15grames;gl means grammes per litre and TUC means total unit count

Table 3 Immunological response of broilers birds orally administered aqueous moringa leaves extract on

Parameter/ Treatment	**A1 ($0gl^{-1}$)**	**A2 ($5gl^{-1}$)**	**A3 ($10gl^{-1}$)**	**A4 ($15gl^{-1}$)**
TP(gdl^{-1})	33.21^{a}	34.08^{c}	35.19^{d}	34.31^{b}
Glu (gdl^{-1})	14.10^{a}	13.27^{b}	13.14^{b}	11.64^{c}
Alb(gdl^{-1})	16.2^{a}	21.58^{b}	22.05^{b}	23.67^{c}
SGPT (ul^{-1})	73.12^{a}	75.04^{b}	77.21^{c}	79.35^{d}
SGOP (ul^{-1})	128.68^{a}	123.04^{a}	113.64^{b}	112.60^{c}
Alp (gdl^{-1})	109.7^{a}	114.23^{b}	116.92^{c}	116.56^{c}

a,b,c,d. means with same superscript are significantly different at p $\geq$ 0.05; A_1,A_2,A_3,&A_4means0,5,10&15grames;gl means grammes per litreTP,Alb,Glu,SGPT,SGOT, means total protein, globulin, albumin, serum glumamic pyruvic transaminase and serum glumatic oxalo-actate transaminase,+or- added to the main mean,g/d/l meam gramme per deciliter and ul means microlitr, Alkanine phosphates Alp.

Effect of Value Addition on Profitability of Snail Agripreneurs in Abia State for Sustainable Economic Development

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ABSTRACT

This study analyzed the effect of value addition on profitability of snail agripreneurs in Abia State for sustainable economic development, specifically; the study identified the percentage contribution of agripreneurs in snail value chain in the state, and determine the effect of value addition on profitability of snail agripreneurs. Simple random sampling technique was used in selecting the respondents used for the study. Primary data, collected using structured questionnaire were analyzed using descriptive statistical tools and ordinary least squares multiple regression model using the computer software Stata 16.0. Results showed that value addition to snail meat increases profitability for marketing and processing agripreneurs in Abia state. Travelling traders added high value to snail meat in the state than other actors in the chain. The significant factors influencing profitability of the wholesaling snail agripreneurs were value addition, educational level, year of experience, household size, and amount of credit obtained. The significant determinants of profitability of the retailing snail agripreneurs were value addition, age, educational level, years of experience, household size and cooperative membership. The result also showed that the significant factors influencing profitability of processing snail agripreneurs were value addition, age, year of experience, sex and cooperative membership. There is need therefore to sustain the growing of snails for commercial purpose in the state as snail meat possesses great potential towards sustainable economic development of the state in particular and of the country in general.

Keywords: Agripreneurs, profitability, snail, value addition

INTRODUCTION

Snail meat production, marketing, processing, and export has become a very lucrative business in Abia state owing to its nutrition value, high cost of supplementary animal protein sources (like beef, pork, chicken, milk and egg) and the growing wave of Agripreneurship in the state. The acceptance and consumption of snails by many households in the state (both rural and urban) attest to the popularity of its consumption in the state. Iheke and Nwankwo (2016) observed that consumption of snail in Abia is popular among both rural and urban households due to its nutritive value. According to Kalu (2017) nearly 3 out of every 5 households in Abia state consumes snails. Its production as a business option in the state has gain momentum in other to meet up with the robust market demand. Snail meat (Congo meat) is of notable relevance in the economic development and growth of the state in particular and of the country in general. It has been described as a strong supporting engine room for sustainable growth of animal protein in Nigerian economy (Kalu, 2017). This is the reason why many agripreneurs such as the snail meat marketing agripreneurs and snail meat processing agripreneurs have joined the snails value chain in Abia state aside the snail meat production agripreneurs.Snail meat value chain ensures that the product moves from the producers to the consumers with many thousands of men and women in small and medium scale businesses found in the middle. Each person and each business performs one task or another in the chain, and each adds value along the way viz-a-viz farming, buying, transporting, storing, checking, packaging, processing and selling. In Abia state, traders (wholesalers and retailers) and processors of snail meat are likely to dominate the chain in terms of the value they add than the producers. Addition of value in Snail meat chain is undertaken by each agripreneur who in return receives an economic return (economic rent). The amount each agripreneur in the snail meat chain receives varies along the value chain. Nonetheless the price production agripreneurs receive for their raw goods is only a trivial fraction of the price paid by the final consumer. The level of variation in the value added by different categories of snail meat agripreneurs will affect the level of profit each actor makes from snail meat business. There is need to empirically understand whether value addition influence the profitability of snail meat agripreneurs in the state.Given the above scenario, it has become pertinent and indeed imperative to analyze the effect of value addition on profitability of snail agripreneurs in Abia State for sustainable economic development. Specifically, the study identified the percentage contribution of agripreneurs in snail value chain in the state, and determine the effect of value addition on profitability of snail agripreneurs. Thus, the study would guide policy makers in formulating appropriate policies aimed at raising the present level of snail meat value addition, given the fact that value addition is directly related to the overall profitability of agripreneurs in the snail meat business.

MATERIALS AND METHODS

The study was conducted in Abia State of Nigeria. Abia is a State in South Eastern Nigeria. It is located between latitude 4° 40^{I} and 6° 14^{I} North of the equator and longitudes 7° 10^{I} and 8° O^{1} East of the equator. Abia has a total land area of 5,243.7 km2, approximately 5.8% of the land area of Nigeria. It has a total population of 2,833,999 inhabitants from the 2006 population census, with a population density of 448.4/km2 (NPC,2006; Wikipedia, 2008). It shares common boundaries to the North with Ebonyi State; to the South and Southwest with Rivers State; and to the East and Southeast with Cross River and Akwa Ibom States respectively. To the West is Imo State and to the Northwest is Anambara State. The State is made up of 17 Local Government Areas, divided into three agricultural zones namely: Ohafia, Umuahia and Aba Agricultural Zones. Agriculture is the major economic sector of the rural inhabitants. There are many persons that engaged in snail meat production, marketing and processing businesses in the state. Simple random sampling technique was adopted in selecting the samples used for the study. The list of snail agripreneurs in the State was collected from State Agricultural Development Programme and ministry of commerce and industry. This was updated by including snail meat agripreneurs whose names were not in the list and those who were based on marketing and processing of the product. These snail agripreneurs were gotten though the help of key informants during the pre-test of the survey instrument. The updated list formed the sampling frame from which a total of 50 snail production agripreneurs, 50 snail marketing agripreneurs and 50 snail processing agripreneurs were selected randomly for the study. Primary data was used for the study. The data were collected using structured questionnaires administered to the respondents. The data relates to the 2019 production season. Data collected for the study were analysis using both descriptive statistics like percentage and regression model. The empirical model was used to determine the effect of value addition on profitability of snail meat agripreneurs is specified explicitly as:

$$PFS_i = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \mu_i \qquad (1)$$

Where, PFS_i = Profitability of agripreneurs in naira {PFS_i = PFS_1(PRD), PFS_2(MKT), PFS_3(PRO)}, PRD = Production agripreneurs; MKT = Marketing agripreneurs; PRO = Processing agripreneurs; X_1 = Value addition (Naira); X_2 = Age of respondents (years); X_3 = Educational level (years); X_4 = Experience (Years); X_5 = Household size (count); X_6 = Sex of respondents (Male = 1; Female = 0); X_7 = Cooperative membership (Yes = 1; No = 0); and X_8 = Amount of credit obtained (Naira), μ_i = Error term.

RESULTS AND DISCUSSION

Percentage of value added in snail meat value chain by agripreneurs

The diagram below shows how value is added at each link in snail meat value chain in Abia state.

Figure 1: Snail meat (Congo meat) value chain in Abia State
Value added = price received by actor – price paid by actor

In the snail meat value chain in Abia state, the work that the travelling agripreneur trader performs adds value so that the price the trader charges for a kilo of snail is 42% higher than the price he/she pays the production agripreneur (producer) for the snail meat. Next, the wholesaler adds value through activities such as packaging so that the price he/she charges the retailer is 11% higher than the price he/she pays the travelling trader. And the price the retailer charges the consumer is 22% higher than the price the retailer pays the wholesaler to offset the costs of services such as transportation. Lastly, the price the processor charges the consumer is 25% higher than the price the processor pays the wholesaler and retailers to offset the costs of services such as transportation, spicing, packaging, sorting and serving. This implies that each actor in the snail meat value chain charges an "economic rent" at his/her stage of the chain.

Effect of value addition on profitability of agripreneurs

The result of the ordinary least squares multiple regression model on the effect of value addition on profitability of snail agripreneurs in the study area is presented in table 1. Figure 1 shows that snail producers do not add value to snail chain in the study area. Therefore, the analysis of the effect of value addition on profitability of snail meat agripreneurs focused only on the activities of marketing and processing agripreneurs.

Table 1: Ordinary Least Square (OLS) multiple regression result of the determinants of profitability for marketing and processing agripreneurs in Abia State

Variable	Wholesalers	Retailers	Processors
Constant	5.432(7.096)***	4.779(6.987)***	4.369(5.270)***
Value addition	1.291(3.889)***	1.201(3.329)***	1.136(3.085)***
Age of respondents	-0.396(-0.041)	-0.893(-2.522)**	-0.981(-2.427)**
Educational level	1.004(2.949)***	0.733(2.477)**	0.036(0.919)
Years of experience	1.032(3.009)**	1.003(2.982)***	1.103(3.542)***
Household size	0.312(3.098)***	0.311(2.158)**	0.017(0.185)
Sex of respondents	-0.075(-1.435)	-0.201(-1.301)	-0.342(-2.296)**
Cooperative membership	0.232(0.942)	0.652(2.475)**	0.845(2.441)**
Amount of credit obtained	0.936(2.481)**	-0.056(-1.308)	-0.052(-1.325)
R^2	0.755	0.846	0.757
Adjusted R^2	0.733	0.824	0.735
F-statistic	31.025***	39.161***	31.073***

*Source: Field survey data, 2019. Note: ***, ** and * represents 1%, and 5% levels of significance respectively. Values in parentheses are t-ratios*

The coefficient of multiple determinations (R^2) for wholesaling, retailing and processing agripreneurs were 0.755, 0.846 and 0.757 respectively. This implies that 75.5%, 84.6% and 75.7% variations in profitability of wholesaling, retailing and processing snail agripreneurs respectively were explained by the explanatory variables included in each of the models. Table 1 shows that the regression coefficient of value addition was positively related to profitability of wholesaling, retailing and processing snail agripreneurs at 1% significant level. This implies that increase in value addition leads to increase in the profitability of wholesaling, retailing and processing snail agripreneurs and vice versa. The regression coefficients of value addition for wholesaling, retailing and processing snail agripreneurs were elastic. This suggests that a 10% increase in value addition results in 12.91%, 12.01% and 11.36% increases in the profitability of wholesaling, retailing and processing snail agripreneurs respectively. This finding is supported by the finding of Chidozie (2014); Ater, *et al* (2018) and Alalade*et al,*., (2019) who reported positive significant relationship between value addition and farm income. Other variables as educational level, year of experience, household size, and amount of credit obtained were positively and significantly related to the profitability of wholesaling snail agripreneurs. This indicates that educational level, year of experience, household size, and amount of credit obtained will bring about increase in profitability of wholesaling snail agripreneurs and vice versa. Age, educational level, years of experience, household size and cooperative membership significantly influenced the profitability of retailing snail agripreneurs. This implies that increase in educational level, years of experience, and household size and being a member of a cooperative group increases the profitability of retailing snail agripreneurs while increase in age decreases the profitability of retailing snail agripreneurs. This may be due to in ability of older retailer to cope with the stress involved in sourcing and retailing snail meat. Age, year of experience, sex and cooperative membership significantly influenced the profitability of processing snail agripreneurs. This implies that increase in year of experience, being a member of a cooperative group and being a female increases the profitability of processing snail agripreneurs. Females being more profitable than their male folk in snail meat processing may be due to their ability to be more technically efficient than their male folks (Iheke and Nwankwo, 2016). Increase in age decreases the profitability of processing snail agripreneurs.

CONCLUSION

Value addition to snail meat increases profitability for marketing and processing agripreneurs in Abia state. Travelling traders added high value to snail meat in the state than other actors in the chain. Therefore, value addition to snail meat is positively related to increase in agripreneurs profitability. There is need therefore to sustain the growing of snail for commercial purpose in the state as it possesses great potential to ensure economic development in the state in particular and in the country at large.

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Performance and Cost Analysis of Broiler Chicks Fed Graded Dietary Levels of Toasted *Mucuna Pruriens* Seed Meal Based Diet

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ABSTRACT
A four week feeding trial was conducted to determine the effect of toasted Mucuna seed meal (TMSM) on the growth performance and cost benefits of broiler starter chicks. To achieve this, three hundred (300) day old broiler starter chicks were randomly allocated to five experimental diets in a completely randomized design (CRD). Each treatment was replicated three times having twenty birds per pen. Toasted Mucuna seed meal was prepared and fed in graded levels of 5.0, 10.0, 15.0, and 20.0 alongside, control. The parameters measured and calculated included final weight, weight gain, feed intake, feed to gain ratio and feed cost per kilogram gain The results showed that dietary levels of inclusion of TMSM had significant (P<0.05) effect on these parameters. The final weight, the weight gains and feed intake of the birds fed 0.0 and 5.0% TMSM were statistically (P>0.05) similar and significantly (P<0.05) higher than those of other treatments. Cost of feed per birds and feed cost per kilogram gain were lower for all TMSM diets, while treatment five (T5) gave the highest cost benefits, which could be because T5 contains higher value of Mucuna seed meal. It was concluded that TMSM has beneficial effects on the performance of broiler starter chicks, with appreciable cost benefits.
Keywords: Toasting, Performance, Mucuna pruriens, Broiler starter, graded level

INTRODUCTION
Feed cost was estimated to be about 70% of the total costof production (Ogundipe *et al.,* 2003). This high cost has been attributed to the over-dependence on the expensive conventional feed stuffs such as soybean and groundnut cake which is mainly used in poultry feed formulation as a major source of protein. Poultry farmers and nutritionists are mostly interested in the total cost of production and the final returns after sales and the major thrust for them is to lower cost without compromising quality. This high cost of feed necessitates research into non-conventional feedstuffs (NCF) that are readily available, cheap and nutritionally safe. Utilization of *Mucuna pruriens* seeds which has crude protein of about 33.4% in poultry feed can lower feed cost because they are cheaper and are not consumed as food by humans. The seeds however, contain anti- nutritional factors such as trypsin inhibitor, tannins, phytic acid (Oke *et al.,* 2003), which need to be detoxified before they are fed to poultry (Akinmutimi and Okwu, 2006). Heat treatment such as boiling is frequently used to improve the utilization of the nutrients in legumes by animals (Tuleun *et al.,* 2008). This study was designed to evaluate the growth performance and cost benefits of broiler starter chicks fed graded dietary levels of toasted *Mucuna* seed meals.

MATERIALS AND METHODS
The experiment was conducted at the poultry section, Department of Livestock, Ministry of Agriculture, Mariri, in Kumbotso Local Government Area of Kano State. Five experimental diets of toasted *Mucuna* seed meal (TMSM) at 0, 5.0, 10.0, 15.0 and 20.0% levels for T1, T2,

T3, T4 and T5 were formulated respectively. The feed composition for the chicks is shown in Table 1. The birds were randomly assigned to pens in a completely randomized design (CRD). There were five treatments (0, 5.0, 10.0, 15.0 and 20.0% TMSM) and three replications of the five treatments each with 20 birds per pen. The management of the birds was carried out according to the standard procedures for brooding, vaccination and medication. The birds and feeds were weighed weekly. The performance characteristics were measured in terms of weight gain, feed intake, and feed to gain ratio. The cost benefit was measured in terms of feed cost per kilogram, per 100kg and per tones respectively. The result obtained from performance was subjected to analysis of variance (ANOVA) using procedure of SAS (2002), significant levels of differences among treatment means were determined using the Duncan‘s multiple range test.

RESULTS AND DISCUSSION

Table 2 shows the performance of broiler starter chicks fed toasted *Mucuna* seed meal. The final weight, weight gain, feed intake and feed to gain ratio, of birds fed 0 and 5.0% toasted *Mucuna* seed meal (TMSM) were similar, higher and better than those on other treatments, this could be an indicationthat chicks were able to efficiently utilize TMSM at 5.0% better than other levels. This result of better feed to gain ratio observed for birds fed 5.0% TMSM could also be due to the fact that there were sufficient digestible nutrients that were better utilized at this level. The results of the feed intake from this study agreed with the findings of Akinmutimi and Okwu, (2006) who reported reduced feed intake in cooked *Mucuna* seed meal as dietary levels of inclusion of cooked *Mucuna* seed meal increased in the diets of broiler chickens. There was significant ($P<0.05$) decrease among treatment means for feed cost per bird and cost per kilogram gain, which decreased as the dietary levels of TMSM increased. The feed cost per bird and per kilogram gain were significantly ($P<0.05$) better for all the TMSM diets compared to the control diet, in which T5 has the highest cost benefits This was because *Mucuna* seeds were cheaper and readily available without much competition from humans as they are not cherished as human food.

Cost-benefit of feeding graded levels of TMSM to broiler chicks

Table 3 shows the cost-benefit of feeding graded dietary levels of MSM to broiler starter chicks. T5 had the least cost/kg diet of ₦ 195.20 which differed from ₦ 240.00, ₦ 220.32, ₦ 210.00 and ₦209.25 values obtained from T1, T2 T3 and T4 respectively. The cost difference indicates that the diet of T5 was the most cost effective having a differential of ₦ 44,800 tonne-1, better than T4, T3 and T2 having ₦ 39,975.00 tonne-1, 30000.00 tonne-1and ₦ 19,680.00 tonne-1 respectively.

CONCLUSION

From the present study, TMSM in the diets of broiler chicks (5, 10, 15 and 20 % 100 kg-1) positively affected the performance of the broiler chicks and cost of feeding is better for T2, T3, T4 and T5. T5 recorded the best cost differentials of ₦ 44,800.00. Hence, TMSM should be introduced into the diets of broiler chicks up to 5% level of inclusion which has the most superior weight of 820.27g per bird without any deleterious effect.

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Table 1: Gross composition of Broiler starter diets containing Toasted *Mucuna* seeds meal (TMSM)

Ingredients (%)	**0**	**5.0**	**10.0**	**15.0**	**20.0**
Maize	48.45	47.98	44.35	41.91	39.90
Groundnut cake	31.60	27.07	25.70	23.14	20.15
Mucuna seed meal	0.00	5.0	10.00	15.00	20.00
Soybean meal	8.00	8.00	8.00	8.00	8.00
Maize offal	5.00	5.00	5.00	5.00	5.00
FIsh meal	2.00	2.00	2.00	2.00	2.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Limestone	1.00	1.00	1.00	1.00	1.00
Common salt	0.30	0.30	0.30	0.30	0.30
Methionine	0.30	0.30	0.30	0.30	0.30
Lysine	0.10	0.10	0.10	0.10	0.10
*Vitamin /trace min. premix	0.25	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**	**100**
Calculated Analysis (%)					
ME (kcal/kg)	2924	2911	2908	2902	2900
Crude Protein	23.00	23.00	23.00	23.00	23.00
Crude fibre	3.40	4.56	6.25	7.43	7.50.
Ether Extract	6.80	6.92	6.45	6.00	6.95
Ash	6.40	6.45	6.45	6.42	6.15
Calcium	1.21	1.23	1.12	1.19	1.20

Table 2: Effects of feeding diets containing toasred *Mucuna* seed meal on performance of Broiler starter chicks

Measurements	**0.0**	**5.0**	**10.0**	**15.0**	**20.0**	**SEM**
Initial weight (g/bird)	90.00	90.00	90.00	90.00	90.00	0.00
Final weight (g/bird)	700.11^{b}	820.67^{a}	700.00^{b}	650.67^{c}	590.60^{d}	2.21
Weight gain (g/bird)	757.11^{a}	753.67^{a}	676.00^{b}	625.67^{c}	571.67^{d}	5.11
Feed intake (g/bird)	1235.17^{a}	1230.28^{a}	1200.82^{ab}	1179.78^{b}	1150.10^{c}	7.45
Feed to Gain Ratio	1.63^{a}	1.63^{a}	1.78^{b}	1.89^{c}	2.01^{d}	0.11
Feed cost/bird (₦)	390.20^{d}	377.28^{c}	355.14^{bc}	342.48^{b}	336.32^{a}	0.57
Feed cost/Kg weight gain (₦)	175.73^{e}	169.03^{d}	160.87^{c}	154.32^{b}	151.61^{a}	0.98

Table 3: Cost benefit of feeding graded levels of TMSM to broiler chicks

Parameters	**T1**	**T2**	**T3**	**T4**	**T5**
Cost 1kg diet (₦)	240.00	220.32	210.00	209.25	195.20
Cost100 kg diet (₦)	24000.00	22032.00	21000.00	20025.00	19520.00
Cost I tone diet (₦)	240000.00	220320.00	210000.00	200025.00	195200.00
Cost benefits (₦)		19680.00	30000.00	39975.00	44800.00

T1=0 % MSM 100 kg-1 diet; T2=5 % MSM 100 kg-1 diet; T3=10 % MSM 100 kg-1 diet; T4=15 % MSM 100 kg-1 diet and T5=20 % MSM 100 kg-1 diet

Meta-Analysis of Production, Management Systems and Challenges Associated with Small Scale Poultry Agribusiness Enterprises in Abia South Senatorial District of Abia State, Nigeria

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ABSTRACT

The study meta-analysed production, management systems and challenges associated with small scale poultry agri-business enterprises in Abia South senatorial district of Abia State, Nigeria. Specifically, the study ascertained their reasons for engaging in poultry production; examined their production and management systems; and identified challenges the encounter in poultry business. Poultry farmers in Aba North and South constituted the population for the study. Random sampling technique was used in selection of the poultry farmers and a total of 70 respondents constituted the sample size for the study. Questionnaires were used to collect data from the respondents. Descriptive statistics was used for the analysis. Results indicated that 97.1% engaged in poultry production for the purpose of earning income while 65.7% engaged in poultry production as a source of employment. Majority of the respondents (94.3%) were into broiler production and the average stocking rate was approximately 1579 birds. Majority (98.6%) of the respondents sourced information from fellow farmers. The study also revealed that all 100% of the respondents sourced credit through personal savings. The study observed use of drugs (1.76), record keeping (1.70), use of disinfectants (1.49), culling (1.37), and vaccination (1.16) as major management practices carried out by poultry farmers. High price of feed (1.99), high cost of commercial ration (1.93) and lack of access to credit (1.79) were indicated as major challenges faced by poultry farmers in the course of carrying out their business. Also, the study showed that 74.3% of the respondents suggested reducing the cost of feed as a strategy for overcoming challenges encountered in poultry production. Based on the results, the study recommended state Government subsidizing the cost of feed for the poultry farmers to enable them stay in business and maximize profit as well as make provision for incentives and support to poultry farmers in form of credit, soft loans, grants, hatcheries etc. as this would help them to obtain necessary raw materials and inputs for their business.

Keywords: Meta-analysis, production, management systems, poultry enterprise

INTRODUCTION

Poultry is the fastest growing agricultural sub- sector, especially in developing countries (Mottet and Tempio, (2016). Poultry accounts for a substantial contribution to food security and nutrition, providing energy, protein, and essential micro nutrients to humans within short production cycles (Robyn *et al,* 2018; Akpabio *et al,* 2016). It also has the ability to convert a wide range of by-products and wastes into meat and eggs edible by humans. Poultry also contributes to poverty alleviation, and constitute a major asset that can be sold in times of crisis and act as household insurance. Mutami (2015) stated that the production of poultry stimulates economic development of urban centres through the development of related micro enterprises wholly or partly responsible for the provision of inputs, processing, packaging, and marketing of outputs as well as the provision of services to the sector. The popularity of poultry production can be explained by the fact that poultry has many advantages over other livestock. Poultry birds are good converters of feed into usable protein in form of meat and egg, and the return on investment is high (Heise *et al*, 2015), Poultry meat is very tender and the rate of acceptability to consumers is high regardless of their religious beliefs. The production cycle is quite short such that capital is not tied up over a long period. Poultry eggs are more affordable for the common person than other sources of animal protein. Other contributions of poultry industry include easy availability of organic fertilizer to farmers which in turn reduce dependency on inorganic fertilizer, employment generation, improvement in economic status and food security (Tej *et al,* 2019). Approximately 10% of the Nigerian population is engaged in poultry production mostly on micro scale or small scale level. However, the output level still remains low compared to the input (Ajiboye *et al,* 2019). Geng *et al.* (2020) stated that stocking rate is one of the most important environmental and management factors to pursue for the maximum economic benefits. Small scale poultry producers suffer from a weak feed industry and poor market access as a result of inadequate infrastructure (Heise *et al,* 2015). Other problems of poultry farming are: low capital base, inefficient management, technical and economic inefficiencies, infection with diseases and parasites, high costs of feeds, poor quality of day-old chicks, inadequate extension and training facilities, market price fluctuation, unfavourable agricultural policies and unfavourable climatic conditions (Matuka *et al,* 2018; Hamid *et al,* 2018; Ajetomobi *et al*. 2020). Consequent upon these, the study raises the following questions; Why do small scale poultry farmers engage in poultry production? What are the challenges peculiar to them? What are the possible solutions or strategies that can be employed to overcome such challenges?

The overall purpose of this study is the analysis of production, management systems and challenges associated with small scale agri-business poultry enterprises in Abia South senatorial district of Abia State, Nigeria. The specific objectives were to:

1. ascertain reasons for engaging in poultry production;
2. examine their production and management systems; and
3. identify challenges encountered in poultry production.

METHODOLOGY

The study was carried out in Abia South Senatorial district of Abia State. A multistage random sampling technique was adopted in selecting the respondents for the study. In the first stage, two Local Government Areas (LGAs) were randomly selected from Abia South senatorial district, namely Aba North and Aba South LGAs. The second stage involved the purposive selection of five communities from each of the LGAs: Aba North (Ogbor Hill, Eziama, Uratta, Umungasi, Osusu) and Aba South (Eziukwu, Ariaria, Abaukwu, Obuda, Ndiegoro) giving a total of 10 communities. The purposive selection was because of the predominance and intensity of poultry farmers in the area. In the last stage, seven poultry farmers were randomly selected from the list of poultry farmers in each of the communities giving a total of seventy poultry farmers for the study. Data for the study was obtained from primary sources. This was achieved through the use of interview schedule that was administered to the respondents. Objectives were analysed using descriptive statistics such as frequency percentage and mean score.

RESULTS AND DISCUSSION

Reasons for Engaging in Poultry Production

Table 1 indicates that majority (97.1%) engaged in poultry production for the purpose of earning income, 65.7% engaged in poultry production as a source of employment, 25.7% engaged in it so as to be food secured, 12.9% as a source of protein, 12.9% engaged in it as a hobby, 7.1% as a source of obtaining organic manure while 4.3% as collateral. This implies that the major aim of the respondents going into poultry business was to earn income. Thus, people establish poultry farms for the purpose of producing eggs, meat and generating high revenue from these products. This result agrees with the opinion of Nmeregini *et al.* (2020) who stated that income is a very important factor in the commencement and operation of any business venture.

Table 1: Reasons for engaging in poultry production

Reasons	Frequency	Percentage
Protein	9	12.9
Food security	18	25.7
Income	68	97.1
Hobby	9	12.9
Collateral	3	4.3
Organic manure	5	7.1
Employment	46	65.7

Field survey data, 2021 *Multiple responses

Poultry Production Systems and Management Practices
Type of Poultry Production

Table 2 shows that 94.3% of the respondents engaged in broiler production, 34.3% of the respondents reared layers, 31.4% reared day old chicks while 24.3% engaged in brooder/ brood rearing and sell. This implies that majority of poultry farmers specialized on broiler production. This could be because of its high demand among the people and short production cycle. This finding agrees with the study of Satapathy *et al.* (2017) who stated that broiler industry is one of the most profitable agro-industries which can effectively tackle the problems of unemployment and underemployment because of its ease of adoption under a wide range of climatic conditions, short production cycle (5-6 weeks), their high feed conversion efficiency, faster return from the investment, and lower initial investment than layer farming. Majority (94.3%) of the respondents use intensive system of production while 5.7% use semi-intensive system. This result is in line with the findings of Meseret (2016) who reported that intensive system for egg-laying hens is perhaps the oldest of the animal farming systems and has low labour cost. The result further shows that majority (81.4%) of the respondents had stocking rate of 20 to 1000, 7.1% had between 1001 and 2000, 5.9% had from 4000 and above birds, 2.8% had between 2001 and 3000, another 2.8% had between 3001 and 4000. The average stocking rate was approximately 1579 birds. Majority (98.6%) of the respondent's sourced information from fellow farmers, 70% sourced from radio while 60%, 48.6%, 21.4% sourced from friends and neighbours, internet and television, respectively. This implies that majority of the respondents depended on informal sources of information. According to Yao *et al.* (2018), the competencies and increased productivity of poultry farmers depend on the degree to which they gain access to information relating to some core poultry practices. Also improved information and knowledge flow is a key component in improving small-scale agricultural production. All (100.0%) the respondents sourced capital from personal savings. This could be due to the interest rate charged by financial institutions, lack of information and knowledge on credit procurement, rigorous bank procedure for credit procurement or unwillingness of banks to give loan for agricultural activities. Other sources of credit for the respondents were friends (18.6%), money lenders (14.3%), relations (12.9%), bank (10.0%), and cooperative society 5.7%. This finding conforms with Ajiboye *et al,* (2017) who stated that informal sources of credit are more popular among small scale farmers.

Table 2: Production Systems of Poultry Farmers

Type of poultry production*	Frequency	Percentage	Mean
Broiler	66	94.3	
Layer	24	34.3	
Day old chicks	22	31.4	
Brooder/brood and sell	17	24.3	
Poultry production system*			
Intensive system	66	94.3	
Semi-intensive system	8	11.4	
Stocking rate			
Less than or equal to 1000	50	81.4	
1001 – 2000	10	7.1	
2001 – 3000	2	2.8	
3001 – 4000	2	2.8	
Above 4001	6	5.9	1,578.73
Sources of information			
Extension agents	1	1.4	
Friends and neighbours	42	60.0	
Radio	49	70.0	
Television	15	21.4	
Research institutes	6	8.6	
Community leaders	2	2.9	
NGOs	6	8.6	
Print media	8	11.4	
Fellow farmers	69	98.6	
Cooperative society	9	12.9	
Internet	34	48.6	
Credit sources			
Personal savings	70	100.0	
Bank	7	10.0	
Cooperative society	4	5.7	
Friends	13	18.6	
Moneylenders	10	14.3	
Relations	9	12.9	

Field survey data, 2021 *Multiple Responses were recorded

Management Practices of Poultry Farmers

Table 3 shows that the most common management practices carried out by the respondents were the use of drugs (1.76), record keeping (1.70), use of disinfectants (1.49), culling (1.37), vaccination (1.16) were among the major management practices carried out by the poultry farmers. Use of drugs is a necessary management practice in poultry production as it increases the ability of the birds to resist certain diseases as stated by Smith (2016). It is necessary to keep records so as to monitor when the poultry enterprise is making profits or incurring losses. Use of disinfectants is one of the most effective ways of providing biosecurity barriers in a poultry house (Gregory, 2019). Isolation of sick or unproductive animals from the stock (culling) is necessary to prevent the incidence and spread of pest and diseases as stated by Hamid *et al*. (2018). Poultry birds are usually vaccinated against a variety of diseases such as newcastle disease and infectious bronchitis. Jacob (2019) noted that producers must establish and maintain administration of vaccines to prevent adverse effects of such diseases. The minor management practices of the poultry farmers were access to veterinary services (0.99), brooding (0.91), debeaking (0.33) and candling (0.07).

Table 3: Management Systems of poultry farmers

Variable	Mean	Std. Deviation
Vaccination	1.16*	0.439
Brooding	0.91	0.737
Candling	0.07	0.354
Culling	1.37*	0.516
Debeaking	0.33	0.503
Recordkeeping	1.70*	0.521
Use of disinfectant	1.49*	0.558
Use of drugs	1.76*	0.432
Access to veterinary services	0.99	0.577

Field survey data, 2021

Challenges Associated with Poultry Production

Table 4 shows that high price of feed (1.99), high cost of commercial ration (1.93), lack of access to credit (1.79), poor /lack of extension services (1.23), unavailability of feed in nearby areas (1.06), stress, strain or stroke (1.00), poor/lack of veterinary services (1.00) were perceived as major challenges faced by poultry farmers in the course of carrying out their business. The high cost of feed adversely affect production cost and have caused many poultry farmers to shut down while those still in production are facing input supply shocks (Robyn *et al*. 2018). One of the major problems confronting small scale farmers in Nigeria is poor access to adequate credit. This result agrees with Azubugwu and Osuafor (2019) who found that farmers do not access formal sources of loans due to stringent measures by the participating banks and collateral requirement. Also, lack of access to extension service hinders the flow of information. Nebiyu (2016) also stated that the major constraints of poultry producers are poor supply and quality of vaccine, lack of veterinary services, shortage of water and inadequate training.

Table 4: Challenges associated with poultry production

Challenges	Mean	Std. Deviation
Health Problems	0.83	0.416
Stress, strain/ stroke	1.00	0.417
Poor litter management	0.57	0.527
Environmental pollution	0.49	0.531
Disease outbreak	0.96	0.397
Unfavourable climate	0.71	0.593
Unhygienic environment	0.19	0.460
Poor housing/ infrastructure	0.70	0.645
High cost of commercial ration	1.93	0.310
Unavailability of day-old-chicks in time	0.86	0.597
Market instability and poor sales	0.79	0.635
Poor supply and quality of vaccine	0.54	0.736
High price of feed	1.99	0.120
Lack/shortage of land	0.71	0.764
Lack/shortage of water	0.16	0.470
Unavailability of feed in nearby areas	1.06	0.611
Marketing difficulties during selling of poultry products	0.77	0.618
lack of access to credit	1.79	0.562
Inadequate training on how to manage poultry	0.67	0.631
Poor /lack of extension services	1.23	0.618
Poor /lack of veterinary services	1.00	0.568
Theft	0.66	0.832
Poor quality of poultry feed	0.64	0.762

Field survey data, 2021

CONCLUSION

Based on the findings of this study, it was concluded that poultry enterprise remains a viable employer of labour and a means of income generation is properly sustained. Poultry farmers can overcome the challenges in poultry production if they can feed suppliers can reduce the cost of feed. Farmers need adequate training on proper management of their poultry birds. Farmers need to belong to cooperatives in order to boost their chances of accessing credit. Veterinary doctors should insist on improved quality of vaccines. The government need to reduce their interest rates on loans as high rates this is can hinder farmers from wanting to access loans as well as provide incentives to poultry farmers to encourage their businesses.

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Growth Response of Weaner Pigs Fed Graded Levels of Toasted Pigeon Pea Seed Meal (*Cajanus cajan*) as Replacement for Soybean Meal

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ABSTRACT
The study was conducted at the piggery unit of the Teaching and Research farm, Rufus Giwa Polytechnic Owo, Ondo state to investigate the replacement level of Cajanus cajan to soybean meal. Sixteen weaner pigs with average weight range of 10 -15kg were used in 49-day feeding trial. Four dietary treatments (T1-T4) were formulated which contained 0, 6, 12, and 18% toasted pigeon pea meal respectively. Pigs were fed and water was given to the animal ad libitum. Each treatment was replicated two times with two pigs per replicate in a completely randomised design, significant levels were separated by Duncan Multiple Range Test. Parameters taken were initial weight, final weight, total weight gain, weekly weight gain, total feed intake, weekly feed intake and feed conversion ratio. Results from the study showed significant (p<0.05) effect on all the parameters measured except initial weight with 0% inclusion level having the highest numerical values of final weight, total weight gain, weekly weight gain, total feed intake, weekly feed intake: 61.50, 36.50, 5.22, 98.70, and 14.10 kg respectively. All other parameters followed the same trend and decreased across the group but animal performed better up till 12% inclusion level for total weight gain and weekly weight gain (growth rate) except at total inclusion level. The study therefore concludes that inclusion rate of toasted pigeon pea seed meal into the diets of weaner pigs up to 12% rate measured favoured growth response; but it should not be a total replacement of soybean meal.
Keywords: Pig, Pigeon pea. Weight gain and feed intake

INTRODUCTION
Shortage and high feed cost of conventional ingredients of protein source, like soybean meal, groundnut cake and fish meal has led to sifting attention to sourcing for unconventional, economical and readily available ingredients of wild legumes in animal feeding. The search for alternative protein sources for livestock feeding in developing countries because of high cost and scarcity of the conventional protein sources such as soybean meal and groundnut cake is a continuous one (Olorode and Longe, 1999). One of such substitute feed ingredients is pigeon pea (*Cajanus cajan*) which belongs to the family of Leguminosae (Ghadge *et al*., 2008). It has been found as a satisfactory protein ingredient (Amaefule and Obioha, 2001), a good source of fibre, iron (Fe), Sulphur, Calcium, Potassium (K), Manganese and water soluble vitamin especially thiamine, riboflavin and niacin (Saxena *et al*., 2013). These seeds can be fed to poultry, and mixture of pigeon pea with maize grain were successfully used Hawaii (Orwa *et al*., 2009). However, pigeon pea seed like most tropical legumes contain anti-nutritional substances like trypsin inhibitors and haemagglutinins, which affect consumption in monogastric animals specially the raw seeds (Onu and Okongwu, 2006). Total eradication of these undesirable factors is customary, that toasting and other processing methods exert

advantageous effect by destroying the anti-nutritional factors inherent in legumes (Balogun *et al*., 2001) soaking, boiling in water also reduce the poisonous effect of anti-nutrients and assist to increase the utilization. So this study investigated the growth response of weaner pigs fed graded levels of toasted pigeon pea seed meal as replacement for soybean meal.

MATERIALS AND METHODS

Site of the study

The study was carried out at the piggery unit of the Teaching and Research Farm, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria.

Procurement and processing of experimental materials

Pigeon pea (*Cajanus cajan*) as the test ingredient was obtained from local markets in Owo, Ondo State, Nigeria. The seeds were handpicked and winnowed to remove all the foreign materials. Fine sand from erosion was poured into a large frying pan, set over burning firewood; pigeon pea seeds were poured into the hot sand and toasted for 5 minutes. The toasted seeds were separated from the sand after cooling for about 30 minutes and milled to obtain toasted pigeon pea seed.

Table1: Composition of experimental diets

Ingredients (%)	T1	T2	T3	T4
Maize	39.80	39.80	39.80	39.80
Soybean Meal	18.00	12.00	6.00	0.00
Toasted pigeon pea meal	0.00	6.00	12.00	18.00
Palm kernel cake	25.00	25.00	25.00	25.00
Wheat offal	10.00	10.00	10.00	10.00
Palm kernel oil	2.00	2.00	2.00	2.00
Bone meal	2.00	2.00	2.00	2.00
Limestone	1.5	1.5	1.5	1.5
Salt	0.5	0.5	0.5	0.5
Premix	0.2	0.2	0.2	0.2
Lysine	0.5	0.5	0.5	0.5
Methionine	0.5	0.5	0.5	0.5
Total	**100**	**100**	**100**	**100**
Calculated analyses				
M.E. (Kcal/kg)	2722.00	2798.50	2863.53	2955.55
Crude protein (%)	17.37	17.02	16.30	15.58
Crude fibre (%)	5.82	5.93	6.14	6.25

Experimental animals and design

Completely randomised design was used, 16 pigs of large white and Duroc strain cross were used, the and animals were acclimatized for seven days, later divided into four dietary treatments (T_1-T_4) with two replicates with two pigs each. Four different diets were formulated as shown in Table 1. The pigs were housed in a well ventilated individual house while the formulated diets and water was given to them *ad libitum* throughout the experimental period during which feed consumption and weight changes was monitored.

Data collection and analysis

Feed intake was taken by measuring the feed consumption per week which was obtained by weighing a known quantity of feed for a particular replicate in a well labelled container at the beginning of the week. The left over at the end of each week was deducted to obtained feed consumed for the corresponding week by difference.

Weight gain was measured by taking the initial weights of the pigs at the commencement of the experiment. Subsequently, body weights were taken on weekly basis, and the difference

between mean weights for two successive weeks was taken to obtain the average weight gain of pigs per week.
Feed conversion ratio was calculated as a ratio of feed consumption and body weight gain.

$$\text{Feed conversion ratio} = \frac{\text{Feed intake}}{\text{Weight gain}}$$

Data collected were subjected to analysis of variance (ANOVA) using SAS (2015) and significant means were separated with Duncan Multiple Range Test.

RESULTS AND DISCUSSION

The results of growth response of weaner pigs fed graded levels of toasted pigeon pea seed meal as replacement for soybean meal was presented in Table 2. It was observed that all parameters measured except the initial weight were significantly ($p<0.05$) affected by the dietary treatment with 0% inclusion level having the highest numerical values for all the parameters, final weight, total weight gain, weekly weight gain, total feed intake, weekly feed intake and feed conversion ratio. Other treatments (T_2-T_4) decreased across the group and followed the same trend, the reason could be that there are still residual anti nutrient in the diets Ganzon-Naret (2014) opined that to reduced absorption by the animals that it may require more than five minutes toasting. The result is in consonance with the work of Batterham *et al*., (1990) and Grimaud (1988) who investigated 45% ground pigeon pea meal inclusion in the diets of growing pigs and reported lower daily gain and degraded feed conversion ratio. Also only low level of pigeon pea seed meal (12-14%) were reported by (LuFuji *et al*., 1999) to provide acceptable results in growing pigs

Table 2: Growth response of weaner pigs fed graded levels of toasted pigeon pea seed meal as replacement for soybean meal

Parameters	T1	T2	T3	T4	SEM
Initial weight (kg)	25.00	25.00	25.00	25.00	0.89
Final weight (kg)	61.50^{a}	60.50^{ab}	54.25^{b}	49.25^{c}	0.12
Total weight gain (kg)	36.50^{a}	35.00^{a}	29.25^{ab}	24.00^{b}	0.07
Weekly weight gain (kg)	5.22^{a}	5.00^{a}	4.18^{ab}	2.93^{b}	0.34
Total feed intake (kg)	98.70^{a}	97.90^{a}	95.15^{ab}	92.35^{b}	0.32
Weekly feed intake (kg)	14.10^{a}	13.99^{a}	13.59^{ab}	13.20^{b}	0.32
Feed conversion ratio	2.71^{b}	2.80^{ab}	3.27^{ab}	4.71^{a}	0.12

$^{abc:}$ means on the same row with different superscript differs significantly ($p\geq0.05$), SEM: Standard error of mean

CONCLUSION

Based on the results of this study, pigs can tolerate graded levels up to 12% toasted pigeon pea seed meal in their diets with correspondent weight gain but not a total replacement of soybean meal.

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SUB-THEME 4

Biotechnology/Biosafety Issues and Strategies in Agriculture

Development of Semi-Autotrophic Hydroponics (SAH) Protocol for the Rapid Multiplication of Ginger Plantlets

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ABSTRACT
Ginger (Zingiber officinale Rosc.) is an herbaceous perennial crop but cultivated annually in different parts of the world. It has both nutritional, medicinal and industrial value. Even though Nigeria is the largest producer of ginger, its production and utilization is not fully maximized due to low genetic base and dearth of quality planting materials. In this study we explore the use of a high-throughput multiplication tool, semi autotrophic hydroponic (SAH) for the rapid multiplication of ginger by determining its survivability and adaptability in selected substrate supplemented with different solution sources. Two ginger varieties UG1 and UG2 were allowed to break dormancy at three different environment, screen house, laboratory slab and tissue culture plantlets. The study showed a significant difference (P<0.05) on survivability among ginger varieties raised from different environment while no significant difference was observed on survivability with the different solutions used.
Keywords: adaptability, multiplication tool, substrate, survivability

INTRODUCTION
Ginger (*Zingiber officinale Rosc.*), an herbaceous perennial usually grown annually and produced mostly in Thailand, India, China, Taiwan, Australia, and Nigeria (Kirdmanee *et al.*, 2004). It has been an important tropical horticultural plant valued all over the world as a spice crop with high medicinal properties (Kankanam et al., 2020). In Nigeria, large-scale cultivation of ginger began in 1927 in southern Zaria, especially within Jemma's federated districts as well as in the adjoining parts of the plateau. Nigeria has tried to widen the genetic base of the crop through introduction of ginger cultivars, mainly from India. Currently, Nigeria is one of the largest producers and exporters of split-dried ginger. The annual production is around 90,000 metric tons from an area of 17,400 ha (Ibrahim, 2018).

Ginger is vegetatively propagated through rhizomes. However, conventional multiplication produces only 10-15 lateral buds from the rhizome of a single plant after 8 months (Bhagyalakshmi and Singh, 1988; Jaffer et al., 2018). It has a habit of rare flowering and non-viable seed production (Ikeda and Tanabe, 1989; Malamung et al., 1991; Prasath et al., 2017). Seed rhizome sprouts during favourable climatic conditions. In addition, ginger cultivation is threatened by systemic disease that spread through the infected rhizomes when used as planting materials. Mostly, the pre-emergence root and yellow disease are transmitted from infected rhizomes (Dohroo, 1989) and 50-70% cost of production goes to planting materials (Villamor, 2010).

Semi Autotrophic Hydroponics (SAH) Technology
The Semi Autotrophic Hydroponics technology is a high ratio rapid multiplication technique for low cost seed multiplication technology that boosts rapid production of planting materials. SAH generated plantlets are usually ready for pruning two to three weeks after inoculation.

The technique was developed by SAHtechno LLC for potatoes but later adapted by BASICS (Building an Economically Sustainable Integrated Seed System for Cassava) project for cassava propagation through the International Institute of Tropical Agriculture (IITA) and National Root Crops Research Institute Umudike (NRCRI) for its rapid multiplication efficiency of clean planting materials.
The objective of this work was to employ the SAH Technology in developing an efficient protocol for the rapid multiplication of Ginger.

MATERIALS AND METHODS

Source of materials

Two varieties of Ginger (UG1 and UG2) were used for this experiment. Three different sources for UG1 variety were considered for this experiment namely: Tissue culture source[TC], Screen house [SH] and Room Slab [RS]. For UG2, the sources used were from the Screen house [SH] and the Room slab [RS].
The rhizomes of Ginger varieties (UG1 and UG2) that were used for this study were obtained from Maro (Southern Kaduna), a substation of National Root Crops Research Institute; these rhizomes were uniformly surface sterilized; for the Screen house source, rhizomes were planted in sterilized soil under controlled conditions and allowed to grow for 12 weeks.
Surface sterilized rhizomes of UG1 and UG2 were spread on a sterile slab in a well-ventilated room and allowed to sprout for 12weeks. Buds from these rhizomes from both sources were excised and surface sterilized according to standard protocol.
Tissue culture plantlets of about 20 weeks old from the NRCRI Tissue culture facility were used for this experiment.
Sprouts were excised from the Screen house and Room slab sources with sharp and sterile knives, surface sterilized and transferred to the SAH facility.
Same procedure was repeated for UG2 materials from the two sources [Screen house and Room slab].

Preparation of SAH substrate

SAH boxes, slightly perforated with 2 to 3 holes on the lid were filled to 2/3 with sterilized Klassman substrate. Each group was labeled with “SAH solution” and “TC Solution” respectively. About 225ml of SAH solution (Control) was added to each of the boxes in group one while 225ml of TC solution was added to each of the boxes. Each box has six explants/sprouts and were replicated into 3 boxes containing SAH solution and 3 boxes containing TC medium respectively.
Boxes were well-sealed, labeled, and kept in SAH growth room at a temperature of 25-28^{o}C and 12- 15-hour photoperiod. The survival rate (survivability) and vigor were the parameters considered.

The experiment was arranged in Completely Randomised (CRD) and replicated three times. Ginger plantlets were kept under uniform condition and watered weekly with the SAH (control) and Tissue culture solutions respectively; Survivability of the plantlets was recorded based on viable count per stand per box and the vigor was assessed on a 1 to 3 scale where 1 = not vigorous, 2 = moderately vigorous, 3= highly vigorous. Data were collected on weekly basis and analysed using R software (ANOVA package) and MSExcel.

RESULTS AND DISCUSSION

From the study, we observed a significant difference ($P<0.05$) on survivability among the different sources of the UG1 ginger variety denoted as Room slab [RS], Screen house [SH] and Tissue Culture [TC]; however, there was no significant effect on the rate of survivability of either Solutions 1[SAH] and Solution 2 [Tissue Culture].
In Fig 1a and b, the mean rates of survivability and vigor were highest for UG1 planting materials sourced from the Room slab [RS] when compared with those from Screen house [SH] and Tissue Culture [TC], in both solutions.

For UG2, Fig 2a and 2b shows the means of the treatment effect on survivability and vigor of the planting materials. Similar to the trend observed with UG1, there was a significant effect ($P<0.05$) on the source. The Room slab [RS] source for both survivability and vigor outperformed that of the Screen house source, irrespective of the solutions which had no significant effect on the outcome.

CONCLUSION

Although, the Room slab [RS] source gave the highest survivability and vigor at the end of the experiment, we recorded a decline in both parameters of both materials considered; UG2 from the Screen house [SH} source in SAH solution were completely lost.

On the average, survivability and vigor declined for both varieties; the Room slab source giving the highest performance. Sprouting ginger on sterile slabs irrespective of the type of solution offers a promising protocol towards the rapid multiplication of the planting materials using the SAH technology.

This is a preliminary evaluation of this study. Further study to establish and modify the protocol is recommended.

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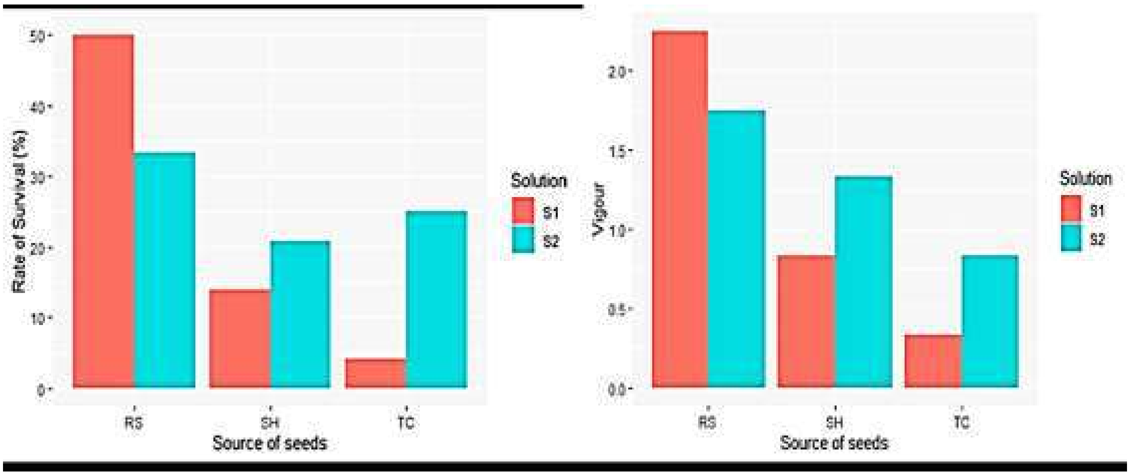

Figure 1: Mean Rate of survivability (Left) and mean vigor (Right) of UG1 in two solutions; S1 and S2, sourced from RS, SH and TC

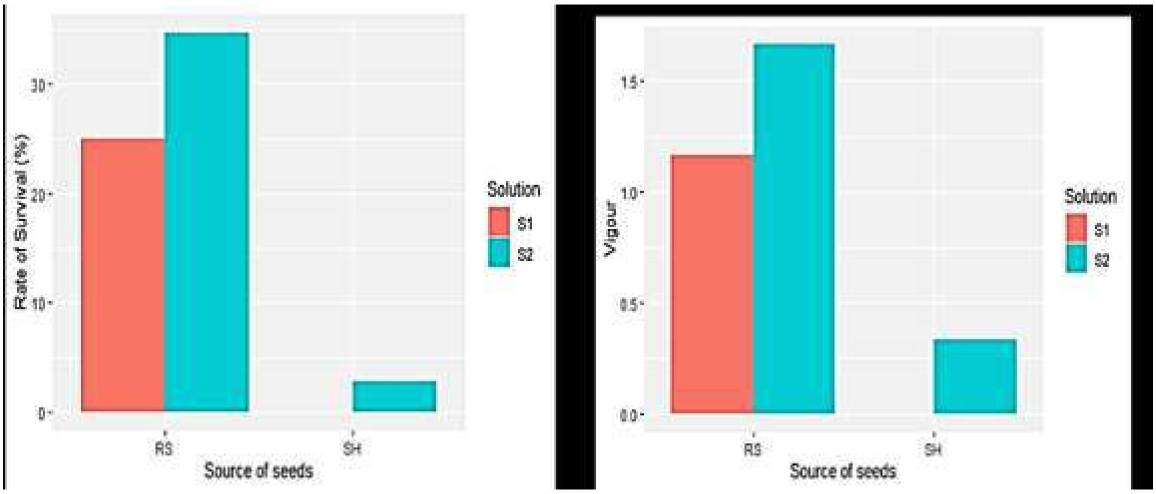

Figure 2: Mean Rate of survivability (Left) and mean vigor (Right) of UG2 in two solutions S1 and S2

Figure 3: SAH derived

Table 1: Mean rate of survival and vigor for UG1 across sources

Source of UG1	**Survival (%)**	**Vigor**
Room Slab (RS)	29.86	1.42
Screen House (SH)	1.39	0.17
Mean	**15.62**	**0.79**
LSD (0.05)	**13.04**	**0.57**
CV(%)	**143.45**	**123.60**

	Survival (%)	**Vigor**
Room Slab (RS)	41.67	2.00
Screen House (SH)	17.36	1.08
Tissue Culture (TC)	14.58	0.58
Mean	24.54	1.22
LSD (0.05)	14.92	0.65
CV(%)	105.48	92.94

Table 2: Mean rate of survival and vigor for UG2 across sources

Evaluating the potentials of Semi Autotrophic Hydroponic (SAH) Multiplication Technology in Cocoyam Seed System

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ABSTRACT
Cocoyams (Colocasia and Xanthosoma) are nutritious food security tuber crops cultivated in most tropical and subtropical regions of the world. It is vegetatively propagated with corms and cormels which is a limiting step to cocoyam production and utilization due to insufficient planting materials. Revolution of cocoyam industry is dependent on breeding and selection of high yielding genotypes with improved nutritional and agronomically traits, as well as viable seed production systems to ensure the availability of planting materials. The semi-autotrophic hydroponic (SAH) system has been explored for the production of potatoes, cassava and yam seeds. In this study, we evaluated the potential of SAH in the production of cocoyam plantlets and optimized the protocol for using SAH in cocoyam multiplication. Three Colocasia cultivars NCe002, NCe003 and NCe005 were used in this study with the application of two set of nutrient solutions. The survival rate and vigor across all three varieties and nutrient solutions 4 weeks after incubation in the growth chamber were high with no significant difference at $P<0.005$. This validates the potential of SAH for the rapid multiplication of cocoyam plantlets for sustainable seed system.
Keywords: cormels, multiplication, multiplication, plantlets, semi-autotrophic hydroponic

INTRODUCTION
Cocoyams (*Colocasia* and *Xanthosoma*) are household crops grown in most tropical and subtropical regions of the world for food security and income. Cocoyam is vegetatively propagated using the corms and to a lesser extent the cormels. As food for human consumption, the nutritional value of cocoyam is primarily caloric (Davis *et al*., 2008). Nigeria is one of the largest producers of cocoyam in the world contributing about 40% of total annual production (Nwabuzor, 2001). The annual production is estimated at 1.5 million tonnes valued at about 600,000,000 Naira (Adedeji and Oluwalana, 2014). They all contain starch and fibre that can provide energy and satiate the consumer.

The future of the cocoyam industry depends on selection of high yielding, quality genotypes and development of low-cost technologies that will enhance its production. Semi Autotrophic Hydroponics (SAH) is a high ratio multiplication tool for the production of clean planting materials. Planting materials generated can be placed under aeroponics system, hydroponics system or even in the field. The technique was developed by **SAHtechno LLC** for potatoes but later adapted by BASICS (Building an Economically Sustainable Integrated Seed System for Cassava) project for cassava propagation through the **International Institute of Tropical Agriculture (IITA)** and National Root Crops Research Institute Umudike (NRCRI) for its rapid and high multiplication ratio. This technology has significantly improved fast multiplication of clean cassava seed both in NRCRI and IITA. It has equally proved very effective in clean yam seed multiplication at IITA.

The objective of this work however is to evaluate the survivability of cocoyam plantlets using the SAH system and to compare adaptability of cocoyam plantlets in different solutions used for the in vitro manipulation of cocoyam.

MATERIALS AND METHODS

Source of material

Cocoyam (*Colocacia esculenta)* cultivars (NCe002, NCe003, NCe005) used for this study were obtained from Plant Tissue Culture of National Root Crops Research Institute, Umudike.

Preparation of SAH substrate

Eighteen (18) SAH boxes slightly perforated with 2 to 3 holes on the lid were filled to 2/3 with sterilized Klasmann substrate making sure there were no clumps in the substrate. The boxes were divided into two, 9 per group. Each group was labeled with "Solution A" and "Solution B" respectively. About 225ml of solution A was added to each of the boxes in group one while 225ml of solution B was added to each of the boxes in group two. Once the substrates absorb the solution, the substrate in each box was lightly pressed into each box.

Introduction of plantlets into substrates

Introduction of tissue culture materials into substrate was done in the cutting room. Shoot tips from each cocoyam cultivar were carefully excised leaving two leaves per shoot. Three cultivars were used in all. Each cultivar was replicated into 3 boxes containing SAH solution and 3 boxes containing TC medium respectively, 6 shoot tips per replicate (box). 36 plantlets were used for each cultivar.

Boxes were thoroughly covered, labeled, and kept in growth chamber at a temperature of 25-28^{o}C and 12 to 15-hour photoperiod. The survival rate, shoot proliferation, vigor and multiplication of the cultivars were assessed.

Statistical analysis

The experimental design was Completely Randomised Design (CRD) and the data were analysed using the R software and MSExcel.

RESULTS AND DISCUSSIONS

Four weeks after incubation in the growth chamber, it was observed that although the survivability rate and vigor across all varieties and solution were very high, the treatment had no significant effect at $P<0.05$ on the parameters under investigation (Figure 1). At 8 weeks, the plantlets were pruned for a second cycle to evaluate their performance and determine their multiplication ratio. Figure 2a shows that there was no significant effect of the treatment on the survivability of the plantlets at 8 weeks but showed a significant effect at $P<0.05$ on the matured plantlets across the varieties (Nce002, Nce003 and Nce005) that were subsequently pruned and used for multiplication experiment. Nce003 gave the highest number of mature plantlets at an average of 97.22% and the least number by Nce005 at 53.34% (Table 1).

Figure 2c shows the treatment effect on the derived plantlets that were pruned from the mature plantlets. The treatment showed significant difference at $P<0.05$ between the number of matured plantlets Nce002 and Nce005; also, a significant effect between variety Nce003 and Nce005 but no significant difference between the varieties Nce002 and Nce003. Fig 3 shows the trend at 12 weeks of the different cocoyam variety plantlets for survivability and vigor in the multiplication phase of the experiment. Nce002 recorded the highest survivability rate at 91.37%, followed byNce003 at 71.67% and Nce005 at 56.82%, with Nce003 showing the most vigorous trend among the three varieties.

CONCLUSION

The experiment showed an impressive adaptability index of the cocoyam varieties to the SAH Technology. Although there was no significance difference of the treatment on survivability and vigor at 4 weeks of establishment, the treatment effect was observed at the multiplication phase, where the number of matured plantlets were significantly influenced by either the variety, solution or an interaction of both. The number of derived plantlets were also influenced by the treatment. At the end of the experiment, the survivability of the three varieties of Cocoyam showed that the adaptation to SAH technology was significantly successfully. This is a preliminary evaluation; thus additional studies are required to enhance and standardize the protocol.

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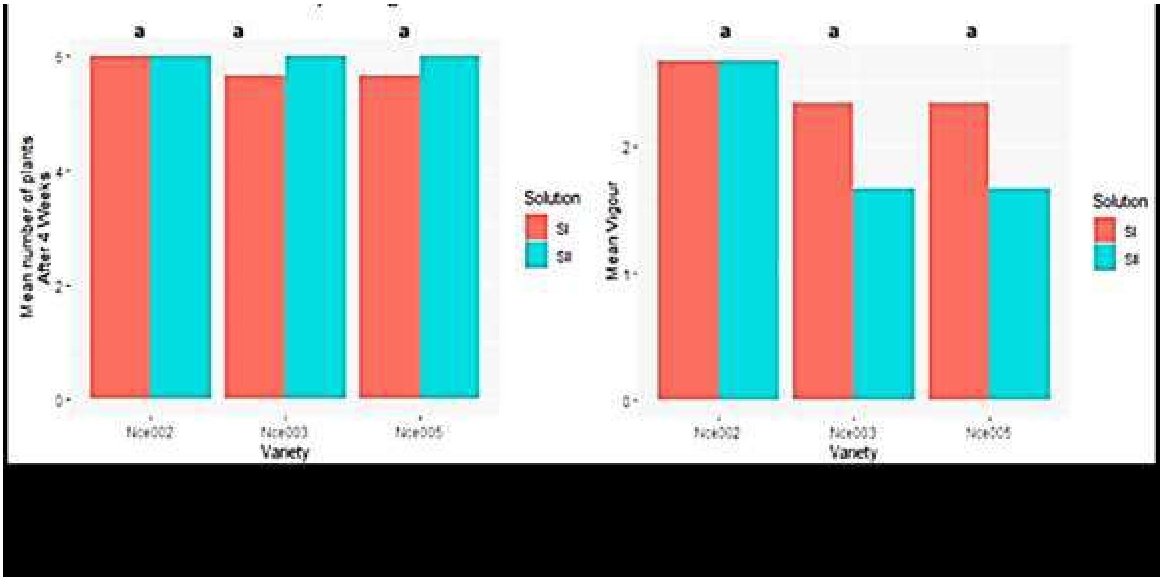

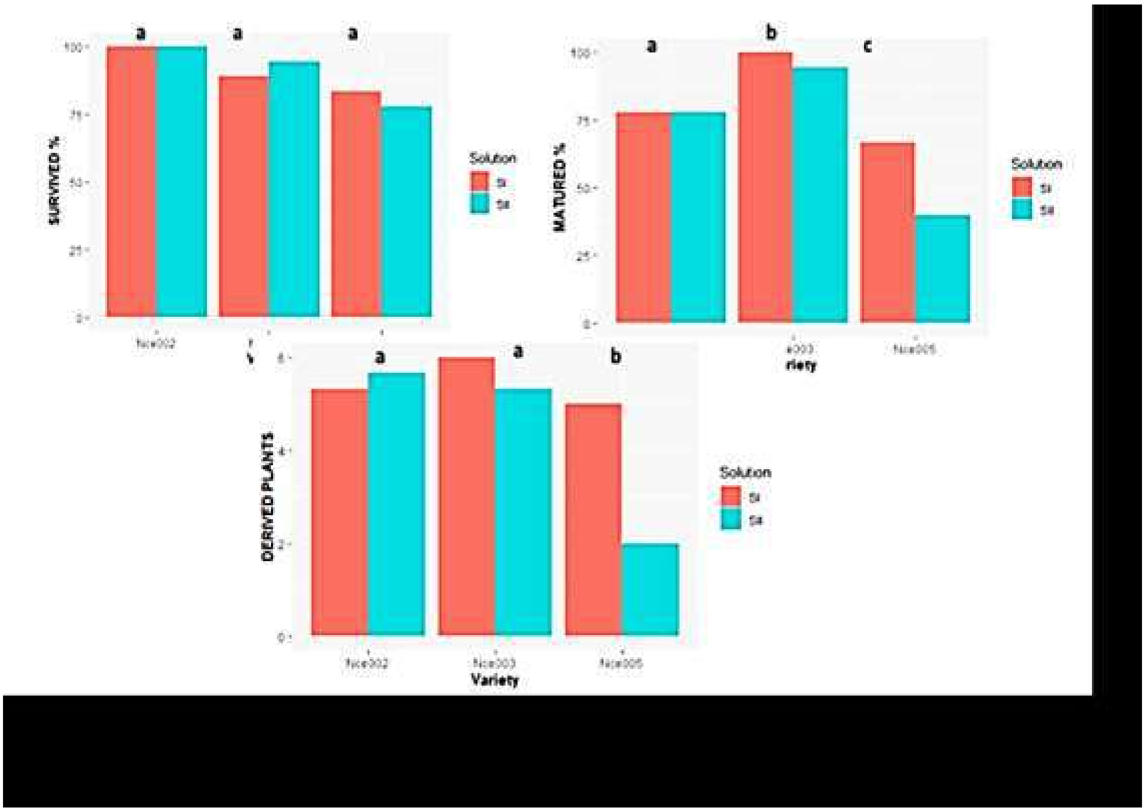

Table 2: Mean survivability, maturity and derived plants across varieties

Varieties	Survival	Maturity	Derived Plant
Nce002	100.00	77.78	5.50
Nce003	91.67	97.22	5.67
Nce005	80.56	53.34	3.50
Mean	90.74	76.11	4.89
LSD (0.05)	20.18	19.09	1.65

Application of Simple Sequence Repeat (SSR) Markers in DNA Molecular Profiling, Genetic Diversity and Polymorphism Information Content in Nigerian Rice *FARO* Inbred Lines

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ABSTRACT

DNA molecular profiling, genetic diversity and polymorphism information content of Nigerian rice FARO inbred lines was achieved using simple sequence repeat (SSR) markers Molecular marker technique is a valuable tool for assessing genetic variability and resolving varietal identities, Molecular marker assisted breeding has the potential to enhance efficiency of genetic improvement in rice, Assessment of genetic diversity and molecular characterization among Federal agricultural release Oryza (Faro) rice varieties of Nigeria is very essential for germplasm management, varietal identification, and DNA fingerprinting. Twenty SSR markers were initially studied but only thirteen (65%) SSR markers were informative and subsequently used across 27 Faro rice varieties. In total 81 allele were dictated and the number of alleles per locus ranged from 3 to 20, with an average of 6.75 alleles across 13 loci. In yet another development, 52 rare alleles were also detected at 12 loci. The results revealed Polymorphic Information content (PIC) values ranged from 0.31 to 0.84, with an average of 0.54, which shows although, low variation, distinct average variation was recorded. The PIC values revealed that RM400 is the best marker for identification and diversity estimation of rice varieties, followed by RM251, RM256, RM229, and RM523 markers. for Pair-wise genetic similarity coefficients the closest genetic distance was obtained between Faro 27 and Faro12 (0.95) and the lowest (0.31) were recorded for Faro 21 & 23, and others, these were regarded most dissimilar numerically which suggested that these genotypes were more genetically diverse. In crop improvement program these genetically diverse genotypes are very critical in creating distinct genetic character. The un-weighted pair group method with arithmetic mean (UPGMA) cluster dendrogram created three major heterotic groups at 100% dissimilarity coefficient of 0.38 differentiating the genotypes into seed sizes of long medium and short grain. However, at 50% dissimilarity coefficient of 0.38 seven heterotic groups emerged The SSR polymorphism and diversity could likely be attributed to pedigree in their grain size and adaptive ecology. These results demonstrate that the identification and certification of varieties using microsatellite markers could serve is a good complement to existing agro-morphological data especially when varieties are closely related. Our study represents the most comprehensive investigation of the genetic diversity and population structure of faro line varieties in Nigeria to date, and provides valuable information for the germplasm collection, genetic improvement, and systematic utilization of faro Nigerian rice varieties. The findings will be useful and useable in back ground selection in crop improvement programmes

Keywords: genotype identification; Genetic diversity; SSR; UPGMA- unweighted pair-group method with arithmetic means.

INTRODUCTION

Rice is World's single most important crop and a stable food for half of the world's population. According to estimates rice is a staple food for about 3.4 billion people providing more than 20% of the daily calorie intake (Seck, *et al.* (2012). Rice (Oryza sativa L). In Nigeria Rice is an increasingly important crop. It is grown for sale and for home consumption. In some areas along the course of river Niger and Benue there is a long tradition of rice growing, on the other hand for many, rice has been considered a luxury food for special occasions only. With the increased availability of rice, it has become part of the everyday diet of many Nigerians. There are many varieties of rice grown in Nigeria. Some of these are considered 'traditional' varieties; others have been introduced within the last twenty years.

Nigeria is currently the largest rice producing country in Africa. This is as the result of conscientious efforts by the present administration to place more emphasis on agricultural production (Udemezue, 2018) with the available literature; annual rice production in Nigeria has increased from 5.5 million tons in 2015 to 5.8 million tons in 2017. In 2015, Nigerians spent not less than N1bn on rice consumption, adding that while spending had drastically reduced, consumption had increased because of increased local production of the commodity. The consumption rate now is 7.9 million tones and the production rate has increased to 5.8 tons per annum. The increase was as a result of the Central Bank of Nigeria (CBN)'s Anchor Borrowers Program with a total of 12 million rice producers and four million hectares of FADAMA rice land (Goronyo, 2017 ;Udemezue, 2018). The move was aimed at reducing the nation's over reliance on oil which has in the past year proved economically devastating as oil prices plummeted on the global market.

Molecular marker has been introduced as a powerful tool for determining genetic variation in rice varieties. Unlike morphological traits, molecular markers can reveal abundant difference among genotypes at the DNA level, providing a more direct, reliable and efficient tool for germplasm profiling, characterization, and management and at the same time is uninfluenced by environmental factors. This suggests that numerous valuable traits of economic significance that remain unutilized by conventional breeding (Hossain *et al.* 2012) can now be exploited. The first step towards determining these is to evaluate the genetic diversity in improved rice genotypes as the success of a crop improvement program depends on the magnitude of genetic variability and the extent to which the desirable characters are heritable (Ravi *et al* 2003). Hence assessment of genetic diversity becomes important in establishing relationships among different cultivars (Kibria *et al.*, 2009;Sivaranjani *et al* 2010). Therefore, different rice varieties of distinct genetic structure are a good promise for the future rice crop improvement. Thus, identification of genotypes and their inter-relationships is important. Development of new biotechnological techniques provides increased support to evaluate genetic variation in both phenotypic and genotypic levels and the results derived from analyses of genetic diversity at the DNA level could be used for designing effective breeding programs aiming to broaden the genetic basis of commercially grown varieties.

In the present study SSR, was the marker of choice as it is co dominant marker systems and are less costly and easier to be developed and used. The genetic diversity analysis can be extended to characters like acid soil tolerance/ other abiotic stress, which are controlled by large number of QTLs which may share homology between genes responsible for other abiotic stresses like temperature, drought, flood, submergence etc.

In the past, it was difficult to clearly identify and differentiate one cultivars from other using conventional morphological characteristics owing to effects of environment. DNA Fingerprinting on the other hand (Rahman, 2009) allows for accurate, unbiased, and rapid genotype identification, which has been established to be an effective tool for crop improvement. (Zhu, 2012). A variety of molecular markers are now available which can be used to establish the fingerprint and evaluate the DNA genetic diversity of rice varieties some of which are: Restriction Fragment Length Polymorphism (RFLP), Random Amplify

Polymorphic DNA(RAPD), Amplify Fragment Length Polymorphism (AFLP) Simple Sequence Repeat(SSR), Single Nucleotide Polymorphism(SNP) and a host of others. More often, SSR markers have been widely used for establishment of unique fingerprint and assessment of DNA genetic diversity due to their abundance, codominant inheritance, high polymorphism, reproducibility, ease of assay by polymerase chain reaction (PCR), and relatively cost effective (Kuleung 2004; Xie *et al.* 2011). This recent, SNPs have received increased consideration because they occur at a much higher rate in the genome than SSRs. Nonetheless, most SNPs are biallelic; thus, an SNP marker has fewer information content than SSR marker (Stich, Van, and. Melchinger , 2010). Furthermore, SSR markers still have their own advantages as compared to SNP markers for population genetics analysis (Hamblin, Warburton and Buckler, 2007) and are still used widely in the construction of molecular fingerprinting databases. Beside (Tang, 2015). SSR markers have been used for fingerprinting and identification in many crop species, such as wheat (Li Wang and Yan 2013), maize (Ping, Liu and Yang 2012), bean (Xue, Tan and Yan .2015), tomato (Scarano, Rao.and Masi, 2015 :Ruiz, Barandalla and Jose, 2011). Furthermore, the fingerprint can be used for the protection of plant genetic resources. The objectives of this study therefore were to (1) Establish the molecular fingerprinting of 27 rice genotypes and (2) to estimate the level of genetic diversity both among and within inbred Faro lines and molecular phylogeny of these rice varieties (3) dictate the presence of latent traits of great agronomic significance.

MATERIALS AND METHODS

Plant material

27 FARO rice varieties were recruited for this experiment all were breed by NCRI breeding unit. From 1954 to 1974 fig 1)

DNA Extraction

DNA was extracted from 2 g of fresh young leaves according to the CTAB procedure of (Doyle and Doyle, 1987) slightly modified quantified using 0.1% agarose gel electrophoresis. The DNA samples were diluted to 25 ng μL-1 and stored at – 20 °C until use. A total of twenty SSR primers covering all the 12 chromosomes were recruited for this experiment but only thirteen were found to be polymorphic (65%) and used in this study. (Table 1). Primers were obtained from the SSR panel in the rice Gramene database (http://www.gramene.org/markers/microsat /ssr.html). Primers were synthesized by Sangon Biological Engineering Technology & Services Co., Ltd. (Shanghai, China). SSR polymerase chain reaction (PCR) amplification was conducted in a 20 μL volume containing 40 ng of genomic DNA, 1 U *Taq* DNA polymerase, 2.5 mM $Mg2+$, 0.20 mM dNTPs and 0.2 μM of each primer. A modified PCR program was used: 5 min at 94 °C, 35 cycles of 30 s at 94 °C, 30 s at SSR specific annealing temperature (53 °C to 64 °C) and 45 s at 72 °C; with a final extension step of 7 min at 72 °C. The PCR products were fractioned on 8% denatured polyacrylamide gel electrophoresis, and stained with silver nitrate.

Table 1: Most informative markers

marker name	Forward/Reverse primers	Repeat_motif	Repeat	Anneal T ^{0}C	Product size
RM224	ATCGATCGATCTTCACGAGG TGCTATAAAAGGCATTCGGG	(AAG)8(AG)13	Tri	55	157
RM225	TGCCCATATGGTCTGGATG GAAAGTGGATCAGGAAGGC	(CT)18	Di	55	140
RM523	AAGGCATTGCAGCTAGAAGC	(TC)14	Di	55	148
RM463	TTCCCCTCCTTTTATGGTGC TGTTCTCCTCAGTCACTGCG	(TTAT)5	Tetra	55	192
RM304	TCAAACCGGCACATATAAGAC GATAGGGAGCTGAAGGAGATG	(GT)2(AT)10(GT)33	Di	55	160
RM400	ACACCAGGCTACCCAAACTC CGGAGAGATCTGACATGTGG	(ATA)63	Tri	55	321
RM340	GGTAAATGGACAATCCTATGGC GACAAATATAAGGGCAGTGTGC	(CTT)8T3(CTT)14	Tri	55	163
RM341	CAAGAAACCTCAATCCGAGC CTCCTCCCGATCCCAATC	(CTT)20	Tri	55	172
RM228	CTGGCCATTAGTCCTTGG GCTTGCGGCTCTGCTTAC	(CA)6(GA)36	Di	55	154
RM229	CACTCACACGAACGACTGAC CGCAGGTTCTTGTGAAATGT	(TC)11(CT)5C3(CT)5	Di	55	116
RM244	CCGACTGTTCGTCCTTATCA CTGCTCTCGGGTGAACGT	(CT)4(CG)3C(CT)6	Di	55	163
RM251	GAATGGCAATGGCGCTAG ATGCGGTTCAAGATTCGATC	(CT)29	Di	55	147
RM256	GACAGGGAGTGATTGAAGGC GTTGATTTCGCCAAGGGC	(CT)21	Di	55	127

Data analysis

Band profiles were scored for distinct and a reproducible bands as present (1) or absent (0) for each SSR primer pair. Jaccard's similarity coefficient values were calculated and dendrograms based on similarity coefficient values were generated using unweighted pair-group method with arithmetic means (UPGMA) by the NTSYS -pc 2. Software (Rohlf,2000). The polymorphism information content (PIC) value of SSR markers was calculated using the following formula (Andersen and Liberstedt, 2003). **Error! Reference source not found.**:

$$PIC = 1 - \sum_{i=1}^{k} p_i^2$$

Where k is the total number of alleles (bands) detected for one SSR locus and p is the proportion of the cultivars or genotypes containing the allele (band) in all the samples analyzed.

RESULTS AND DISCUSSION

Assessment of genetic diversity and molecular characterization within some federal agricultural release oryza was carry out using simple sequence repeat (SSR) markers. twenty SSR markers were used but only Thirteen SSR markers were polymorphic (65%) and were used (table 1) across 27 genotypes of rice to characterize and discriminate among Faro varieties of rice. Bands are scored for distinct and reproducible bands (alleles) as present (1) or absent (0) for each SSR primer pair represents the fingerprint profiles for the genotypes under investigation (Table 4). The number of alleles per locus ranged from 3 to 20, with an average of 6.75 alleles across 13 loci (Table3). A total of 52 rare alleles were detected at 12 loci. The results revealed that the 27 rice varieties produced rare alleles that could be used for molecular characterization, and DNA profiling of these varieties. Polymorphic Information content (PIC) values ranged from 0.31 to 0.84, with an average of 0.5498, which revealed that there is narrow but distinct variation among the rice genotypes studied. The PIC values revealed that RM400 was the best marker for identification and diversity estimation of rice varieties, followed by RM251, RM256, RM229, and RM523 markers (Table3).

Table 2: pedigree, duration of maturation and ecology of the rice varieties used in the study

Variety	Ecology	Year of Release	Growth Duration	Grain Type	Variety	Ecology	Year of Release	Growth Duration	Grain Type
FARO 1	SS	1954	135-174	B	FARO 15	SS	1974	145-160	B
FARO 2	SS	1958	135-176	B	FARO 16	SS	1974	140-160	B
FARO 3	UPLAND	1958	95-120	B	FARO 17	SS	1974	145-160	B
FARO 4	SS	1959	189-220	B	FARO 18	DS	1974	167-179	B
FARO 5	SS	1960	135-154	B	FARO 19	DS	1974	135-140	B
FARO 6	SS	1961	176-198	A	FARO 20	SS	1974	125-130	B
FARO 7	SS	1962	160-217	A	FARO 21	IS & SS	1974	90-110	C
FARO 8	SS	1963	155-160	A	FARO 22	IS & SS	1974	145-150	B
FARO 9	SS	1963	189-220	A	FARO 23	IS & SS	1974	145-150	B
FARO 10	UPLAND	1963	115-145	A	FARO 24	IS & SS	1974	135-145	A
FARO 11	SS	1966	115-120	B	FARO 25	Upland	1976	115-120	B
FARO 12	DS	1969	145-155	B	FARO 26	IS & SS	1982	130-135	B
FARO 13	SS	1970	135-140	B	FARO 27	IS & SS	1982	110-115	A
FARO 14	SS	1971	170-198	B					

SS = Shallow swamp; A = Long grain type; DS = Deep swamp; B = Medium grain type; IS = Irrigated swamp; C = short grain type.

Table 3: Number of alleles, major allele frequency, gene diversity, polymorphism information content (PIC) of markers among 27 rice genotypes for 13 SSR markers

Marker	Total Allele No	Frequent allele	Major Allele Count.	Major. Allele Freq	Rare Allele	Size /bp	PIC
RM225	4	3	20	0.63	1	157	0.40
RM228	7	2	16	0.48	5	140	0.55
RM251	6	3	8	0.22	3	148	0.72
RM340	5	2	21	0.67	3	192	0.37
RM341	7	2	16	0.48	5	160	0.59
RM523	5	3	12	0.33	2	321	0.62
RM224	5	2	16	0.48	3	163	0.54
RM229	5	3	14	0.41	2	172	0.62
RM256	6	2	14	0.42	4	154	0.62
RM304	5	1	22	0.72	4	116	0.31
RM463	3	2	18	0.56	1	163	0.42
RM400	20	1	3	0.11	19	147	0.84
RM244	3	3	16	0.29	0	127	0.46
Sum	81	29	196	5.80	52	2160	7.05
Mean	6.23	2.23	28	0.82	7.42	166.15	0.54

The gel images of amplified fragment using primer selected for the SSR marker RM400 and RM340 are shown in Figures
below

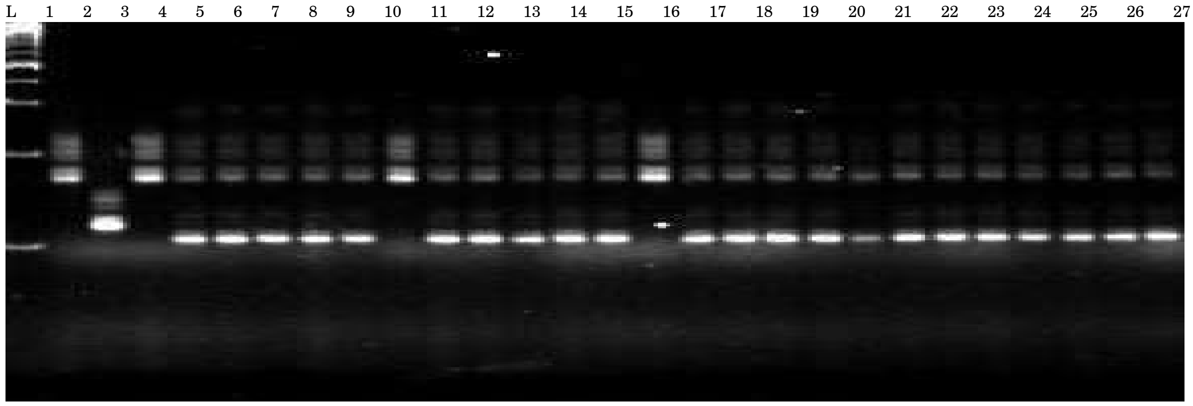

Figure 1 : Electropherogram profiles of molecular marker (RM225). Identified in 27 Faro lines

Electropherogram profiles of molecular marker (RM225). Identified in 27 Faro lines rice varieties and DL 500 (DNA molecular ladder). The numbers of lanes 1 to 27 correspond to the rice varieties studied

Table 4: DNA fingerprinting of 27 Faro lines by SSR markers

genotype	fingerprint
A, A, A, A, A, A, B, B, B, C, C, C, D, D, D, E, E, E, F, F, F, G,G	G, H, H, H, I, I, I, J, J, J, K, K, K, K, K, K, K, K, K, L, L, L
FARO 07, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0, 0	1, 0, 0, 1, ?, ?, ?, ?, ?, 0, ?, ?, ?, ?, ?, ?, ?, 0, 0, ?, ?, 0
FARO 06, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 0	1, ?, ?, ?, 0, 0, 1, 1, 0, 0, 0, 0, 0, 1, 0, 0, ?, 0, 0, ?, ?, 0
FARO 10, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 0	1, ?, ?, ?, 0, 0, 1, ?, ?, 0, ?, ?, ?, ?, ?, ?, ?, 0, 0, 0, 1, 0
FARO 22, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0, ?, ?, ?, 0, 1, 0, 0, 0	1, 0, 1, 0, 0, 0, 1, 1, 0, 0, ?, ?, ?, ?, ?, ?, ?, 0, 0, 0, 1, 0
FARO 23, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, ?, ?, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 1	0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0, 0, 0, 1, 0
FARO 27, 0, 1, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 0, ?, ?, 0, 0, 1	0, 0, 1, 1, 1, 1, 0, 1, 0, 0, ?, ?, ?, ?, ?, 0, 0, 0, 0, 0, 1, 0
FARO 18, 1, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, ?, ?, ?, 0, 1, 0, 0, 1, 0, 0, 1	0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 0, 1, 1, 1, 1, 0, 1, 0
FARO 24, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 0, 1, ?, ?, ?, 0, 1, 0, ?, 0, 0, 0, 1	0, 0, 1, 0, 0, 0, 1, ?, ?, 0, 0, 1, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0
FARO 25, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, ?, ?	?, 0, 1, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0
FARO 12, 1, 0, 0, 1, 0, 0, 1, 0, 1, 1, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 1	1, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 1, 1, 1, 1, 1, 0, 0
FARO 21, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0	1, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 0, 0
FARO 03, 0, 0, 1, 0, ?, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, ?, ?	?, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1, 0, 0
FARO 19, 1, 0, 0, 0, ?, 0, 1, 0, 1, 0, 1, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0	1, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1, 1, 1, 0, 1, 1, 1, 0, 0, 1, 0, 0
FARO 16, 0, 0, 1, 0, ?, 0, 0, 0, 1, 0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 1, 0, 0, 0	1, 0, 1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 1, 0, 0, ?, ?, 0
FARO 17, 0, 0, 1, 1, ?, 0, 0, 0, 1, 0, 1, 0, ?, ?, ?, 0, 0, 1, 0, 1, 0, 0, 1	1, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 0, 0, 1, 0, 0
FARO 12, 0, 0, ?, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 1, 0, 0, 1, ?, 0, 0, 0, 0	1, 0, 1, 0, 0, 0, 1, 0, 1, 0, ?, ?, ?, ?, ?, ?, ?, ?, ?, 1, 0, 0
FARO 20, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 1, 1, 1, 0, 0, 0	0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1, 1, 0, 0, 1, 1, 1, 0, 1, 1, 0, 0
FARO 13, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0	0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 0, 0
FARO 15, 0, 0, 1, 0, ?, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0	1, 0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1, 0, 0
FARO 09, 0, 0, 1, 0, ?, 0, 0, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 1	0, 0, 0, 0, 1, 1, 0, ?, ?, 0, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1, 0, 0
FARO 18, 0, 0, 1, 0, ?, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0, 1	0, 1, 1, 0, 0, 0, 1, ?, ?, 0, ?, ?, ?, ?, ?, ?, ?, ?, ?, 0, 1, 0
FARO 05, 0, 0, ?, 1, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, ?, ?	?, 1, 1, 0, 0, 0, 1, ?, ?, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0
FARO 02, 0, 0, ?, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, ?, ?, 0, 0, 0	1, 1, 1, 0, 0, 0, 1, 1, 0, 0, 1, 1, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0
FARO 14, 0, 0, 1, 1, 0, 0, 1, 0, 0, ?, ?, ?, 0, 0, 1, ?, ?, ?, 1, 0, 0, 0, 0	1, ?, ?, ?, 0, 0, 1, 1, 0, 0, 1, 1, 0, 1, 0, 1, 1, 0, 0, 1, 0, 0
FARO 04, 0, 0, 1, 1, 0, 0, ?, 0, ?, 0, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0	1, 1, 1, 0, 0, 0, 1, ?, ?, 0, 1, 0, 0, 0, 0, 0, 1, 1, 1, 1, 0, 0
FARO 01, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0	1, 1, 1, 0, 0, 0, 1, 1, 0, 0, 1, 1, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0
FARO 11, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0	1, 1, 1, 0, 0, 0, 1, 1, 0, 0, 1, 1, 0, 1, 0, 1, 0, 0, 1, 0, 1, 0

Informative markers are represented by alphabets : RM225 =A, RM228=B, RM251=C, RM340=D, RM341=E, RM523=F, RM224=G, RM229=H, RM256=I, RM304=J, RM463=K, RM400=L, RM244=M.

Genetic diversity

Average genetic diversity of 0.59 indicates moderate level of diversity existing within the genotypes surveyed. Which ranged from 0.38 RM 340 to 0.84 in RM 400. The highest genetic diversity (0.94) was recorded in locus RM400 and the lowest genetic diversity (0.33) was detected in locus RM305 (Table 3).

Polymorphism information content (PIC).

PIC value is an expression of allelic diversity and frequency among the varieties. PIC value of each marker was evaluated on the basis of the number of alleles and it varied greatly for all the SSR loci tested. Thus, the allelic diversity as well as the level of polymorphism among 27 rice varieties was evaluated using 13 SSR informative loci and showed variability among markers, which varied widely among loci. The highest PIC value was obtained for RM 400 (0.84) fallowed by RM251 (0.72), and the least value of (0.31) goes for RM 304. (Table 3)
Although, the average PIC value obtained in the present work of (0.55) was lower than that reported by (Rama *et al* , 2015; Rangel *et al,* 2008; Giarrocco, Marass. and Salerno, 2012) and (Shakil, *et al.,* 2015) who observed an average PIC value of 0.74 and 0.69, respectively. The PIC values observed in our study were consistent with previous estimates of SSR marker analysis in rice by (Siwach, *et al*. 2004:Yan, *et al.*2017 and Zeng,*et al.* 2009a).

Pair-wise genetic similarity coefficients

The pair-wise genetic similarity coefficients indicated that the closest genetic distance was obtained between Faro 27 and Faro12 (0.95) as well as between Faro 12 and Faro07 (0.92) (Table 5) On the other hand Faro 21 and Faro 23, Faro 11and Faro 02, Faro 10 and Faro 06, Faro 07 and Faro 10 each with (0.31) were most dissimilar which suggested that these genotypes were more genetically diverse. In crop improvement program these genetically diverse genotypes are very important in creating distinct genetic character.

Table 5: Similarity coefficient and genetic distance values between 27 Faro rice line varieties

Genotype	24 22 06 05 03 12 07 16 10 20 17 23 19 18 14 15 21 21 27 01 11 12 18 25
FARO24	0.00,
FARO 22	0.69, 0.00,
FARO 06	0.85, 0.54, 0.00,
FARO 05	0.69, 0.69, 0.77, 0.00
FARO 03	0.62, 0.54, 0.46, 0.62, 0.00,
FARO 12	0.62, 0.69, 0.85, 0.62, 0.77, 0.00,
FARO 07	0.77, 0.54, 0.46, 0.77, 0.69, 0.92, 0.00,
FARO 16	0.77, 0.38, 0.46, 0.77, 0.46, 0.69, 0.62, 0.00,
FARO 10	0.69, 0.38, 0.31, 0.62, 0.54, 0.85, 0.31, 0.62, 0.00,
FARO 20	0.69, 0.62, 0.62, 0.69, 0.46, 0.69, 0.77, 0.54, 0.69, 0.00,
FARO 17	0.62, 0.54, 0.69, 0.62, 0.54, 0.54, 0.77, 0.46, 0.69, 0.54, 0.00,
FARO 23	0.54, 0.38, 0.62, 0.69, 0.46, 0.77, 0.77, 0.54, 0.54, 0.69, 0.62, 0.00,
FARO 19	0.69, 0.62, 0.62, 0.62, 0.38, 0.69, 0.85, 0.54, 0.69, 0.62, 0.69, 0.62, 0.00,
FARO 02	0.77, 0.62, 0.62, 0.38, 0.62, 0.62, 0.77, 0.69, 0.62, 0.62, 0.69, 0.69, 0.54, 0.00,
FARO 13	0.62, 0.54, 0.62, 0.46, 0.46, 0.69, 0.77, 0.62, 0.62, 0.38, 0.54, 0.54, 0.46, 0.38, 0.00,
FARO 04	0.62, 0.62, 0.62, 0.31, 0.62, 0.69, 0.62, 0.69, 0.46, 0.62, 0.62, 0.69, 0.54, 0.38, 0.38, 0.00,
FARO 09	0.62, 0.77, 0.69, 0.62, 0.54, 0.85, 0.69, 0.69, 0.62, 0.69, 0.62, 0.69, 0.69, 0.69, 0.62, 0.54, 0.00,
FARO 18	0.69, 0.62, 0.69, 0.62, 0.62, 0.77, 0.62, 0.62, 0.54, 0.69, 0.62, 0.62, 0.77, 0.62, 0.62, 0.54, 0.46, 0.00,
FARO 14	0.69, 0.54, 0.54, 0.62, 0.62, 0.77, 0.77, 0.69, 0.54, 0.69, 0.77, 0.62, 0.54, 0.46, 0.38, 0.46, 0.77, 0.77, 0.00,
FARO 15	0.85, 0.69, 0.62, 0.62, 0.54, 0.77, 0.77, 0.62, 0.69, 0.62, 0.69, 0.77, 0.46, 0.46, 0.38, 0.46, 0.46, 0.62, 0.46, 0.00
FARO 21	0.54, 0.31, 0.46, 0.54, 0.31, 0.62, 0.62, 0.38, 0.46, 0.54, 0.46, 0.31, 0.38, 0.46, 0.31, 0.46, 0.62, 0.69, 0.46, 0.54, 0.00,
FAR0 27	0.85, 0.77, 0.77, 0.85, 0.69, 1.00, 0.92, 0.85, 0.77, 0.85, 0.92, 0.62, 0.69, 0.62, 0.69, 0.85, 0.69, 0.69, 0.77, 0.62, 0.69, 0.00,
FARO 01	0.69, 0.38, 0.54, 0.46, 0.54, 0.54, 0.62, 0.46, 0.54, 0.54, 0.46, 0.54, 0.62, 0.31, 0.46, 0.38, 0.62, 0.54, 0.54, 0.54, 0.31, 0.85, 0.00,
FARO 11	0.77, 0.38, 0.54, 0.62, 0.62, 0.77, 0.62, 0.54, 0.46, 0.62, 0.62, 0.54, 0.69, 0.38, 0.46, 0.46, 0.69, 0.38, 0.54, 0.54, 0.46, 0.69, 0.31, 0.00,
FARO 12	0.62, 0.62, 0.69, 0.69, 0.46, 0.77, 0.85, 0.69, 0.69, 0.69, 0.62, 0.46, 0.38, 0.62, 0.54, 0.69, 0.77, 0.85, 0.62, 0.77, 0.38, 0.77, 0.62, 0.69, 0.00,
FARO 18	0.54, 0.54, 0.77, 0.85, 0.62, 0.85, 0.85, 0.69, 0.69, 0.77, 0.69, 0.38, 0.62, 0.69, 0.62, 0.85, 0.85, 0.62, 0.69, 0.85, 0.54, 0.62, 0.69, 0.54, 0.38, 0.00,
FARO 25	0.62, 0.54, 0.62, 0.62, 0.31, 0.85, 0.69, 0.62, 0.62, 0.62, 0.62, 0.46, 0.54, 0.54, 0.38, 0.62, 0.62, 0.69, 0.54, 0.54, 0.31, 0.62, 0.54, 0.54, 0.46, 0.54, 0.00

4.7 UPGMA Cluster Analysis

Cluster analysis was used to group the varieties and to construct a dendrogram. The similarity matrix representing the DICE Co-efficient was used to cluster the data using the UPGMA algorithm. The UPGMA based dendogram obtained from the binary data deduced from the DNA profiles of the samples analyzed adds a new dimension to the genetic dissimilarity. A total of 7 distinct groups resulted out of analysis of pooled SSR marker data (Figure III). This dendrogram revealed that the genotypes cluster more closely the closer there are genetically.

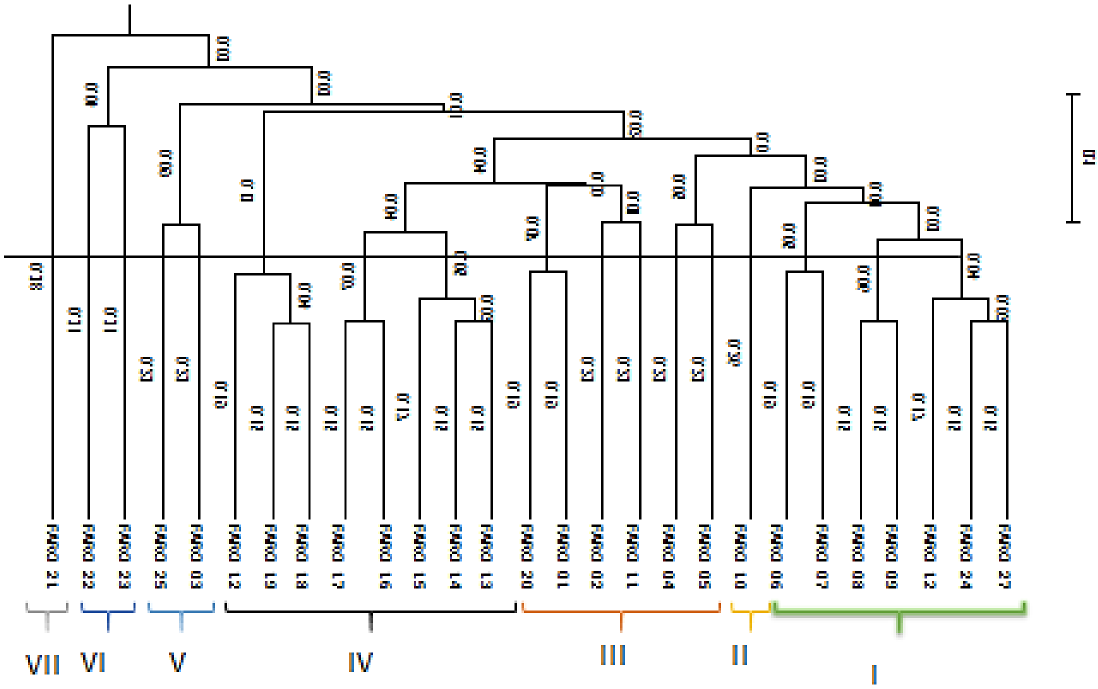

Figure 3: An UPGMA cluster dendogram showing the genetic relationship among 27 rice Faro varieties.

The genetic relationship between Faro lines genotypes was assessed by a UPGMA clusters dendrogram (**Error! Reference source not found.**) , The un-weighted pair group method with arithmetic mean (UPGMA) cluster dendrogram created three major heterotic groups at 100% dissimilarity coefficient of 0.38 differentiating the genotypes into seed sizes of long medium and short grain. However, at 50% dissimilarity coefficient of 0.38 seven heterotic groups emerged. and additional sub clusters within some of the major clusters.

Cluster (I) consist of eight (8) varieties these were Faro 06, 07,08,09,12,24 & 27 the second cluster (II) was formed by Faro10 alone for its drought resistant trait, these group is long grained types (table 2) and was well adapted to shallow swamp ecology. The next cluster, cluster (III) have had traits for medium grain and were adapted to shallow swamp as well, these comprises of Faro 01, 02,04,05,11,& 20 This cluster was followed by cluster (IV) which was formed by some eight (8) other varieties of Faro lines these were Faro12,13,14,15,16,17, 18, and 19 these were sub divided into two (IVA) (Figure III) Faro12,18 & 19, were adapted to deep swamp while (IVB) were Faro13,14,1516,17, adapted to shallow swamp both had traits for medium grain, The next two major clusters (V &VI) were each made up of two genotypes Faro 03, and 25 for group (V) both of them had trait for drought resistance and were also of medium size grained (Table 2) While Cluster (VI) was made up of Faro 22 and 23 these also form part of the medium grain shallow swamp in addition to good adaptation to irrigation as well. The last (VII) cluster was an out group and consisted of only one variety which is faro 21 it is the only rice variety that has differentiated trait of short grain (table2).

In the course of our study it was observed that no two varieties are carbon copy (duplicate) of one another (100% similarity) thus further proves the efficiency of SSR as one of the most powerful molecular marker not only for identification of genetically distinct genotypes but also for discriminating genotypes with narrow genetic distance.

About twenty (20) SSR markers were used in this work but only 13 SSR markers used in this investigations produced polymorphic bands in the genotypes. Similar results were obtained by (Rahman *et l.*, 2010: Mamunur 2012 :Shahriar 2015: Giarrocco, 2007). However, the average number of alleles per locus detected in the present study (6.75) was lower than the average number of alleles reported by (JayamaniI *et al*., 2007 :Anupam *et al*., 2017:Zeng, 2007: Shahriar 2015:Prathepha., 2012) who reported an average of 7.7 and 11.85, alleles per locus, but was very consistent with some earlier reports by(Rahman *et al.,* 2012) (Ni, *et al.,* 2002) and (Bhatt, *et al.,*2017) , who reported 5.79, 6.8 and 6.13 alleles per locus, respectively. and In contrast, were higher to the result reported by (Etemad and Maziah , 2012), who detected 3.57 alleles per SSR locus, (Hossain *et al.,*2012) detected a mean of 3.8 alleles per locus, in 12 aromatic rice landraces using SSR markers which is lower than our report. Some earlier reports by(Pervaiz *et al.,*2010) and(Rahman *et al.,* 2012), who found 4.4 and 4.18, (average) alleles per locus is also markedly lower than our study. The variability in the number of alleles detected per locus might be due to the use of diverse genotypes and selection of different SSR primers with scorable alleles. The present investigation proves that molecular fingerprinting using SSR markers is a proficient tool for genotyping rice varieties with high accuracy.

Nevertheless, in order to identify genetically distinct characters, such as high yielding, stress resistances (biotic and abiotic) that could be exploited for further breeding experiments. A good elucidation of the dendrogram is imperative. Selecting parents from heterotic groups will not only fetch out latent agronomic traits but also will enrich and broaden the genetic base for better adaptability. For instance, Faro 25 a high yielding highly palatable aromatic variety that is also drought resistant from a different group could be hybridize with Faro 10 from another cluster having similar traits of resistance for better adaptability. Experiment could be inferred depending on needs by looking at the varies clusters, for better yield results, resistant to drought, pest and diseases and for adaptability.

The utilization of 13 SSR markers in the analysis of Faro lines rice varieties revealed a high level of genetic polymorphism which could be exploited for a number of breeding programme develop through hybridization s. Such a permutations and recombination in breeding will not only enhanced the level of local adaptability but also broaden the genetic base. The study has successfully track some genetically distinct traits which allow us to differentiate and group these genotypes into heterotic groups that will enable a variety of hybridization experiments. The genetic fingerprinting database of Faro lines varieties generated in this work could be expended to cover more varieties using the same set of primers as the number of varieties increases. Utilization of heterosis between major clusters and sub clusters is currently one of the major ways in rice variety improvement. Faro line rice germplasms has a narrow range of genetic diversity which has significantly lessened its improvement from its parental genotypes. The alternate strategy of transferring desirable genes from local accessions by conventional breeding methods has not been very successful because of progenies associated with high sterility, poor plant type, and linkage drag (Zhu *et al.,*2012; Yan, *et al.,* 2017) consequently, a cost effective genotype identification of breeding materials with high fidelity and discrimination, is extremely important in rice improvement. Molecular markers are critical tools in the evaluation of genetic variation, in the exposition of genetic relationships in and between species and have demonstrated the potential to detect genetic diversity for an efficient management of plant genetic resources (Reddy, *et al.*, 2002: Virk *et al.* 2000) (Song, *et al.* 2016) and (Teixeira, 2005). Biotechnological techniques evaluate genetic variation much better at genotypic levels.

It has been established that more than 85 % of genetic diversity potential is yet to be exploited (Pandey and Kumar, 2015), that means there is huge among of priceless allele variations and agronomic traits of great significance that are unutilized. Genetic diversity among populations of diverse crop plants is vital for the management and development of agricultural resources (Salgotra, *et al.* 2015: Pandey and Kumar, 2015). consequently, identification of distinct allele among is genotype and their inter-relationship is vital for future crop improvement.

CONCLUSION

Characterization of the fingerprint of 27 FARO line rice genotypes was achieved. A total of 81 alleles were detected across the 13 SSR loci with an average of 6.75 per locus. Genetic variation and diversity among the 27 FARO rice genotypes was determined and revealed that average variation was present among the studied varieties. The Polymorphic Information content (PIC) values revealed that RM400 is the best marker for identification and diversity estimation of rice varieties PIC values ranged from 0.31 to 0.84, with an average of 0.500. Genetic relationship among the genotypes revealed seven clusters with a dissimilarity coefficient of 0.38. The study has successfully tracked some genetically distinct traits and allows us to group them into several hetorotic clusters for future hybridization experiments.

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Cellulase Inhibition for Termite Control: A Case Study of Subterranean Termites (*Amitermes eveuncifer Silverstri*)

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ABSTRACT
Some species of termites such as Amitermes eveuncifer Silverstri are highly voracious and destructive and cause substantial damage to agricultural products. Cellulose, a main structural constituent of plants, is the major nutritional component for wood-feeding termites. Termites, such as Amitermes eveuncifer Silverstri require cellulase to efficiently digest cellulose for survival and inhibiting their cellulase activity is a potential means of managing their destructive potentials. Table salt which contains predominantly NaCl is both toxic and lethal to termites and is used to control the insect traditionally. In an attempt to find out a scientific explanation for this and possibly design a pesticide for the destructive insect, we investigated the effects of sodium salts on cellulase obtained from Amitermes eveuncifer Silverstri. The actions of eight sodium salts were tested on the activity of partially-purified enzyme gotten from termites. The purified enzyme was assayed using the Nelson-Somogyl method and absorbance was read at a wavelength of 540nm. The purified enzyme was assayed in the presence of the sodium salts and an assay without salt was used as the standard check. Results showed that all sodium salts tested inhibited the enzyme. At all concentrations, Na_2SO_4 had the least inhibitory effect on the activity of cellulase obtained from termite workers with an inhibition range of 1.60% – 16.80%. NaH_2PO_4, Na_2CO_3 and $NaHAsO_4$ had the highest inhibitory effects on the enzyme with an inhibition range of 69.60% - 100.00%, 96.60% - 98.40% and 59.30% – 100.00% respectively. This study has shown that it is possible to inhibit cellulase activity in termites using the sodium salts tested and could be useful for possible adoption in design and production of pesticides against termites

Keywords: Termites, Cellulose, Cellulase, Pesticide, Enzymes

INTRODUCTION
Termites are eusocial arthropod decomposers and improve soil fertility, crop yield and also are used by humans for their benefits across the world. However, some species of termites are becoming a threat to the farming community as all major field crops and ornamental plants are affected by termites (Rathour *et al*., 2014; Lin *et al*., 2015) and they directly and indirectly cause major losses to the agricultural system. It is estimated that termites cost the global economy more than 40 billion USD annually, and considerable research is being done on their management. The major nutritional component for wood-feeding termites is cellulose, which is plant's main structural constituent and previous studies have purified cellulase from many species of termite such as *Nasutitermes takasagoensis* (Shiraki), *N. exitiosus* and *N. walkeri, Amertermes eveuncifer Silvestri* (Tokuda *et al*., 1997; Tokuda *et al*., 2000; Tokuda *et al*., 2004; Tokuda *et al*., 2005; Tokuda and Watanabe, 2007; Fagbohunka *et al.,* 2015) as a tool to investigate their ability to digest cellulose. The cellulase system is a mixture of three major classes of enzymes including endo-1, 4-β-glucanases, exo-1,4-β-glucanases, and β-

glucosidase which work synergistically to hydrolyse cellulose and inhibiting any of these enzymes in the system would be a potential termite management avenue. Traditionally, table salt which contains predominantly NaCl, is used to control the insect, as it is both toxic and lethal to termites. To our knowledge, there have been very few scientific reason proposed to explain this phenomenon. Studies have shown that salts containing cation and anion will either inhibit or activate enzyme activity and it is suspected that either the Na or Cl ion or both might be inhibiting or totally deactivating the activities of some crucial enzyme such as the cellulase system in termites thereby killing them. In an attempt to find out a scientific explanation for this table salt management and possibly design a pesticide for the destructive insect, we investigated the effects of sodium salts on cellulase obtained from *Amitermes eveuncifer Silverstri*.

MATERIALS AND METHODS

Reagents and Apparatus

All the reagents used in this research were of analytical grades and were obtained from Bio-Rad Laboratories, Richmond, California, U.S.A., Pharmacia AB, Uppsala, Sweden, Sigma Chemical Company Limited, St. Louis, Mo, U.S.A., Pierce Chemical Company, Rockfold, Illinois, U.S.A., BDH Chemicals Limited, Poole, England., from Eastern Kodak, Company, Rochester, N.Y., U.S.A., Glass distilled water was used for all preparations of solutions and all pH measurements were made at 250C using the standard pH meter Radiometer, Copenhagen. Apparatus used include, top load weighing balance (Mettler PN1210), pH meter (Mettler MP200) and UV/VIS Spectrophotometer (Cecil 2041), Ultracentrifuge (Beckman Optimal LE-80K Ultracentrifuge), mortar and pestle.

Extraction and partial purification of enzyme

Termite workers were washed and well rinsed with distilled water. The termites were gently homogenized with a pre-frozen warring blender or mortar and pestle in an ice bath using acid washed sand. An aliquot of 10mM sodium acetate buffer, pH 5.0, containing 1mM EDTA, was added intermittently in the ratio of 5:1 (v/w); buffer/termites, while homogenizing. The mixture collected was centrifuged at 15,000rpm for 15minutes with a bench centrifuge at room temperature. The supernatant was collected and stored in a refrigerator. The supernatant was salted out by bringing the crude extract to 70% (w/v) saturation with Ammonium sulfate. After 24 hours, it was centrifuged at 5000rpm for 15min and the precipitate was harvested and dissolved in minimal amount of homogenization buffer. A column (70cm x 2.5) of Bio-Gel P-100 was prepared in accordance with Bio-Rad Handbook and the flow rate of the column was determined. 25ml of the Ammonium precipitated sample was layered on the bed and was allowed to drain into the bed before the addition of buffer to wash the sample into the bed. The column was then connected to a buffer reservoir. The protein was eluted with the buffer at the same flow rate with which the column was packed and 5ml fractions were collected. The fractions containing cellulase activity were pooled and precipitated with Ammonium sulfate (salting out).

Enzyme Assays for Cellulase

Cellulase activity toward CM-cellulose was measured by the appearance of reducing end groups in solution of CM-cellulose. The assay mixture consisted of 0.5ml of 1% (w/v) CM-cellulose (in 10mM sodium acetate buffer, pH 5.0 containing 1mM EDTA) and 0.1ml of the enzyme solution. This was incubated at 400C for 30 minutes. After incubation, 0.4ml of water and 1.0ml of combined copper reagent containing alkaline solution of $CuSO4$ buffered with a (carbonate-bicarbonate mixture containing Sodium potassium tartarate) were added according to the method of Hurst and his coworkers (Hurst *et al*., 1977). The above mixture was heated at 1000C for 20 minutes and allowed to cool to room temperature. Arsenomolybdate reagent (containing concentrated H_2SO_4 and sodium arsenate) (1.0ml) was added and mixed immediately and thoroughly to dissolve all precipitated Cu_2O. For easy absorbance reading, 7.0ml of distilled water was added to dilute mixture which was thoroughly mixed by covering the tube with parafilm and inverting it 3 to 4 times. The absorbance was read at 540nm. A unit of cellulase activity in this work is defined as the amount of enzyme that produces a change of an absorbance at 540nm of 0.10 under the conditions defined (Hurst *et al*., 1977). The activity of the enzymes in the presence of the salts was calculated using the formula:

$$\% \text{ Activity} = \frac{\text{Activity with salt}}{\text{Activity without salt (standard)}} \times 100$$

Percentage inhibition was then calculated using the formula: % Inhibition = 100 - % Activity

RESULTS AND DISCUSSION

Partial purification of enzyme and activity

Table 1 below summarizes the purification process carried out on the cellulase sample from the termite worker and its yield. The partial purified cellulose gave specific activity of 1830.

Table 1: **Activity of cellulase from termite worker at each partial purification step**

Purification step	Total volume (ml)	Total protein (mg)	Total activity (unit)	Specific activity	% yield
Crude extract	300	244	91420	325	100
Ammonium sulphate precipitate	110	157	87640	461	94.7
Biogel P-100	25	30	54900	1830	59.9

Inhibition of cellulase as potential for termite control

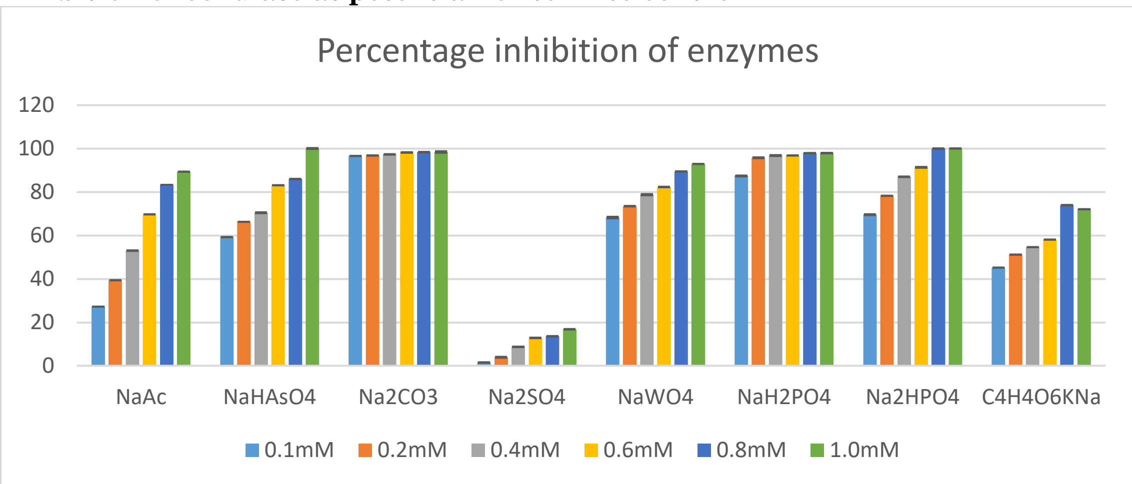

Figure 1: Percentage inhibition of cellulase as potential for termite control

The action of sodium salts on cellulase were investigated and the results are presented in figure 1. All the sodium salts tested inhibited the enzyme; the greatest inhibition was by sodium carbonate, disodium hydrogen orthophosphate and sodium tungstate while the lowest inhibition was by sodium sulphate. The inhibition was concentration-dependent. At 0.1mM, the highest inhibition was by $NaCO_3$ while Na_2HPO_4 had the highest inhibition at 1.0mM. The lowest inhibition at all concentration was caused by Na_2SO_4. This research has shown that the sodium ions in NaCl (which traditionally is used to manage termites) contributes to the lethal effect of the salt on *Amitermes eveuncifer Silverstri* termites through the inhibition of its cellulase system. This is in agreement with previous works on cellulase from termite *Amitermes eveuncifer Silverstri* soldier (Fagbohunka *et al*, 2008, 2015) but at variance with the works on cellulase from the Giant African Snail *Achachatina marginata* (Agboola *et al*., 2008) which reported that Cl^- rather than Na^{2+} is responsible for the inhibition of snail cellulose by NaCl. The results support the use of common salt for the control of termites as it is made up of NaCl thus providing a scientific clue to the toxicity of NaCl to subterranean termites. This has also shown that most sodium salts are inhibitors of cellulase and so can be used to effectively design pesticides against termites.

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Effects of Different Substrates on Yield Performance of Mushrooms (*pleurotus ostreatus (jacq.) p. kumm.* in Benue state, Nigeria

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ABSTRACT
The effects of different substrates on growth and yield performance of mushroom (Pleurotus ostreatus) was studied in the crop production facility of the Federal University of Agriculture Makurdi, Benue state, Nigeria. The study evaluated the impact of readily available agro-wastes on growth and yield parameters of the fungus. The organic wastes used include T1= Sawdust – 100% control, T2= Rice bran – 100%, T3= Cassava peel - 100%, T4= Maize cob - 100%, T5= Guinea corn shaft -100%, T6= Cowpea waste - 100%, T7 = Sawdust/Rice bran - 50% / 50%, T8 = Sawdust/Cassava peels - 50% / 50%, T9 = Sawdust/Maize cobs - 50% / 50%, T10 = Sawdust/Guinea corn waste - 50% / 50% and T11 = Sawdust/Cowpea waste - 50% / 50%. The experiment was set out using a completely randomized design which comprised of 11 treatments and three replicates. Ten out of the eleven substrates used in this study, supported the growth of the mushroom studied. Only T2 (Rice-bran) did not sustain the growth and development of fruit bodies. From the study, the substrate T1, T3, T4, T5, T6, T7, T8, T9. T10 and T11 supported excellent formation of healthy fruit bodies. In all the parameters (average number of healthy fruit bodies, average fresh and dry weight of fruit bodies, biological efficiency) considered in this study P. ostreatus had a better performance on T4, T9 and T10. T4 (Maize cobs) proved to be better substrate than T10 (Sawdust/Guinea-corn waste) except in biological efficiency where T10 proved to be better off. The best results with reference to number of fruiting bodies was produced from sawdust/cassava peels, sawdust/maize cobs and maize-cobs only in that order. This result is highly significant because the number of fruiting bodies forms an important factor in available material that affects consumable part of the mushroom. The variations experienced could be attributed to the chemical composition and Carbon to Nitrogen ratio (C:N) of the substrates. These agro-wastes found in abundance in Benue state can be said by this study to support fruit body formation of Pleurotus ostreatus.
Keywords: agro-wastes, fruit body, mushroom, Pleurotus ostreatus, substrates

INTRODUCTION
In most parts of Africa, wild edibles form an integral part of the feeding habits of many communities (Alemu, 2015). However, consumption of wild edibles is more common in food insecure areas such as the rural than would be experienced in urban cities (Teklehaymanot and Giday, 2010). Mushrooms are the fruiting bodies of certain types of fungi many of which play highly beneficial roles in forest ecosystems. Many of these fungi have unique abilities to break down wood, leaves, and other organic matter and recycle nutrients back into the system. Mushrooms belong to the kingdom Fungi under the *Basidomycota* due to its unique fungal characteristics (Song, 2004). It decomposes the complex organic materials on which it grows (the substrate) to generate simpler compounds for its nutrition (Girmay *et.al.*, 2016). Mushroom cultivation has grown up in almost all the parts of the world and during the last decades the world mushroom production achieved the growth rate of about 10% (Pathania *et.al.,* 2017). Mushroom with their great variety of species, constitute a cost-effective means of

supplementing the nutrition of man especially in areas of abject poverty (Chang and Miles, 1991). A survey of mushroom occurrence in Benue state, Nigeria, revealed that the state is endowed with a wide variety of mushrooms which includes *Pleurotus* species. The study recorded abundance of mushroom species identified in the wild with *Pleurotus ostreatus* being of interest as an edible mushroom. There's however a preponderance of wild collection of these species and almost zero cultivation in the state (Bayo and Odiaka, 2020). The economic importance of the mushroom lies primarily in its use as food for human consumption. It is rich in Vitamin C and B complex and mineral salts required for the human body. The niacin content is about ten times higher than any other vegetables. (Randive, 2012). Edible mushrooms are highly nutritious and can be compared with eggs, milk and meat. Mushroom is also easily digestible and it has no cholesterol content (Oei, 2003, Marshall and Nair, 2009). The spent substrate left after harvesting the mushrooms, which is entangled with innumerable mushroom threads (collectively referred to as mycelia), can also be used as animal feed (more palatable), bio-fertilizer for soil fertility enrichment and biogas (Alice and Kustudia, 2004).

Mushrooms cultivation offers benefit to market gardens when it is integrated into the existing production system by producing nutritious food at a profit, while using materials that would otherwise be considered "waste" (Beetz and Kustudia, 2004). This is because mushrooms contain many essential nutrients and they are found to solve dietary related health problems (Atikpo *et.al*., 2008, Firenzuoli *et.al.,* 2008). Commonly cultivated mushrooms of genus *Pleurotus* are interesting because of its antioxidant, anti-inflammatory and analgesic properties, high fiber content and proteins (Bobek and Galbavy, (2001), Daba *et.al.,* (2008). This study aims at assessing the impact of different substrates on mushroom performance in Benue State, Nigeria. The specific objectives are to investigate the effects of agro wastes singly and in combination with saw dust on the yield parameters of *Pleurotus ostreatus* in Benue state, Nigeria, by determining substrate effect on crop yield in terms of number of fruiting bodies, fresh and dry weight of fruiting bodies and biological efficiency of the substrate.

MATERIALS AND METHODS

The substrates were collected from various mills in Makurdi local government area of Benue state where these farm harvest processing takes place. The substrates are Maize cobs and guinea corn shaft from the farm centres, rice bran from the rice mills, saw dust from the saw mills, cowpea shaft and cassava peels from the farming centres and guinea corn shaft. *Pleurotus ostreatus* spawn in well-sealed bottles were obtained from Forestry Research Institute of Nigeria [FRIN], Ibadan, Nigeria.

Growth substrate

Eleven organic wastes were used as substrates. They include:
T1= Sawdust – 100% control.
T2= Rice bran – 100%
T3= Cassava peel - 100%
T4=Maize cob - 100%.
T5= Guinea corn shaft -100%.
T6= Cowpea waste - 100%.
T7 = Sawdust/Rice bran - 50% / 50%.
T8 = Sawdust/Cassava peels - 50% / 50%.
T9 = Sawdust/Maize cobs - 50% / 50%.
T10 = Sawdust/Guinea corn waste - 50% / 50%.
T11 = Sawdust/Cowpea waste - 50% / 50%.

Substrate preparation and inoculation

All the substrates were dried and chopped in to smaller pieces of 1-2cm in length. The Substrates were soaked with enough water. All excess water was drained off. 5g of calcium carbonate ($CaCO_3$) were mixed with substrates to increase alkalinity of the substrate so as to exclude bacterial contaminants. 1000g of each substrate were weighed out and filled into the clear polythene bags (33x33cm) The filled substrates were compressed with fingers to expel all air spaces and prevent air pockets and sealed up. The substrate bags were arranged in a 200 litre drum fit with a wooden frame at the base and pasteurized for four hours. At the end of the process substrates were allowed to cool. The experimental room was thoroughly swept, washed and properly disinfected with 95% ethanol. Inoculation was done at the rate of 16g of spawn per bag. Vigorously growing mycelia culture was used to inoculate the substrate bags, which were incubated at 27 $\pm 1^0$C in the incubation room, Stanley (2010), Ogundele *et al* (2014).

Data collection

The following parameters were measured:

1. Number of fruit bodies: The number of fruit bodies were counted for each treatment and the mean calculated.
2. Fresh and dry weight: The fruit bodies were weighed immediately after harvest using electronic balance. After recording the weight, they are then dried in an oven at 80^0C for 24 hours. Their mean weight was also recorded.
3 Biological efficiency was also calculated using the following formula.

Biological efficiency (BE) = (Grams of fresh weight of mushroom / dry weight of substrate) x 100. ANOVA was the statistical method used in the analysis of data. Completely Randomized Design (CRD) was used as the experimental design.

RESULTS AND DISCUSSION

Table 1: Effect of Substrates on Mushroom number of fruit bodies

1.	Sawdust	8.33^{cd}
2.	Rice bran	0.00
3.	Cassava peels	6.55^{cd}
4.	Maize cobs	21.11^{b}
5.	Guinea corn waste	11.56^{c}
6.	Cowpea waste	4.22^{cd}
7.	Sawdust/Rice bran	7.00^{cd}
8.	Sawdust/Cassava peels	33.22^{a}
9.	Sawdust/Maize cobs	28.89^{b}
10.	Sawdust/Guinea corn waste	11.22^{c}
11.	Sawdust/Cowpea waste	11.22^{c}

Means in the same column having different superscript are significantly different (p≤0.05)

Table 1 shows the effect of substrates on mushroom number of fruit bodies of *P. ostreatus*. The number of fruit bodies represents the whole mushroom bodies available for harvesting. T8 (sawdust/cassava peels), T9 (sawdust/maize cobs) and T4 (maize cobs) were the most abundant harvested. The harvests were averages of 33.22,28.89 and 21.11 respectively were collected. The lowest substrates that supported mushroom fruiting with average of 11.22 fruiting bodies were T3 (Cassava peels) and T6 (cowpea wastes).

Table 2: Effect of Substrates on Mushroom fresh and dry wt (gm)

S/N	Substrates	Fresh wt (gm)	Dry wt (gm)
		P. ostreatus	*P. ostreatus*
1	Sawdust	33.31^{d}	4.88^{c}
2	Rice bran	0.00	0.00
3	Cassava peels	44.14^{bcd}	5.22^{c}
4	Maize cobs	81.31^{a}	14.72^{a}
5	Guinea corn waste	48.39^{bcd}	10.51^{ab}
6	Cowpea waste	36.46^{cd}	6.98^{bc}
7	Sawdust/Rice bran	41.61^{bcd}	6.63^{bc}
8	Sawdust/Cassava peels	48.24^{bcd}	9.97^{abc}
9	Sawdust/Maize cobs	65.14^{abc}	8.49^{bc}
10	Sawdust/Guinea corn waste	68.30^{ab}	14.25^{a}
11	Sawdust/Cowpea waste	55.99^{abcd}	13.79^{a}

Means in the same column having different superscript are significantly different (p≤0.05)

Table 2 shows the effect of substrates on mushroom fresh and dry weight of *P. ostreatus*. Fresh and dry weights of the *P. ostreatus* yield posted varying results. The highest fresh and dry weight results were produced by T4 and T10 respectively for both fresh and dry weight. T4 produced 81.31gm of fresh weight an T10 produced 68.30gm of fresh weight while the dry weights were 14.72gm (T4) and 14.25gm (T10) respectively. T9 produced 65.14gm of fresh weight but T11 gave 13.79gms of dry weights. The control treatment T1 gave the least results with 33.31gm and 4.88gm fresh and dry weights respectively.

Table 3: Effect of Substrates on Mushroom Biological Efficiency (%)

1	Sawdust	12.26^{cd}
2	Rice bran	0.00
3	Cassava peels	36.07^{ab}
4	Maize cobs	26.78^{abc}
5	Guinea corn waste	24.40^{abc}
6	Cowpea waste	16.04^{bcd}
7	Sawdust/Rice bran	18.34^{bcd}
8	Sawdust/Cassava peels	18.21^{bcd}
9	Sawdust/Maize cobs	19.10^{bcd}
10	Sawdust/Guinea corn waste	44.12^{a}
11	Sawdust/Cowpea waste	16.64^{bcd}

Means in the same column having different superscript are significantly different (p≤0.05)

Table 3 shows the biological efficiency of the different substrates on P. *ostreatus* growth and yield. T10 expressed the highest biological efficiency with 44% followed by T3 at 36% and T4 (26.7%). The control T1 had the lowest biological efficiency of 12.26%.

Ten out of the eleven substrates used in this study, supported the growth of the mushroom studied. Only T2 (Rice-bran) did not sustain the growth and development of fruit bodies. From the study, the substrate T1, T3, T4, T5, T6, T7, T8, T9. T10 and T11 supported excellent formation of healthy fruit bodies. In all the parameters (average number of healthy fruit bodies, average fresh and dry weight of fruit bodies, biological efficiency) considered in this study P.o streatus had a better performance on T4, T9 and T10 as against T3, T5, T6, T7, T8 and T11 (table 3, 4 and 5). Furthermore, T4(Maize cobs) proved to be better substrate than T10 (Sawdust/Guinea corn waste) except in biological efficiency where T10 proved to be better off. There were however some significant differences in the results. Of particular interest is T8 (Sawdust/Cassava peels) which is not a usual choice as a substrate but had the highest number of fruiting bodies in this study. The result was also significant as it shares the top spot on the table. The result also posed better outcomes than those obtained from a similar study by Girmay et al (2016), where cotton seed substrates produced 32.00, Paper straw and Wheat straw substrates produced 18.64 and 18.30 respectively as against average of 33.22 from Sawdust/cassava (T8), 28.89 and 21.11 from Sawdust/maize cobs and Maize cobs respectively. This result is quite significant because the number of fruiting bodies forms an important factor in available material that affects consumable part of the mushroom. Bhatti *et. al* (1987) also posited that the chemical composition and Carbon to Nitrogen ratio (C:N) of the substrate can account for the observed variations.

CONCLUSION

This study addressed three main areas. First and foremost is to affirm that the organic wastes studied with the exception of rice bran successfully supported the growth of *P.ostreatus* appreciably. Secondly the study reveals that nutritious foods can be produced at profit while using materials that would otherwise be considered as waste. And thirdly this success could also be a method of controlling wastes in the environment and also increase protein supply most especially for the rural populace on a more sustainable basis if cultivated and mushroom consumption is encouraged. More research is encouraged especially in combination treatments. This to a large extent will encourage better use of these organic wastes.

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Aeroponics System: A Modern Technology for Rapid Seed Yam Multiplication in Umudike, Southeastern Nigeria – A Review

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ABSTRACT

The yam is an important prestigious carbohydrate food for over 60 million people and could be consumed in a number of ways. However, the crop is fraught with many problems which included scarcity of planting material (seed yam) ware yam production. Much effort had been made in technologies for rapid seed yam production, none has been able to increase the ratio beyond 1:30. This review tend to trace the history of aeroponics and the application of the technology to mass production of seed yam in Umudike Southeastern Nigeria. With the development of aeroponic system, the ratio of seed yam production has increased from one node cutting to over 282,240 disease free seed yam tubers per year for commercial ware yam production. Also, an average of 3 micro-tubers is generated per yam plant in the aeroponics system in Umudike and this has a potential of generating over 1,693,000 micro-tubers per year which when planted give the same number of seed yams.

Keywords: aeroponics, seed yam, technology, low ratio and disease free

INTRODUCTION

Yam (*Dioscorea spp*) the king of all roots and tuber crops is an important food crop for over 60 million people in West Africa and equally plays a pivotal role in the economic and social life of the people. The crop is being celebrated and used in all social ceremonies especially in the eastern part of the country, Nigeria. Despite the important place of the crop in the life of millions of people, the crop is being affected by many factors that hinders its production and large scale productivity. One of the major factors affecting yam production is lack of planting materials. That is the seed yam for planting to obtain the ware yam. This has resulted into reduction in the area under yam production, high cost of yam in the market, inability of the farmers and the country to export yam, low value addition in yam produce, low value chain along the market route, low employment in yam farming, many people turning over to cultivation of other crops rather than yam.

Novel approaches had been developed to overcome this problem of scarcity of planting materials such as: yam minisett technique, vine propagation and micro-propagation. All these methods have not answered or solve the problem of mass production of seed yams for ware yam production. Technologies are moving fast to provide solutions for this challenge of scarcity of seed yam. Recently, the aeroponics system has been utilized in mass production of seed yam for commercial yam production. This system increases the higher ratio propagation technique of seed yam than other techniques. The techniques have been used to produce high quality disease free yam seed yams. This paper reviewed the history of aeroponic system and the application of the technique for rapid disease free seed yam production for commercial ware yam production and for seed yam export. However, what is aeroponic?

The Aeroponic System: Aeroponics is the process of growing plants in air or mist environment without the use of soil or an aggregate media. It also refers to the technique of growing crop with their roots suspended in a misted nutrient medium. The basic principle of aeroponics is to grow plants in a closed or semi-closed environment by spraying the plant's roots with a nutrient rich solution. The set-up of aeroponic system involved a screen house or greenhouse, a power house adjacent to the screen house, source of power (electricity), Source of water supply, Fertilizers and clean planting materials or sprouted vine cuttings.

The history of the development of the aeroponic system: History of aeroponics started around 1942, when Carter (1942) commenced studies on air culture growing technique. He described a method of growing plants in water vapour to facilitate examination of roots on Citrus. Also Wotz was the person who first discovered vapour misted on citrus plants in a facilitated research of his studies of diseases of citrus and avocado roots (Stoner, 1983). In 1952, G. F. Trowel first grew apple trees in a spary culture and in 1957, the first air-growing process was coined as aeroponics after a successful process of growing coffee plants and tomatoes with air-suspended roots and applying a nutrient mist to the roots (Stoner, 1983). This system of growing plants in air or mist environment ensures that the plants spend 99.98% of its time in air and 0.02% in direct contact with hydro-atomized nutrient solution (Wikipedia, 2016). This less time spent without water allows the roots to capture oxygen more efficiently, and thereby significantly contributes to the effective oxygenation of the roots which is as a result of an enabling aerobic environment with a constantly replenishing nutrient supply for the root system.

Plants grow well in aeroponics system, primarily because of the highly aerobic environment unlike water culture as plant's always show good root hair development, which is extremely important for nodulation. The system makes it possible to examine completely intact root systems without disturbing or damaging them and thereby provides a non-invasive way for root examination under development.

Since the development of this system to sustain plants in an air culture in laboratories commence, it has been used to propagate plants such as strawberry and lettuce. The system has also helped in sustaining wheat, pea, maize, spring onion in Sputnik 4 earth's orbit in 1960 (Halstead and Scott, 1960). Zobel and his co- workers (1975) had reported that aeroponic system of farming had been used for crops such as Pisum *sativum L., Vicia faba L., Arachis hypogeal L., Glycine max* (L.) Merril and other crops. Also the technology has been used by commercial potato seed producers in eastern Africa countries like Kenya, Uganda, Tanzania and Southern Africa like Mozambique and Malawi. In Nigeria, the International Institute of tropical Agriculture (IITA) launched the system for the growing of Irish Potato in Ibadan in 2008.

In 2011, the IITA started experimenting on the use of aeroponics for seed yam production, and in 2014 in collaboration with Yam Improvement for Income and Food Security in West Africa (YIIFSWA) launched the seed yam propagation technology with the aeroponics system at National Root Crops Research Institute, Umudike, Nigeria. This was the birth of another break-through and revolution of seed yam propagation as the system intends to generate not just disease-free but also virus-free and clean varieties of seed yam. With the technology, a solution has been provided to the problem of the inability of the country to produce high quality seed yam, overcome the embargo on the export of yams from Nigeria to Europe and America and the production and supply of all-year round seed yams for ware yam production.

Description of the Aeroponic System: The aeroponics system in Umudike has the prototype of such system in the entire world. It is a plastic film insect proof-screen house that has a gabble roof on steel base structure which contains the entire systems in a climate controlled condition. The environmental condition is such that it provides favourable condition for the yam plants to survive. The power house is located at the back of the screen house that provides power that drives the entire system.

The power house contains two centrifugal 1 HP pumps that is regulated by an automatic control unit, which periodically controls the pumps. The pumps create high-pressure delivery of plants' nutrient solution from the nutrient tanks into the aeroponic system boxes that grows the yam vines via the misters. The nutrient tanks are two 1000 litres of plastic tanks that are buried in the earth to enable supplied mist nutrient return and get recycled through the return pipes into the tank by gravity. The nutrient tanks contain enriched nutrient solution of Ammonium Nitrate (N), Magnesium Sulphate (Mn), Calcium Nitrate (Ca) and Microsol (Fe; Cu; Zn; B; Mo and Mn) for yam plants'. The nutrients are mixed in required proportion. The centrifugal pump lifts the nutrient solution from the tank and delivers a pressurized nutrient solution via the feeding pipe to the misters. The misters create a fine misty solution of a hydro-atomizing spray at 360^o in order to cover large areas of roots utilising air pressure misting. Water droplet size is crucial for sustaining aeroponic growth. Too fine a water droplet (misty environment) in the system; it produces excessive root hair without developing a lateral root system. Also because the yam roots in the system are suspended through Styrofoam boards, the roots are suspended in unrestricted access to air which increases the aeration of nutrient solutions that delivers more oxygen to plant roots, stimulating growth and helping prevent pathogen formations. This continuous process is being regulated by the automated control unit that allows an idle time of 15 minutes and running time of 15 minutes. The running time is the time the centrifugal pump to discharge the nutrient through the misters, while the idle time is when no work is done by the pump; this helps the machine not to break down easily.

Aeroponic Box: The screen house has 12 aeroponic boxes which contain the system that sustains the yam varieties in air culture measures. Each box measures 4.8m by 1.2m and 0.6m of length, width and height respectively, with a distance of 1m between two consecutive boxes, a table per box; there are four sections of each table. The tops of the boxes are covered with Styrofoam of 50mm thickness cut into pieces of 1.2m by 1.2m for each sub-section of a table. Each table styrofoam is perforated at 20cm by 20cm corresponding to 49 planting holes per table (400cm^2 per plant). The sides and bottom of the box are covered with 5mm thick Styrofoam boards to create a favourable temperature condition for the roots. These are further covered with thick polythene bags to forestall sunlight from entering into the box. This is because a dark atmosphere in the box typifies soil environment and also does not allow the growth of vegetation

Planting and harvesting of vines on the box: Two node vines of *D. alata* or *D. rotundata* are planted on each hole, suspended with closed cell foams which are squeezed around the supporting system of the plant (stem). As the yam vines develop and grow, they are supported by the trellis to suspend extra weight of vegetation. Vines are harvested at two vine node cuttings and transplanted into sterilised soils in small plastic pots for a period of 3 weeks before being planted in the field, and thereafter harvested as seed yams and/or ware yams after 6 months. Micro-tubers are harvested carefully from the roots of the suspended yam vines as well from the aeroponics system after 120 days and planted in pots as well (after breaking dormancy).

Precaution in the Screen House: The screen house has a foot -dip that sterilised with a solution of germicides which helps in keeping up clean surroundings and to keep away the spread of unsafe microorganisms that may contaminate the plants on the boxes. Visitors to the screen house step their feet into the foot dip and must disinfect their hands on entering the screen house. Latex gloves are usually worn before tampering with the trelled vines or the micro-tubers. The vines are disinfected every two weeks with insecticides and fungicides. These steps are kept to ensure that the plants are free from diseases and maintain clean status for quality assurance. Other precautionary measure is to cover uncemented floor areas in the aeroponic screen house with three quarter inch chippings to enhance easy infiltration of any spilt water or nutrient solution into the soil and avoid flooding that can harbour microorganism thereafter and breed mosquitoes and other insects.

Prospects: *Dioscorea* spp are traditionally propagated with very low multiplication rate (less than 1:10 compared in some cereals) (Maroya *et al*., 2015). The vine cutting multiplication technique which is an improvement for high ratio propagation of yam from the minisett technique (generating up to 30 setts per tuber of 1 kg) is used in NRCRI, Umudike to generate up to 60 vines of one node per plant. The aeroponic system at NRCRI, Umudike has the potentials of generating over 282,240 one node vines per year that are planted into the nylon pots. An average of 3 micro-tubers is generated per yam plant in the aeroponics system in Umudike and this has a potential of generating over 1,693,000 micro-tubers per year. The continuous harvests are done without destructive harvesting of the rooting system to allow the plants to continue their growth in aeroponics system and are grown perennially without senescing.

Field planting and maintenance: One node vines are harvested from parent plants and planted into black nylon pots filled with sterile soils and are kept away from direct sunlight. After 3 weeks of planting in the nylon pots, vines are transplanted to the field and planted at 25cm by 100cm inter and intra row spacing. The plants are also kept away from direct sunlight as palm fronds are kept over the transplanted yam vines for a period of 30 days. This is done to enable the transplanted vines to acclimatize into the new field environment and avoid shock due to heat from sunlight. Organic fertilizers are applied and thereafter inorganic fertilizers are applied at recommended rates after transplanting. The yam vines are also trelled, irrigated if during the dry season and/or dry spells and harvested at 6 months after planting. Micro-tubers harvested are stored in a well ventilated environment to allow for breaking of dormancy. A dormancy period of about 90 days is usually allowed for the micro-tubers before being planted in the field.

Benefits of Aeroponic System: The aeroponics system ensures that clean, efficient and rapid production of yam vines and micro-tubers are produced perennially without any form of interruption and contamination from pests and micro-organisms. The system ensures that fertilizer (nutrient usage) of the system is reduced. Little excess nutrient is lost to evapotranspiration or runoff. Plants are grown in diseases free environment. Seed yams are mass produced.

Challenges

The system requires expertise to operate and maintained. The system requires constant power supply. This could come through either electricity or solar powered for the survivability and performance of the plants in the aeroponics. The system could only be handled by big time commercial seed companies because of the cost involved in maintenance.

CONCLUSION

The Aeroponics technology is a breakthrough for the rapid multiplication of seed yam for commercial ware yam production. The technology is used to produce disease free seed yam with only one vine cutting suspended in the air with nutrients fed through the box to mass produce thousands of seed yam in a very high ratio and in a sustainable production year round.

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Respond of Human Monocytic Cell Lines (Thp-1cell) and Interleukin-8(Il-8) Concentration when Treated with Bulk Zno and Zno Nanoparticle Dispersions (Cationic, Anionic and Non-Ionic)

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ABSTRACT
The responses of THP-1 cell (human monocytic cell lines) to nano ZnO with dispersant of different charges (cationic, anionic and non-ionic) and bulk ZnO was compared by observing interleukine-8 concentration of the cells. Treatment of the cell lines with different dispersants resulted to clustering of the cells and degree of clustering was shown to differ with the various treatments (bulk ZnO and ZnO nano-particle dispersions). The cationic treated cells showed a higher degree of agglomeration. The cell membranes were generally disrupted in all cases giving rise to irregular unbounded cells. The effect of ZnO nanoparticles on THP-1 IL-8 production was higher than that of bulk ZnO irrespective of the nano-particle charge. THP-1 cells produced the highest concentration of IL-8 when treated with anionic (AN) nanoparticle, this was closely followed by non-ionic (NI) and then cationic which produced the least of IL-8 from treatedTHP-1 cells. There was significant difference between the control and cationic ($p<0.0022$), control and anionic ($p<0.002$), control and non-ionic ($p<0.00023$) and control and bulk ($P<0.09389$). Similarly, there was a significance difference in IL-8 concentration between cationic and anionic ($p<0.01153$) and between cationic and non-ionic ($p<0.01136$)

Keywords: Human monocytic cells, interleukin-8, bulk ZnO, nanoparticles and Responds

INTRODUCTION
Zinc oxide and other related nano-particles have found usefulness in diverse and wide technological applications such as in the area of biomedical and cancer treatment, environmental protection, textiles, renewable energy, pharmaceuticals, personal care, food, etc (Tsuzuki, 2009). There is a growing trend in the current and potential application of nano-particles that covers a wide range of markets and industries; this has led to the public being exposed to a large quantity of nano-materials, hence, raising safety concerns (Prach *et al.*, 2012).

Experimental studies using non-particulate (bulk) form of zinc oxide and titanium have been implicated to have few adverse effects in animals (Yu and Li, 2011). On this basis, however, zinc oxide has been classified as GRAS (Generally recognised as safe) for use as food additive by FDA. On the other hand, products with ZnO nano-particles such as personal care products are extensively used for skin protection against harsh UV rays in human and others used as antibacterial agent in consumables such as surgical instruments. However, there is no regulation specific for the use of these chemicals in nanoparticle format (Yu and Li, 2011) since it is not clear whether or not ZnO containing materials are hazardous to human health or safe enough to be allowed for health related uses (Morag *et al,* 2012). Several studies have provided evidence that nano-particles exhibits size-dependent properties when they are compared with their bulk type for example, ZnO NPs (zinc oxide nano-particles) showed more cytotoxicity than the bulk. In the present study, the responses of THP-1 cells (human monocytic cell lines) to nano ZnO with dispersant of different charges (cationic, anionic and non-ionic) and bulk ZnO was compared by observing interleukine-8 concentration of the cells.

MATERIALS AND METHOD

THP-1 cell cytospin and Diff-Quik staining

A THP-1 cell suspension was provided by the immunology laboratory, Edinburgh Napier University, Scottland, UK, at a density of approximately 1x106 cells/ml for the cytospin preparation. A cytocentrifuge smear was then prepared by adding 160μl culture medium and 40μl of cell suspension at a concentration of $2x10^6$ cells/ml to a fully assembled sample chamber. Cells were then centrifuged at 110xg for 5 minutes in a Shandon cytospin 3 one after the other (control, LPS, bulk ZnO(bZnO), cationic (cat), anionic (An) and non-anionic (NI) ZnO). Slides were left to air dry and labelled with initials and date.

With gloved hands, lids were taken off all Coplin staining jars and were placed in the tray. The slides were immersed in a jar containing solution A fixative (methanol) for 30 seconds one after the other and were all drained off the excess by touching the edge of each slide on the side of the jar. Each of the slides was then immersed into eosin solution B for 15-30 seconds by slowly agitating the slides in the solution. Excess was drained off on the jar. Slides were transferred to the haematoxylin solution C without rinsing and staining was repeated as for solution B. Subsequently, slides were immersed in a jar of rinsing buffer and placed in a second tray to air dry. The dried cytospin slides were observed under the microscope and images seen were photographed.

Pre-coated ELISA plate

Appropriate pre-coated ELISA plate (IL-8 capture antibody) was collected from the laboratory bench and the coating antibody solution from the ELISA plate shaken into the sink. ELISA plate was washed 4 times using a Wash Buffer in a spray bottle and it (ELISA plate) was transfer to 4 sheets of blue roll on the bench. Plates were turned upside down on the sheets of paper roll and banged dried. To each well of the plate, 300μl of Assay Buffer was added to block the plate and this was incubated at room temperature for one hour.

Standard/samples with blocked ELISA

Assay Buffer from the ELISA plate was shaken into the sink after one-hour incubation and the Wash Buffer in the spray bottle was used to wash the ELISA plate 4 times. ELISA plate was transfer to 4 sheets of blue roll on the bench, turned upside down on the sheets of paper and banged until the plate was dry. A tube of IL-8 standard (stock standard, 800pgml^{-1}) was collected from the Laboratory bench and was double diluted in duplicate in Assay Buffer. Using eppendoff tubes, serial dilution was carried out by adding 300μl of Assay Buffer to each pair of eppendoffs (14 in total) which were labelled accordingly as 400, 200, 100, 50, 25, 12.5, and 6.2pgml^{-1}. The serial dilution was carried out starting with 800pgml^{-1} by transferring 300μl of each standard to the next tube and vortexing each tube. 100μl of the standards, samples and blanks (Assay Buffer) was added as in the template. About 50μl detection Antibody was added to all wells and plate was labelled with initials and incubated for 2 hours.

Streptavidin-HRP conjugate

The detection Antibody from the ELISA plate was shaken off into the sink and the Wash Buffer in spray bottle was used to wash the ELISA plate 4 times and was subsequently transfer to 4 sheets of blue roll on the bench. The plate was turn upside down on the sheets of paper and banged until it was dry. About 00μl of Streptavidin-HRP conjugate collected from the Laboratory bench was added to each well and incubated for 20mins at room temperature. The plate was kept to avoid direct light.

Substrate solution

The ELISA plate was shaken off of the Avidin-HRP conjugate into the sink and Wash Buffer from spray bottle was used to wash the ELISA plate 4 times and transfer to 4 sheets of blue roll on the bench. The plate (ELISA) was turned upside down on the sheets of paper and banged till plate was dry. 100μl Hydrogen peroxide (H2O2) and Tetramethylbenzidine (TMB) liquid substrate was added to each well and incubated for 10mins at room temperature. 50μl stop solution (2N H2SO4) was added to each well and absorbance at 450nm (reference absorbance 650nm) with an ELISA plate reader was measured and results read and printed.

Statistical analysis

Obtained data were subjected to statistical analysis using t-test for level of significance between certain treatments. IL-8 concentration was calculated for each treatment using the standard curve equation $y=0.0015x-0.0016$,

RESULTS AND DISCUSION

Cell morphology: Observation of cell under a light microscope (x40 magnification) showed cells clustering together. The degree of clustering however differs with the various treatments (bulk ZnO and ZnO nano-particle dispersions). From figure 1 below, the cationic treated cells showed a higher degree of agglomeration. The cell membranes were generally disrupted in all cases giving rise to irregular unbounded cells.

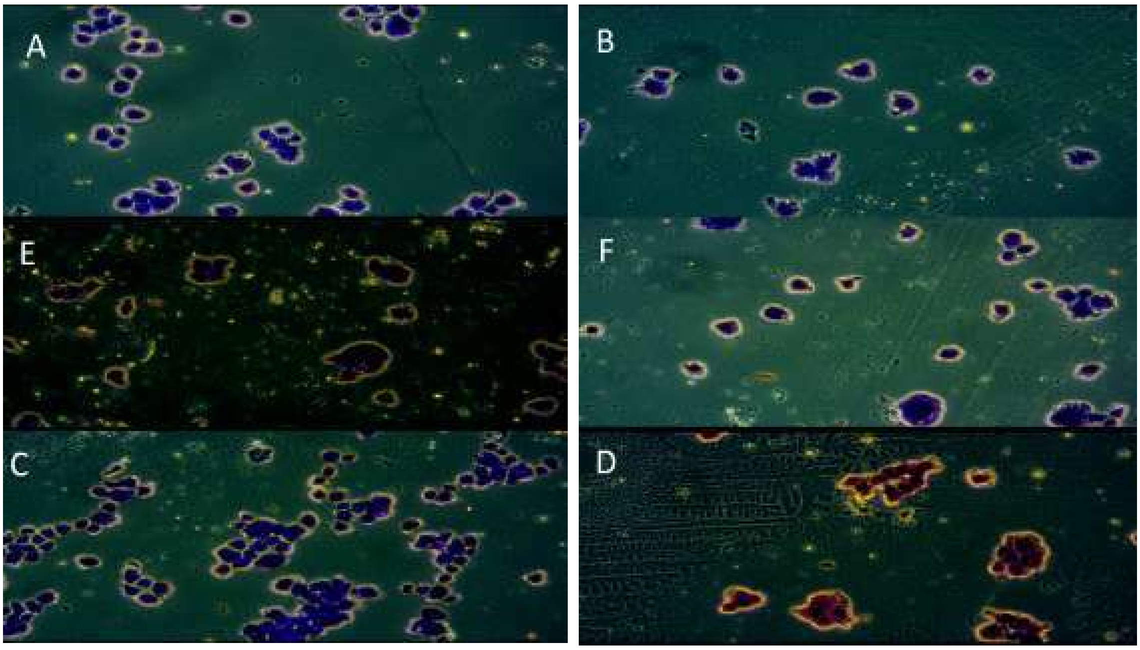

Fig.1. *Representative images of THP-1 treated with bulk (F) ZnO and ZnO nanoparticles dispersions: cationic(C), anionic (D), non-ionic (E), control (A) and lipopolysaccharide (B) as observed under a light microscope (x40).*

ZnO bulk and ZnO nanoparticle dispersions (cationic, anionic and non-ionic) effect on

THP-1 production of IL-8: The effect of ZnO nanoparticles on THP-1 IL-8 production was higher than that of bulk ZnO irrespective of the nanoparticle dispersions (Fig. 2). There were however, differences in THP-1 production of IL-8 when treated with different ZnO nanoparticle dispersions. THP-1 cells produced the highest concentration of IL-8 when treated with anionic (AN) nanoparticle, this was closely followed by non-ionic (NI) and then cationic which produced the least of IL-8 from treatedTHP-1 cells. There was significant difference between the control and cationic ($p<0.0022$), control and anionic ($p<0.002$), control and non-ionic ($p<0.00023$) and control and bulk ($P<0.09389$). Similarly, there was a significance difference in IL-8 concentration between cationic and anionic ($p<0.01153$) and between cationic and non-ionic ($p<0.01136$) (Fig.2).

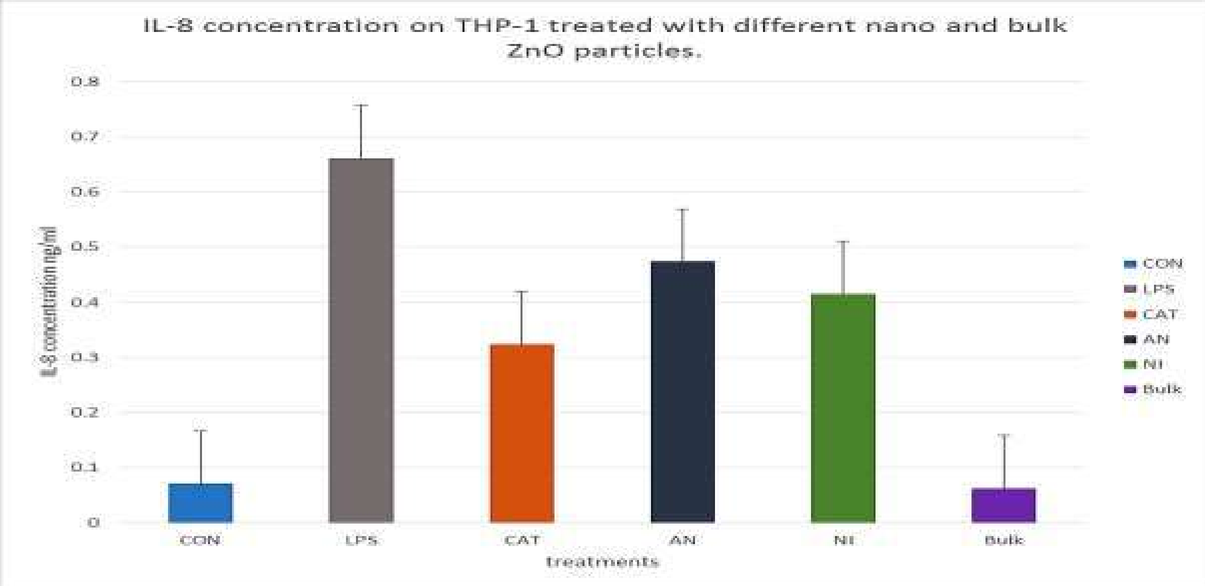

Fig.2 *Effect of ZnO (BULK) and ZnO nanoparticle dispersions: CAT (cationic), AN (anionic), NI (non-ionic) and LPS (lipopolysaccharide) on IL-8 production of THP-1 human cells*

Results from the microscopic photograph showed disruption of the THP-1 cells membrane which could cause an influx of the ZnO particles. Such membrane disruption had also been observed by previous Researchers (Roiter

The aim of this present work was to study the cytotoxicity of both bulk and nanoparticles of ZnO (size effect) and charge difference among the nanoparticles (cationic, anionic and non-ionic) on THP-1 cells. From the results of this study, it is clear that toxicity of ZnO to THP-1 cells is size dependant as all particles of nano size irrespective of charge were more cytotoxic than the bulk ZnO. This agrees with the findings of Prach *et al* (2012) who also observed a similar trend in their study with ZnO particles and monocytes.
Between charge differences also exist as demonstrated by the results from this study. Cationic ZnO nanoparticle showed a higher degree of toxicity making them more potent than the other nanoparticles which suggest likely higher affinity to the membranes which are mostly negatively charged. From the results it is also obvious that charge plays a role in cytotoxicity of nanoparticles. This also agrees with the findings of Prach *et al* (2012) who asserted that despite their extensive and rapid solubility, in cell medium, charge can still influence their biological activities.

CONCLUSION

From the results of this study it is concluded that there is a significant difference in cytotoxicity between bulk and nanoparticles of ZnO (size effect) and between the different charges of the nanoparticles (charge effect). This agrees with the hypothesis of this experiment.
The study was unable to show what effect the up regulation of IL-8 production have whether it will be a positive or negative effect. There is also the need to know the dose of the nanoparticles at which they are sublethal and when they become lethal. Finally, their mode of action should be investigated to know whether they act via the classic type 1 proinflammatory activation of innate immune cells.

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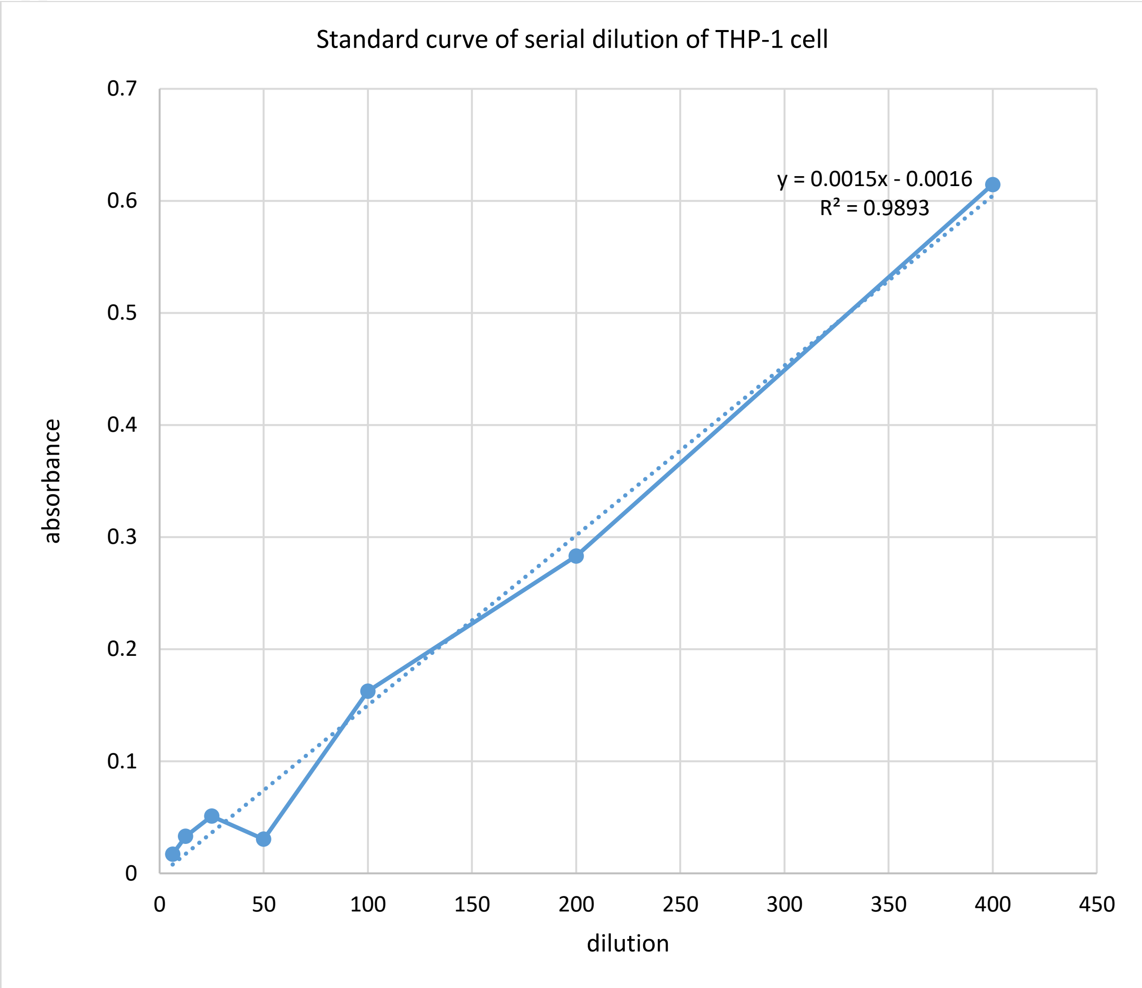
Appendix 1



Effect of Three Carbon Sources (Glucose, Fructose and Sucrose) On Solvent Producing Ability of Bacterium *Clostridium Acetobutylicum* Atcc 824, A Bioprocess

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ABSTRACT
The performance of Clostridium acetobutylicum on three carbon substrates (glucose, fructose and sucrose) for solvents (acetone, butanol and ethanol-ABE) production was characterised in a batch fermentation study, in the bioprocess laboratory of Edinburgh Napier University, Scotland, UK. The cultivation of Clostridium acetobutylicum ATCC 824, was carried out in the anaerobic chamber hood using TYA (trypwton, yeast, acetate) medium. Formation of acetobutylicum spores was found to increase with successive increase in the breakdown of the substrates which in turn led to a proportionate increase in the solvents production. Production of butanol by all substrates was found to be highest followed by acetone and ethanol respectively. Of the three substrates, glucose recorded the highest production of all solvents and acids, followed by sucrose and fructose in that order.
Keywords: Clostridium acetobutylicum, solvents, substrates, fermentation and bioprocess.

INTRODUCTION
Different strains of *Clostridium* have been used for solvent production and one of such is *Clostridium acetobutylicum*, a spore forming bacterium that is strictly anaerobic. It has an important ability of using organic compounds to obtain energy which it uses to produce acetone, butanol and ethanol from sugary substrates (Jones and Wood, 1986). Of recent, *C. acetobutylicum* has received rave attention because of this ability of producing these solvents (ABE) of industrial importance which can be used as fuel and other uses in different industries such as foods, plastics, chemistry and as component for feeds in animals (Ezeji *et al*., 2005).
ABE fermentation is faced with limitations that stand major drawbacks in a typical batch fermentation that need to be overcome (Jones and Wood, 1986). Some of these drawbacks include: high substrate cost; low final butanol concentration caused by butanol inhibition; low yield of butanol due to hetero-fermentation (0.28–0.33 g/g); high cost of butanol recovery from low-concentration yields (distillation was used in the past) among many others (Tashiro and Sonomoto, 2013). Identifying substrates with very high final product yield of ABE fermentation would significantly have a positive impact on one of the drawbacks (substrate cost). In the present study, the performance of *C. acetobutylicum* on three different carbon substrates (Glucose, Fructose and Sucrose) for ABE fermentation was characterized.

MATERIALS AND METHODS
The microorganism and culture medium: The microorganism used for this study was *C. acetobutylicum* strain ATCC 824 given in the laboratory. Spore stock were germinated in Reinforced Clostridial Medium (RCM; Oxoid) made by suspending 38g in 1 l distilled water

that was completely dissolved by boiling, separated into 20ml aliquots in universals glass and sterilised by autoclaving at 121°C for 15 minutes. Tryptone, yeast, acetate (TYA) was used as the culture medium. It is made up of the following component (g l^{-1}): Tryptone 6.0; Yeast Extract 2.0; Ammonium acetate 3.0; KH_2PO_4 0.5; $MgSO_4.7H_2O$ 0.3; $FeSO_4.7H_2O$ 0.01; Carbonhydrate (50g/l); PH c.a. 6.5 (Hipolitoet al. 2008). Bacterial were cultured by adding 20ml of different carbon sources (Glucose Fructose and Sucrose-one carbon source for each group of experimenters) to 80ml TYA and 5ml (5% inoculum size) of the overnight *C. acetobutylicum* was inoculated into the resulting mixture. The cultures were incubated at 37°C.

Optical density and PH determination
The optical density (OD) of the culture samples were measured at day 0 and day 7 at 600nm with a spectrophotometer and PH determined using a Mettler-Toledo (MP220) PH meter following manufacturer instructions.

Fermentation analysis (sugar and solvent analysis)
2x1.5ml of culture samples were removed on day 0 and day 7 and centrifuged (12000rpm for 10 minutes) for sugar and solvent analysis. Using a 0.20μM cellulose acetate syringe filter (Anachem Supatop, ALG422A), the supernatant was carefully removed using a pipette and filter sterilised for HPLC (High Performance Liquid Chromatography) and GC (Gas Chromatography). About 1ml of supernatant was pooled for HPLC and GC analysis: for the GC, 10μl propan-1-ol was added to the pooled 1m and for HPLC 1.25μl 1M H2SO4 was added to the remaining pooled 1ml sample. These were sent for GC and HPLC by BfRC using the GC Chrompack 9001 gas chromotograph with flame ionisation dector and a CP SIL 5CB column (10cm length and 0.32mm diam; Chrompack, Middleburg, Netherlands). The solvent concentrations were determined by a calibration curve generated using known concentrations of A, B and E.

Determination of cell count
Cell concentration was estimated by way of plate counts through serial dilution and spread plate method of pre-coated agar plates. Cell numbers were expressed as cfu/ml. Conversion of cfu was done using the following formula;
CFU= A/DXV
Where CFU= Colony Forming Unit
A= average number of colonies on dilution plate (from replicates)
D= dilution plated and V= volume plated (ml).

Motility
Samples of the culture were examined for bacterial motility through a wet-mount method by dropping 20μl of the culture suspension to a clean microscope slide using a sterile disposable loop upon which a cover slip was paced on the culture drop avoiding bubbles. This was immediately viewed under microscope using the x40 and x100(under oil immersion) lens objective.

Gram Stain
Gram staining was done according to the modified Hucker method (Hucker, 1923) and slides were examined under the bright field microscope using the x10, and x40 lens objectives. Slides were also viewed under oil immersion using the x100 lens objective.

Sporulation assays
Cells were heat shocked and treated with malachite green and counter-stain with 0.5% safranin for 1-1.5 min on day 0 and day 7 and were observed under the microscope for spores.

RESULTS AND DISCUSSION
Figure 1 shows *C. acetobutylicum* spores formed under different concentrations of substrates as recorded on day 0 and 7 of incubation. The number of spores formed on day 0, were fewer

than those formed on day7. Substrate concentrations (Glucose, Fructose and Sucrose) were higher on day 0 than day7 (2.27:0.38; 1.957:0.1633 and 2.275:0.79 for Glucose, Fructose and Sucrose respectively). Solvent concentration like the number of spores formed were higher in day7 than in day0 (Table 1). Jones *et al* (2011), stated that spore formation is coupled with solvent production which are both stationary-phase-events, this agrees with the result of this work as more solvent and spores are formed on day7 (Figure 1 and Table 1). This established a form of relationship between sporulation and solvent production as the increase in one leads to a proportionate increase of the other. This also agrees with the work of Huang *et al* (2007), were they observed that sporulation-specific sigma factors affect solvent formation.

Spores are formed during very hard environmental conditions so as to survive. With the high utilization of the substrates on day7 as noted above, nutrients would have become a limiting factor for further vegetative growth of the organism hence, the reversion to spore formation.

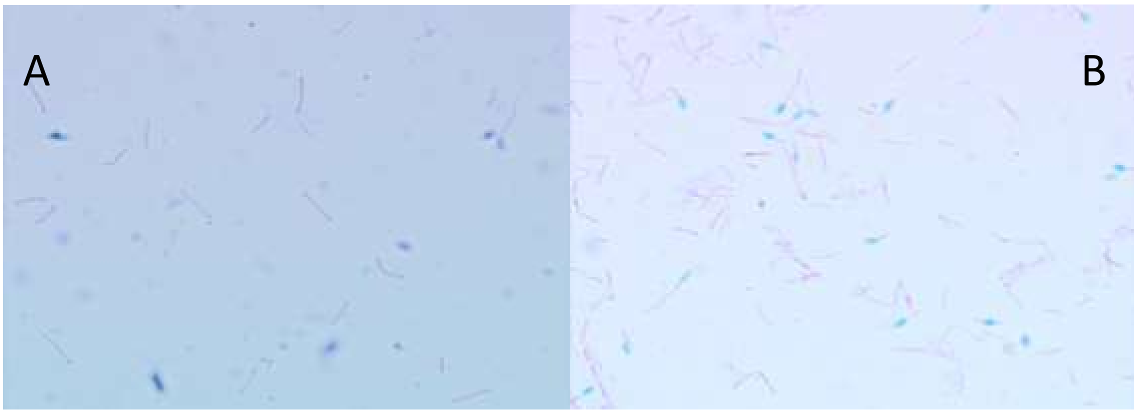


Fig1. Spore population as observed from the microscope after day0 and day7 of incubation. A= Day0 population B= Day7 spore population

Table 1 *C. acetobutylicum* ATCC824 production of solvents and acids from the three carbon sources

Glucose

Day	Acetone	Butanol	Ethanol	Butyric acid	Acetic acid
0	0.00	0.00	0.00	0.022±0.001	0.029±0.002
7	0.1883±0.00	0.3115±0.016	0.0579±0.003	0.0463±0.003	0.076±0.001

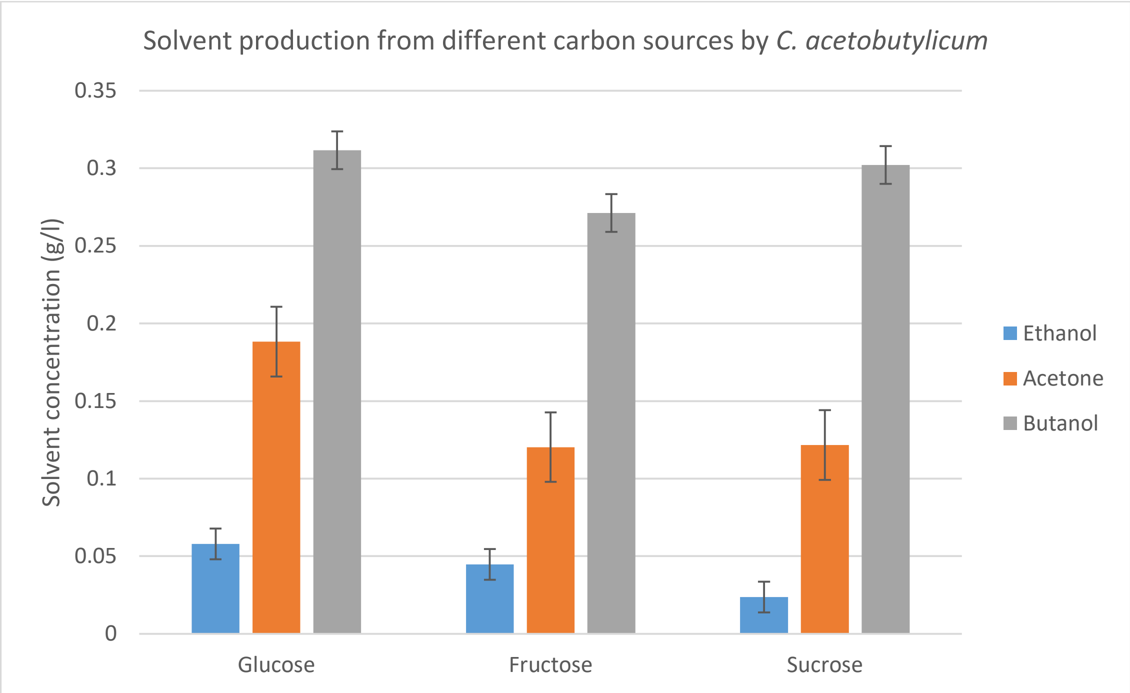
Fructose

Day	Acetone	Butanol	Ethanol	Butyric acid	Acetic acid
0	0.00	0.00	0.00	0.012± 0.002	0.028± 0.004
7	0.1203± 0.009	0.2713± 0.007	0.0447± 0.002	0.044± 0.004	0.074± 0.003

Sucrose

Day	Acetone	Butanol	Ethanol	Butyric acid	Acetic acid
0	0.00	0.00	0.00	0.017± 0.001	0.014± 0.001
7	0.0275± 0.027	0.0040± 0.004	0	0.035±0.005	0.02±0.002

Solvents production by *C. acetobutylicum* from the various carbon sources in this experiment are shown in fig.2 (A). Fig 2(B) present the production of acetic and butyric acids from the various carbon sources, while Fig2 (C) is the total ABE and total acids produced from each carbon source. From Fig. 1A, butanol was the highest solvent produced by each of the carbon sources followed by acetone while ethanol was the list produced solvent. Between the carbon sources, glucose produced the highest quantities of all solvent types followed by sucrose and fructose produced the least overall solvents (fig. 2a). Glucose also produced the highest concentration of all acids.



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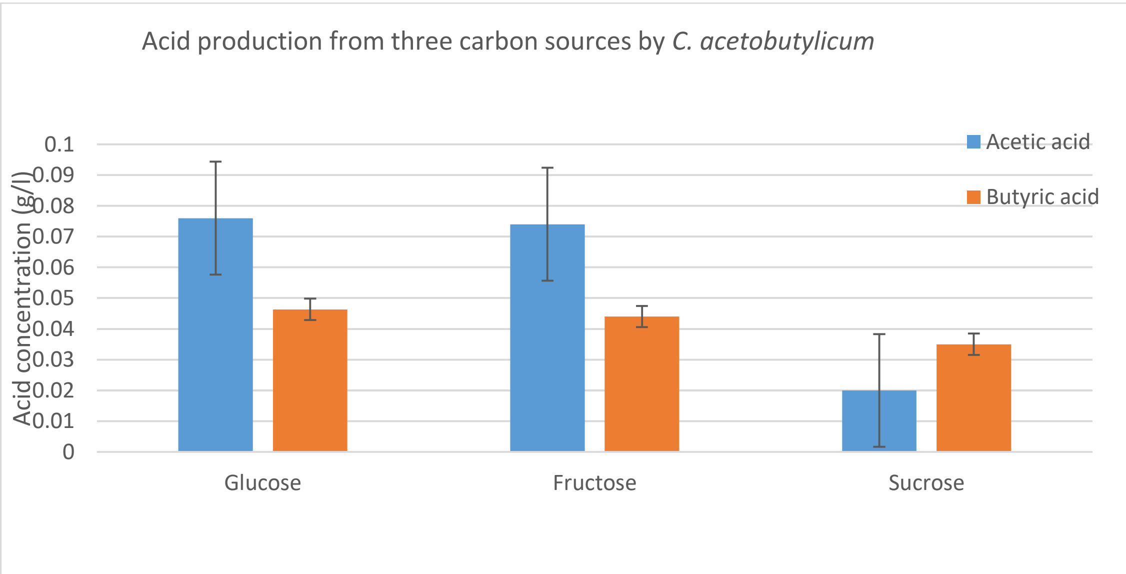

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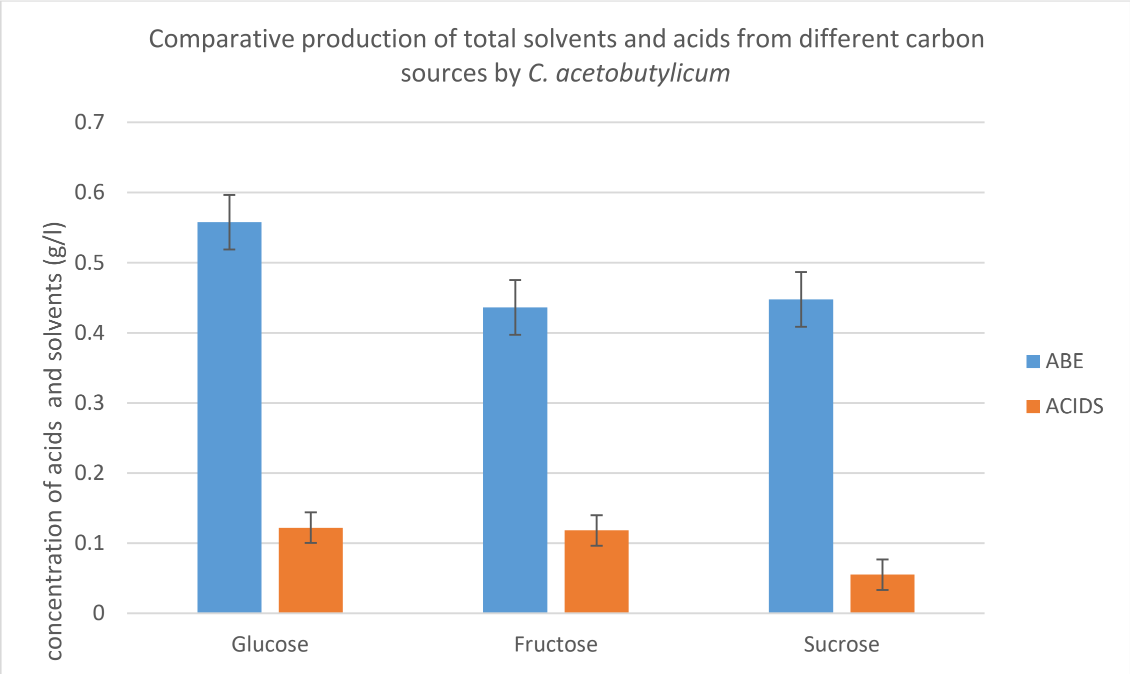


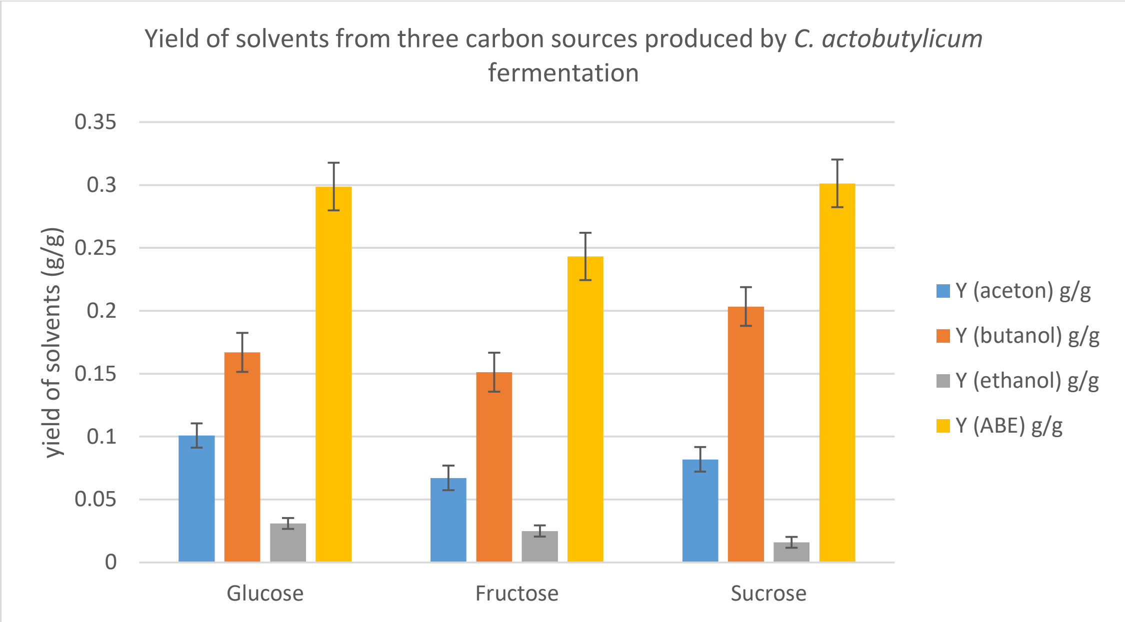
C

Fig 2. Production of solvents (ABE) and acids from three different carbon sources (glucose, fructose and sucrose by C. acetobutylicum. 2A (solvent production from glucose, fructose and sucrose), 2B (acids production from glucose, fructose and sucrose) and 2D (total solvents and acids production from glucose, fructose and sucrose)

Table 2 shows the initial substrates concentration and percentage substrates utilization. Initial substrate concentration is indicated to have a significant effect on butanol production. Khamaiseh, *et al* (2014), had recorded a low amount of fermentation products and the attributed this to the relative low initial concentration of the carbon source used. The results obtained from this work indicates a similar trend as demonstrated in table 2. From table 2, glucose had the highest initial concentration followed by sucrose, this corresponded with the final solvent concentrations produced by the same carbon sources (Fig.2a). It is more striking that though sucrose had the lowest substrate utilization (64.47%) as against that of fructose (90.8%) yet, it produced higher amounts of ABE. This can be attributed to the initial substrate effect. Monosaccharides are implicated to favour solvent production more than sucrose (Casas *et al*., 2006) this is in contrast to the result obtained in this work as sucrose produced higher amounts of ABE that fructose which is a monosaccharide, however, this abnormality from their finding may be attributed to the high initial concentration of sucrose.

Table 2 Initial and final substrate concentration and percentage substrate utilization of carbon sources by *C. acetobutylicum*

Carbon source	Initial concentration	Final concentration	% utilization
Glucose	2.2467	0.38	83.11
Fructose	1.957	0.163	90.8
Sucrose	2.275	0.79	64.47



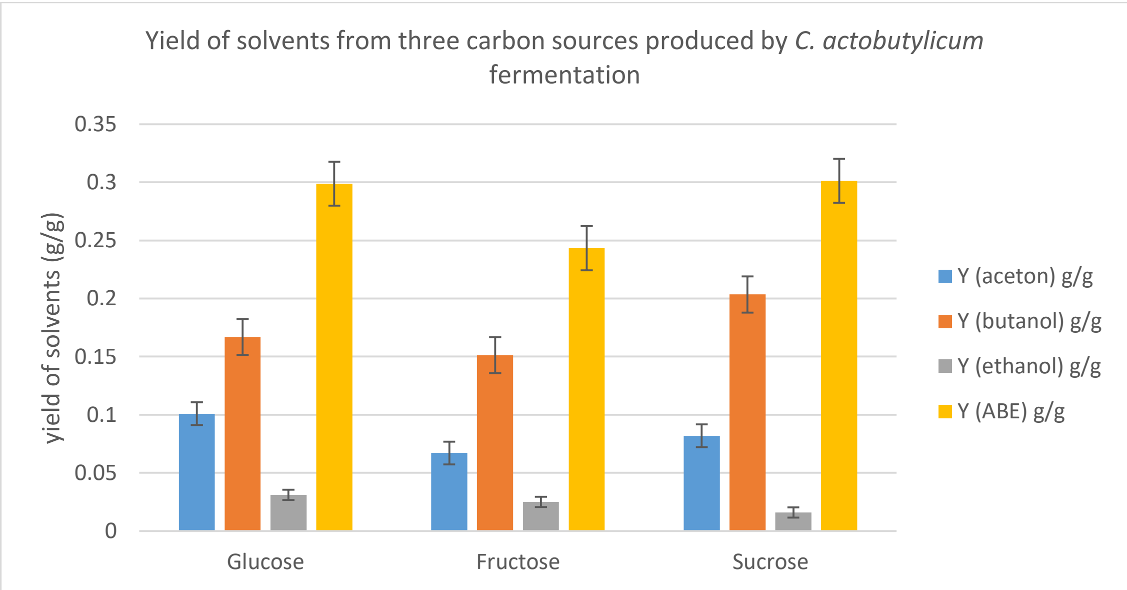


Fig.3 yield and productivity of solvent obtained from three carbon sources by C. acetobutylicum. 3A (yield of solvents from the batch culture of C. acetobutylicum using glucose, fructose and sucrose), 3B (productivity of solvent obtained from three carbon sources by C. acetobutylicum).

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Application of Simple Sequence Repeat (SSR) Markers in DNA Molecular Profiling, Genetic Diversity and Polymorphism Information Content in Nigerian Rice *FARO* Inbred Lines

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ABSTRACT

Molecular marker technique is a valuable tool for assessing genetic variability and resolving varietal identities, Molecular marker assisted breeding has the potential to enhance efficiency of genetic improvement in rice, Assessment of genetic diversity and molecular characterization among Federal agricultural release Oryza (Faro) rice varieties of Nigeria is very essential for germplasm management, varietal identification, and DNA fingerprinting. Thirteen SSR markers were studied across 27 Faro rice varieties. In total 81 allele were dictated and the number of alleles per locus ranged from 3 to 20, with an average of 6.75 alleles across 13 loci. In yet another development, 52 rare alleles were also detected at 12 loci. The results revealed Polymorphic Information content (PIC) values ranged from 0.31 to 0.84, with an average of 0.54, which shows although, low variation, distinct average variation was recorded. The PIC values revealed that RM400 is the best marker for identification and diversity estimation of rice varieties, followed by RM251, RM256, RM229, and RM523 markers. for Pair-wise genetic similarity coefficients the closest genetic distance was obtained between Faro 27 and Faro12 (0.95) and the lowest (0.31) were recorded for Faro 21 & 23, and others., these were regarded most dissimilar numerically which suggested that these genotypes were more genetically diverse. In crop improvement program these genetically diverse genotypes are very critical in creating distinct genetic character. The un-weighted pair group method with arithmetic mean (UPGMA) cluster dendrogram created three major heterotic groups at 100% dissimilarity coefficient of 0.38 differentiating the genotypes into seed sizes of long medium and short grain. However, at 50% dissimilarity coefficient of 0.38 seven heterotic groups emerged The SSR polymorphism and diversity could likely be attributed to pedigree in their grain size and adaptive ecology. These results demonstrate that the identification and certification of varieties using microsatellite markers could serve is a good complement to existing agro-morphological data especially when varieties are closely related. In this study, all the SSR markers produced specific alleles that were useful for DNA fingerprinting of these varieties. The findings could help in back ground selection in crop improvement programmes

Keywords: genotype identification; Genetic diversity; SSR; UPGMA- unweighted pair-group method with arithmetic means.

INTRODUCTION

Rice is World's single most important crop and a stable food for half of the world's population. According to estimates rice is a staple food for about 3.4 billion people providing more than 20% of the daily calorie intake (Seck, *et al.* (2012). Rice (Oryza sativa L). In Nigeria Rice is an increasingly important crop. It is grown for sale and for home consumption. In some areas along the course of river Niger and Benue there is a long tradition of rice growing, on the other hand for many, rice has been considered a luxury food for special occasions only. With the increased availability of rice, it has become part of the everyday diet of many Nigerians. There are many varieties of rice grown in Nigeria. Some of these are considered 'traditional' varieties; others have been introduced within the last twenty years.

Nigeria is currently the largest rice producing country in Africa. This is as the result of conscientious efforts by the present administration to place more emphasis on agricultural production (Udemezue, 2018) with the available literature; annual rice production in Nigeria has increased from 5.5 million tons in 2015 to 5.8 million tons in 2017. In 2015, Nigerians spent not less than N1bn on rice consumption, adding that while spending had drastically reduced, consumption had increased because of increased local production of the commodity. The consumption rate now is 7.9 million tones and the production rate has increased to 5.8 tons per annum. The increase was as a result of the Central Bank of Nigeria (CBN)'s Anchor Borrowers Program with a total of 12 million rice producers and four million hectares of FADAMA rice land (Goronyo, 2017; Udemezue, 2018). The move was aimed at reducing the nation's over reliance on oil which has in the past year proved economically devastating as oil prices plummeted on the global market.

Molecular marker has been introduced as a powerful tool for determining genetic variation in rice varieties. Unlike morphological traits, molecular markers can reveal abundant difference among genotypes at the DNA level, providing a more direct, reliable and efficient tool for germplasm profiling, characterization and management and at the same time is uninfluenced by environmental factors. This suggests that numerous valuable traits of economic significance that remain unutilized by conventional breeding (Hossain *et al.* 2012) can now be exploited. The first step towards determining these is to evaluate the genetic diversity in improved rice genotypes as the success of a crop improvement program depends on the magnitude of genetic variability and the extent to which the desirable characters are heritable (Ravi *et al.,* 2003). Hence assessment of genetic diversity becomes important in establishing relationships among different cultivars (Kibria *et al.*, 2009; Sivaranjani *et al.,* 2010). Therefore, different rice varieties of distinct genetic structure are a good promise for the future rice crop improvement. Thus, identification of genotypes and their inter-relationships is important. Development of new biotechnological techniques provides increased support to evaluate genetic variation in both phenotypic and genotypic levels and the results derived from analyses of genetic diversity at the DNA level could be used for designing effective breeding programs aiming to broaden the genetic basis of commercially grown varieties.

In the present study SSR, was the marker of choice as it is co dominant marker systems and are less costly and easier to be developed and used. The genetic diversity analysis can be extended to characters like acid soil tolerance/ other abiotic stress, which are controlled by large number of QTLs which may share homology between genes responsible for other abiotic stresses like temperature, drought, flood, submergence etc.

In the past, it was difficult to clearly identify and differentiate one cultivars from other using conventional morphological characteristics owing to effects of environment. DNA Fingerprinting on the other hand (Rahman, 2009) allows for accurate, unbiased, and rapid genotype identification, which has been established to be an effective tool for crop improvement. (Zhu, 2012). A variety of molecular markers are now available which can be used to establish the fingerprint and evaluate the DNA genetic diversity of rice varieties some of which are Restriction Fragment Length Polymorphism (RFLP), Random Amplify Polymorphic DNA(RAPD), Amplify Fragment Length Polymorphism (AFLP) Simple Sequence Repeat(SSR), Single Nucleotide Polymorphism (SNP) and a host of others. More often, SSR markers have been widely used for establishment of unique fingerprint and assessment of DNA genetic diversity due to their abundance, codominant inheritance, high polymorphism, reproducibility, ease of assay by polymerase chain reaction (PCR), and relatively cost effective (Kuleung 2004; Xie *et al.* 2011). This recent, SNPs have received increased consideration because they occur at a much higher rate in the genome than SSRs. Nonetheless, most SNPs are biallelic; thus, an SNP marker has fewer information content than SSR marker (Stich, Van, and. Melchinger , 2010). Furthermore, SSR markers still have their own advantages as compared to SNP markers for population genetics analysis (Hamblin, Warburton and Buckler, 2007) and are still used widely in the construction of molecular fingerprinting databases. Beside (Tang, 2015). SSR markers have been used for fingerprinting and identification in many crop species, such as wheat (Li Wang and Yan 2013), maize (Ping *et al*., 2012), bean (Xue *et al.*, 2015), tomato (Scarano*et al*., 2015 :Ruiz, Barandalla and Jose, 2011). Furthermore, the fingerprint can be used for the protection of plant genetic resources. The objectives of this study therefore were to. (1) Establish the molecular fingerprinting of 27 rice genotypes and (2) to estimate the level of genetic diversity both among and within inbred Faro lines and molecular phylogeny of these rice varieties (3) dictate the presence of latent traits of great agronomic significance.

MATERIALS AND METHOD

Plant material

27 FARO rice varieties were recruited for this experiment all were breed by NCRI breeding unit. From 1954 to 1974 fig 1)

DNA Extraction

DNA was extracted from 2 g of fresh young leaves according to the CTAB procedure of (Doyle and Doyle, 1987) slightly modified quantified using 0.1% agarose gel electrophoresis. The DNA samples were diluted to 25 ng µL-1 and stored at – 20 °C until use. A total of twenty SSR primers covering all the 12 chromosomes were recruited for this experiment but only thirteen were found to be polymorphic and used in this study.(table 1) . Primers were obtained from the SSR panel in the rice Gramene database (http://www.gramene.org/markers /microsat/ssr.html). Primers were synthesized by Sangon Biological Engineering Technology & Services Co., Ltd. (Shanghai, China). SSR polymerase chain reaction (PCR) amplification was conducted in a 20 µL volume containing 40 ng of genomic DNA, 1 U *Taq* DNA polymerase, 2.5 mM Mg2+, 0.20 mM dNTPs and 0.2 µM of each primer. A modified PCR program was used: 5 min at 94 °C, 35 cycles of 30 s at 94 °C, 30 s at SSR specific annealing temperature (53 °C to 64 °C) and 45 s at 72 °C; with a final extension step of 7 min at 72 °C. The PCR products were fractioned on 8% denatured polyacrylamide gel electrophoresis, and stained with silver nitrate.

Data analysis

Band profiles were scored for distinct and a reproducible bands as present (1) or absent (0) for each SSR primer pair. Jaccard's similarity coefficient values were calculated and dendrograms based on similarity coefficient values were generated using unweighted pair-group method with arithmetic means (UPGMA) by the NTSYS -pc 2. Software (Rohlf,2000). The polymorphism information content (PIC) value of SSR markers was calculated using the following formula (Andersen and Liberstedt, 2003). **Error! Reference source not found.**.

$$PIC = 1 - \sum_{i=1}^{k} p_i^2$$

Where k is the total number of alleles (bands) detected for one SSR locus and p is the proportion of the cultivars or genotypes containing the allele (band) in all the samples analyzed.

RESULTS AND DISCUSSION

Assessment of genetic diversity and molecular characterization within some federal agricultural release oryza was carry out using simple sequence repeat (SSR) markers twenty were used but only Thirteen SSR markers were polymorphic and were used across 27 genotypes of rice to characterize and discriminate among Faro varieties of rice. The number of alleles per locus ranged from 3 to 20, with an average of 6.75 alleles across 13 loci. A total of 52 rare alleles were detected at 12 loci. The results revealed that the 27 rice varieties produced rare alleles that could be used for molecular characterization, and DNA profiling of these varieties. Polymorphic Information content (PIC) values ranged from 0.31 to 0.84, with an average of 0.5498, which revealed that there is narrow but distinct variation among the rice genotypes studied .The PIC values revealed that RM400 was the best marker for identification and diversity estimation of rice varieties, followed by RM251, RM256, RM229, and RM523 markers.

Genetic diversity

The genetic diversity ranged from 0.38 RM 340 to 0.84 in RM 400 with an average of 0.59, indicating a high level of diversity existing within the genotypes surveyed. The highest genetic diversity (0.94) was recorded in locus RM400 and the lowest genetic diversity (0.33) was detected in locus RM305 (Table 2).

Polymorphism information content (PIC)

PIC value is an expression of allelic diversity and frequency among the varieties. PIC value of each marker was evaluated on the basis of the number of alleles and it varied greatly for all the SSR loci tested. Thus, the allelic diversity as well as the level of polymorphism among 27 rice varieties was evaluated using 13 SSR informative loci and showed variability among markers, which varied widely among loci. The highest PIC value was obtained for RM 400 (0.84) fallowed by RM251 (0.72), and the least value of (0.31) goes for RM 304. (Table 2)

Although, the average PIC value obtained in the present work of (0.55) was lower than that reported by (Rama *et al* , 2015; Rangel *et al,* 2008 ; Giarrocco, Marass. and Salerno, 2012) and (Shakil, *et al.,* 2015) who observed an average PIC value of 0.74 and 0.69, respectively. The PIC values observed in our study were consistent with previous estimates of SSR marker analysis in rice by (Siwach, *et al*. 2004:Yan, *et al*.2017 and Zeng,*et al.* 2009a).

Pair-wise genetic similarity coefficients

The pair-wise genetic similarity coefficients indicated that the closest genetic distance was obtained between Faro 27 and Faro12 (0.95) as well as between Faro 12 and Faro07 (0.92) (Table 4) On the other hand Faro 21 and Faro 23, Faro 11and Faro 02, Faro 10 and Faro 06, Faro 07 and Faro 10 each with (0.31) were most dissimilar which suggested that these genotypes were more genetically diverse. In crop improvement program these genetically diverse genotypes are very important in creating distinct genetic character.

UPGMA Cluster Analysis

Cluster analysis was used to group the varieties and to construct a dendrogram. The similarity matrix representing the DICE Co-efficient was used to cluster the data using the UPGMA algorithm. The UPGMA based dendogram obtained from the binary data deduced from the DNA profiles of the samples analyzed adds a new dimension to the genetic dissimilarity. A total of 7 distinct groups resulted out of analysis of pooled SSR marker data (Figure III). This dendrogram revealed that the genotypes that are genetically similar clustered more closely together.

The genetic relationship between Faro lines genotypes was assessed by a UPGMA clusters dendrogram (**Error! Reference source not found.**) , The un-weighted pair group method with arithmetic mean (UPGMA) cluster dendrogram created three major heterotic groups at 100% dissimilarity coefficient of 0.38 differentiating the genotypes into seed sizes of long medium and short grain. However, at 50% dissimilarity coefficient of 0.38 seven heterotic groups emerged. and additional sub clusters within some of the major clusters.

Cluster (I) consist of eight (8) varieties these were Faro 06, 07,08,09,12,24 & 27 the second cluster (II) was formed by Faro10 alone for its drought resistant trait, these group is long grained types and was well adapted to shallow swamp ecology. The next cluster, cluster (III) have had traits for medium grain and were adapted to shallow swamp as well, these comprises of Faro 01, 02,04,05,11,& 20 This cluster was followed by cluster (IV) which was formed by some eight (8) other varieties of Faro lines these were Faro12,13,14,15,16,17,18,and 19 these were sub divided into two (IVA) Faro12,18 & 19, were adapted to deep swamp while (IVB) were Faro13,14,1516,17, adapted to shallow swamp both had traits for medium grain, The next two major clusters (V &VI) were each made up of two genotypes Faro 03, and 25 for group (V) both of them had trait for drought resistance and were also of medium size grained. While Cluster (VI) was made up of Faro 22 and 23 these also form part of the medium grain shallow swamp in addition to good adaptation to irrigation as well. The last (VII) cluster was an out group and consisted of only one variety which is faro 21 it is the only rice variety that has differentiated trait of short grain.

In the course of our study it was observed that no two varieties are carbon copy (duplicate) of one another (100% similarity).thus further proves the efficiency of SSR as one of the most powerful molecular marker not only for identification of genetically distinct genotypes but also for discriminating genotypes with narrow genetic distance.

About twenty (20) SSR markers were used in this work but only 13 SSR markers used in this investigations produced polymorphic bands in the genotypes,. Similar results were obtained by (Rahman, Sohag, & Rahman, 2010: Mamunur 2012:Shahriar 2015:Giarrocco, 2007.)

However, the average number of alleles per locus detected in the present study(6.75) was lower than the average number of alleles reported by (JayamaniI *et al*., 2007 :Anupam *et al*., 2017:Zeng, 2007:Shahriar 2015:Prathepha., 2012) who reported an average of 7.7 and 11.85, alleles per locus, but was very consistent with some earlier reports by(Rahman *et al.,* 2012) (Ni, *et al.,* 2002) and (Bhatt, *et al.,*2017) , who reported 5.79, 6.8 and 6.13 alleles per locus, respectively. and In contrast, were higher to the result reported by (Etemad and Maziah , 2012), who detected 3.57 alleles per SSR locus, (Hossain *et al.,*2012) detected a mean of 3.8 alleles per locus, in 12 aromatic rice landraces using SSR markers which is lower than our report. Some earlier reports by(Pervaiz *et al.,*2010) and(Rahman *et al.,* 2012), who found 4.4 and 4.18, (average) alleles per locus is also markedly lower than our study. The variability in the number of alleles detected per locus might be due to the use of diverse genotypes and selection of different SSR primers with scorable alleles. The present investigation proves that molecular fingerprinting using SSR markers is a proficient tool for genotyping rice varieties with high accuracy.

Nevertheless, in order to identify genetically distinct characters, such as high yielding, stress resistances traits (biotic and abiotic) that could be exploited for further breeding experiments. A good elucidation of the dendrogram is imperative. Selecting parents from heterotic groups will not only fetch out latent agronomic traits but also will enrich and broaden the genetic base for better adaptability. for instance a cross between Faro 21 an out-group in the clusters having the shortest duration on the field (90 days) and short grained could be bred with Faro 10 belonging to another cluster (heterotic group) long grained and drought resistant. Also Faro 25 a high yielding highly palatable aromatic variety that is also drought resistant from a different group could be hybridize with Faro 10 from another cluster having similar traits of resistance for better adaptability. Experiment could be inferred depending on needs by looking at the varies clusters, for better yield results, resistant to drought, pest and diseases and for adaptability

The utilization of 13 SSR markers in the analysis of Faro lines rice varieties revealed a high level of genetic polymorphism which could be exploited for a number of breeding programme develop through hybridization s. Such a permutations and recombination in breeding will not only enhanced the level of local adaptability but also broaden the genetic base. The study has successfully track some genetically distinct traits which allow us to differentiate and group these genotypes into clusters which enable the breeder a wide range of choices.

The genetic fingerprinting database of Faro lines varieties generated in this work can be expended to cover more varieties using the same set of primers as the number of varieties increases. Utilization of heterosis between major clusters and sub clusters is currently one of the main ways in rice variety improvement. Faro line rice germplasms has a narrow range of genetic diversity which has significantly lessened its improvement from its parental genotypes. The alternate strategy of transferring desirable genes from local accessions by conventional breeding methods has not been very successful because of progenies associated with high sterility, poor plant type, and linkage drag (Zhu *et al.,*2012 ;Yan, *et al.,* 2017) consequently, a cost effective genotype identification of breeding materials with high fidelity and discrimination, is extremely important in rice improvement. Molecular markers are critical tools in the evaluation of genetic variation, in the exposition of genetic relationships in and between species and have demonstrated the potential to detect genetic diversity for an efficient management of plant genetic resources (Reddy, *et al.*, 2002: Virk *et al.* 2000) (Song, *et al.* 2016) and (Teixeira, 2005) Biotechnological techniques evaluate genetic variation much better at genotypic levels.

It has been established that more than 85 % of genetic diversity potential is yet to be exploited (Pandey and Kumar, 2015), that means there is huge among of priceless allele variations and agronomic traits of great significance that are unutilized. Genetic diversity among populations of diverse crop plants is vital for the management and development of agricultural resources (Salgotra, *et al.* 2015: Pandey and Kumar, 2015). consequently, identification of distinct allele among is genotype and their inter-relationship is vital for future crop improvement.

CONCLUSION

Characterization of the fingerprint of 27 FARO line rice genotypes was achieved. A total of 81 alleles were detected across the 13 SSR loci with an average of 6.75 per locus. Genetic variation and diversity among the 27 FARO rice genotypes was determined and revealed that average variation was present among the studied varieties. The Polymorphic Information content (PIC) values revealed that RM400 is the best marker for identification and diversity estimation of rice varieties PIC values ranged from 0.31 to 0.84, with an average of 0.500. Genetic relationship among the genotypes revealed seven clusters with a dissimilarity coefficient of 0.38. The study has successfully tracked some genetically distinct traits and allows us to group them into several hetorotic clusters for future hybridization experiments.

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APPENDIX

The gel images of amplified fragment using primer selected for the SSR marker RM400 and RM340 are shown in Figures
below

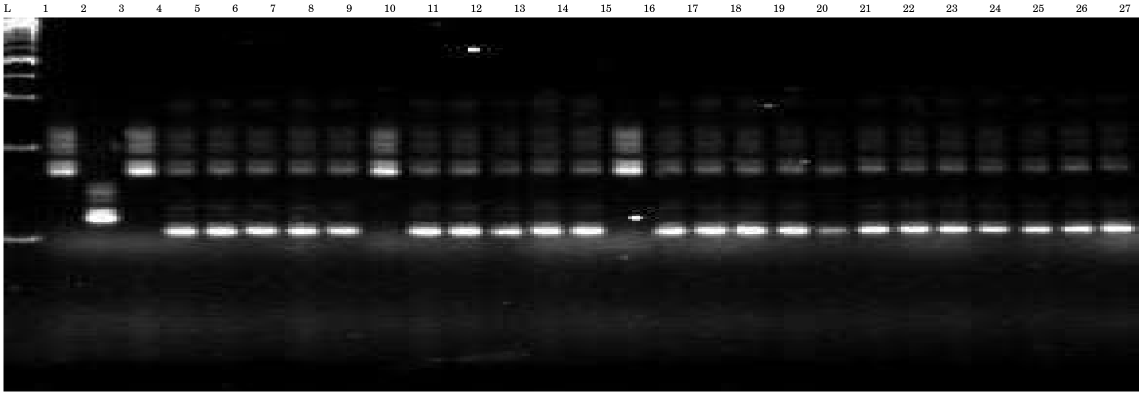

Figure 1 : Electropherogram profiles of molecular marker (RM225). Identified in 27 Faro lines

Electropherogram profiles of molecular marker (RM225). Identified in 27 Faro lines rice varieties and DL 500. (DNA molecular ladder). The numbers of lanes 1 to 27 correspond to the rice varieties studied

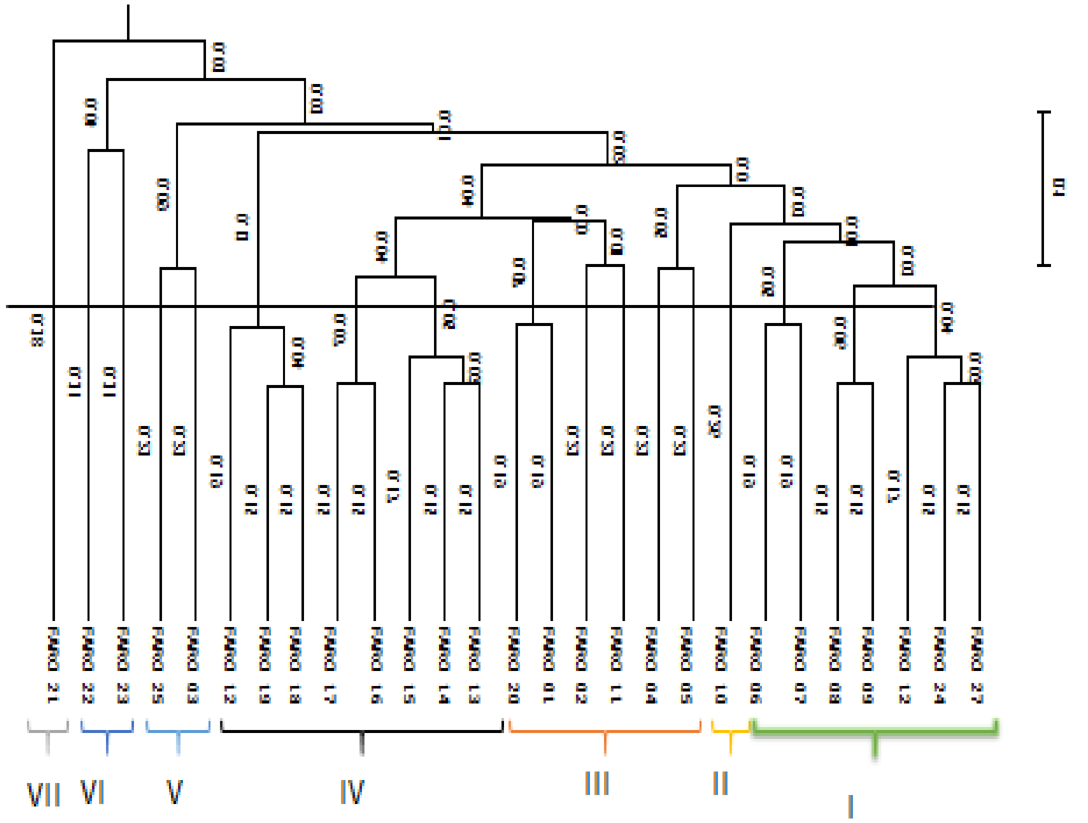

Figure 3: An UPGMA cluster dendogram showing the genetic relationship among 27 rice Faro varieties.

Table 1: Most informative markers

marker name	Forward/Reverse primers	Repeat_motif	Repeat	Anneal T ^{0}C	Product size
RM224	ATCGATCGATCTTCACGAGG TGCTATAAAAGGCATTCGGG	(AAG)8(AG)13	Tri	55	157
RM225	TGCCCATATGGTCTGGATG GAAAGTGGATCAGGAAGGC	(CT)18	Di	55	140
RM523	AAGGCATTGCAGCTAGAAGC	(TC)14	Di	55	148
RM463	TTCCCCTCCTTTTATGGTGC TGTTCTCCTCAGTCACTGCG	(TTAT)5	Tetra	55	192
RM304	TCAAACCGGCACATATAAGAC GATAGGGAGCTGAAGGAGATG	(GT)2(AT)10(GT)33	Di	55	160
RM400	ACACCAGGCTACCCAAACTC CGGAGAGATCTGACATGTGG	(ATA)63	Tri	55	321
RM340	GGTAAATGGACAATCCTATGGC GACAAATATAAGGGCAGTGTGC	(CTT)8T3(CTT)14	Tri	55	163
RM341	CAAGAAACCTCAATCCGAGC CTCCTCCCGATCCCAATC	(CTT)20	Tri	55	172
RM228	CTGGCCATTAGTCCTTGG GCTTGCGGCTCTGCTTAC	(CA)6(GA)36	Di	55	154
RM229	CACTCACACGAACGACTGAC CGCAGGTTCTTGTGAAATGT	(TC)11(CT)5C3(CT)5	Di	55	116
RM244	CCGACTGTTCGTCCTTATCA CTGCTCTCGGGTGAACGT	(CT)4(CG)3C(CT)6	Di	55	163
RM251	GAATGGCAATGGCGCTAG ATGCGGTTCAAGATTCGATC	(CT)29	Di	55	147
RM256	GACAGGGAGTGATTGAAGGC GTTGATTTCGCCAAGGGC	(CT)21	Di	55	127

Table 2: pedigree, duration of maturation and ecology of the rice varieties used in the study

Variety	Ecology	Year of Release	Growth Duration	Grain Type	Variety	Ecology	Year of Release	Growth Duration	Grain Type
FARO 1	SS	1954	135-174	B	FARO 15	SS	1974	145-160	B
FARO 2	SS	1958	135-176	B	FARO 16	SS	1974	140-160	B
FARO 3	UPLAND	1958	95-120	B	FARO 17	SS	1974	145-160	B
FARO 4	SS	1959	189-220	B	FARO 18	DS	1974	167-179	B
FARO 5	SS	1960	135-154	B	FARO 19	DS	1974	135-140	B
FARO 6	SS	1961	176-198	A	FARO 20	SS	1974	125-130	B
FARO 7	SS	1962	160-217	A	FARO 21	IS & SS	1974	90-110	C
FARO 8	SS	1963	155-160	A	FARO 22	IS & SS	1974	145-150	B
FARO 9	SS	1963	189-220	A	FARO 23	IS & SS	1974	145-150	B
FARO 10	UPLAND	1963	115-145	A	FARO 24	IS & SS	1974	135-145	A
FARO 11	SS	1966	115-120	B	FARO 25	Upland	1976	115-120	B
FARO 12	DS	1969	145-155	B	FARO 26	IS & SS	1982	130-135	B
FARO 13	SS	1970	135-140	B	FARO 27	IS & SS	1982	110-115	A
FARO 14	SS	1971	170-198	B					

SS = Shallow swamp; A = Long grain type; DS = Deep swamp; B = Medium grain type; IS = Irrigated swamp; C = short grain type.

Table 3: Number of alleles, major allele frequency, gene diversity, polymorphism information content (PIC) of markers among 27 rice genotypes for 13 SSR markers

Marker	Total Allele No	Frequent allele	Major Allele Count.	Major. Allele Freq	Rare Allele	Size /bp	PIC
RM225	4	3	20	0.63	1	157	0.40
RM228	7	2	16	0.48	5	140	0.55
RM251	6	3	8	0.22	3	148	0.72
RM340	5	2	21	0.67	3	192	0.37
RM341	7	2	16	0.48	5	160	0.59
RM523	5	3	12	0.33	2	321	0.62
RM224	5	2	16	0.48	3	163	0.54
RM229	5	3	14	0.41	2	172	0.62
RM256	6	2	14	0.42	4	154	0.62
RM304	5	1	22	0.72	4	116	0.31
RM463	3	2	18	0.56	1	163	0.42
RM400	20	1	3	0.11	19	147	0.84
RM244	3	3	16	0.29	0	127	0.46
Sum	81	29	196	5.80	52	2160	7.05
Mean	6.23	2.23	28	0.82	7.42	166.15	0.54

Table 4a: DNA fingerprinting of 27 Faro lines by SSR markers.

Genotype	Fingerprint																						
FARO	RM 225	RM 225	RM 225	RM 228	RM 228	RM 228	RM 251	RM 251	RM 251	RM 340	RM 340	RM 340	RM 341	RM 341	RM 341	RM 523	RM 523	RM 523	RM 224	RM 224	RM 224	RM 229	RM 229
FARO 07	0	0	1	1	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	1	0	0	0
FARO 06	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0
FARO 10	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0
FARO 22	0	0	1	1	0	0	0	0	1	0	1	0	1	0	0	?	?	?	0	1	0	0	0
FARO 23	0	0	1	1	0	0	0	0	1	0	?	?	0	0	1	0	1	0	0	1	0	0	1
FARO 27	0	1	0	0	1	1	1	0	0	0	1	0	0	0	1	0	1	0	?	?	0	0	1
FARO 18	1	0	0	1	0	0	1	0	0	1	0	0	?	?	?	0	1	0	0	1	0	0	1
FARO 24	0	0	1	1	0	0	0	1	0	0	0	1	?	?	?	0	1	0	?	0	0	0	1
FARO 25	0	0	1	1	0	0	1	0	0	0	1	0	0	0	1	0	1	0	0	1	0	?	?
FARO 12	1	0	0	1	0	0	1	0	1	1	0	0	0	0	1	0	1	0	0	1	0	0	1
FARO 21	0	0	1	1	0	0	0	0	1	0	1	0	0	0	1	0	1	0	0	1	0	0	0
FARO 03	0	0	1	0	?	0	0	0	0	0	1	0	0	0	1	0	1	0	0	1	0	?	?
FARO 19	1	0	0	0	?	0	1	0	1	0	1	0	0	0	1	0	1	0	1	0	0	0	0
FARO 16	0	0	1	0	?	0	0	0	1	0	1	0	0	1	1	0	1	1	0	1	0	0	0
FARO 17	0	0	1	1	?	0	0	0	1	0	1	0	?	?	?	0	0	1	0	1	0	0	1
FARO 12	0	0	?	1	1	0	0	0	1	0	0	1	1	0	1	0	0	1	?	0	0	0	0
FARO 20	0	0	1	0	0	1	0	0	0	0	1	0	0	1	1	0	0	1	1	1	0	0	0
FARO 13	0	0	1	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	0
FARO 15	0	0	1	0	?	0	1	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	0
FARO 09	0	0	1	0	?	0	0	1	0	0	1	0	0	0	1	0	0	1	0	1	0	0	1
FARO 18	0	0	1	0	?	0	1	0	0	0	1	0	0	1	0	0	0	1	0	1	0	0	1
FARO 05	0	0	?	1	0	0	0	0	1	0	1	0	0	0	1	0	0	1	1	0	0	?	?
FARO 02	0	0	?	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	?	?	0	0	0
FARO 14	0	0	1	1	0	0	1	0	0	?	?	?	0	0	1	?	?	?	1	0	0	0	0
FARO 04	0	0	1	1	0	0	?	0	?	0	1	0	0	0	1	0	0	1	1	0	0	0	0
FARO 01	0	0	1	1	0	0	0	0	1	0	1	0	1	0	1	0	0	1	0	1	0	0	0
FARO 11	0	0	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0

Table4b: DNA fingerprinting of 27 Faro lines of Nigerian rice varieties by SSR markers

Genotype	Fingerprint																					
FARO Lines	RM 229	RM 256	RM 256	RM 256	RM 304	RM 304	RM 304	RM 463	RM 463	RM 463	RM 400	RM 400	RM 400	RM 400	RM 400	RM 400	RM 400	RM 400	RM 400	RM 244	RM 244	RM 244
FARO 07	1	0	0	1	?	?	?	?	?	0	?	?	?	?	?	?	?	0	0	?	?	0
FARO 06	1	?	?	?	0	0	1	1	0	0	0	0	0	1	0	0	?	0	0	?	?	0
FARO 10	1	?	?	?	0	0	1	?	?	0	?	?	?	?	?	?	?	0	0	0	1	0
FARO 22	1	0	1	0	0	0	1	1	0	0	?	?	?	?	?	?	?	0	0	0	1	0
FARO 23	0	0	1	0	0	0	1	1	0	0	0	0	0	1	0	1	1	0	0	0	1	0
FARO 27	0	0	1	1	1	1	0	1	0	0	?	?	?	?	?	0	0	0	0	0	1	0
FARO 18	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0	1	1	1	1	0	1	0
FARO 24	0	0	1	0	0	0	1	?	?	0	0	1	0	1	1	1	0	0	0	1	0	0
FARO 25	?	0	1	0	0	1	0	1	0	0	1	0	0	1	1	1	0	0	0	1	0	0
FARO 12	1	0	1	0	0	0	1	1	0	0	1	0	0	0	0	1	1	1	1	1	0	0
FARO 21	1	0	1	0	0	0	1	1	0	0	1	1	0	1	1	1	1	0	0	1	0	0
FARO 03	?	0	1	0	0	0	1	1	0	0	1	1	0	0	0	1	1	1	1	1	0	0
FARO 19	1	0	1	0	0	0	1	1	0	0	1	1	1	0	1	1	1	0	0	1	0	0
FARO 16	1	0	1	0	0	0	1	1	0	0	0	1	1	0	1	1	1	0	0	?	?	0
FARO 17	1	0	1	0	0	0	1	0	1	0	0	1	1	0	1	1	1	0	0	1	0	0
FARO 12	1	0	1	0	0	0	1	0	1	0	?	?	?	?	?	?	?	?	?	1	0	0
FARO 20	0	0	1	0	0	0	1	1	0	0	1	1	0	0	1	1	1	0	1	1	0	0
FARO 13	0	0	1	0	0	0	1	1	0	0	1	1	0	1	1	1	1	0	0	1	0	0
FARO 15	1	0	1	1	0	0	0	1	0	0	1	1	0	1	1	1	1	0	1	1	0	0
FARO 09	0	0	0	0	1	1	0	?	?	0	1	1	0	1	1	1	1	0	1	1	0	0
FARO 18	0	1	1	0	0	0	1	?	?	0	?	?	?	?	?	?	?	?	?	0	1	0
FARO 05	?	1	1	0	0	0	1	?	?	0	0	1	0	0	0	1	0	0	0	1	0	0
FARO 02	1	1	1	0	0	0	1	1	0	0	1	1	0	1	0	1	0	0	0	1	0	0
FARO 14	1	?	?	?	0	0	1	1	0	0	1	1	0	1	0	1	1	0	0	1	0	0
FARO 04	1	1	1	0	0	0	1	?	?	0	1	0	0	0	0	0	1	1	1	1	0	0
FARO 01	1	1	1	0	0	0	1	1	0	0	1	1	0	1	0	1	0	0	0	1	0	0
FARO 11	1	1	1	0	0	0	1	1	0	0	1	1	0	1	0	1	0	0	1	0	1	0

Table 5a: Similarity coefficient and genetic distance values between 27 Faro rice line varieties.

OUT	FAR O24	FARO 22	FARO 06	FARO 05	FARO 03	FARO 12	FARO 07	FARO 16	FARO 10	FARO 20	FARO 17	FARO 23	FARO 19	FARO 02
FARO24	0.00													
FARO 22	0.69	0.00												
FARO 06	0.85	0.54	0.00											
FARO 05	0.69	0.69	0.77	0.00										
FARO 03	0.62	0.54	0.46	0.62	0.00									
FARO 12	0.62	0.69	0.85	0.62	0.77	0.00								
FARO 07	0.77	0.54	0.46	0.77	0.69	0.92	0.00							
FARO 16	0.77	0.38	0.46	0.77	0.46	0.69	0.62	0.00						
FARO 10	0.69	0.38	0.31	0.62	0.54	0.85	0.31	0.62	0.00					
FARO 20	0.69	0.62	0.62	0.69	0.46	0.69	0.77	0.54	0.69	0.00				
FARO 17	0.62	0.54	0.69	0.62	0.54	0.54	0.77	0.46	0.69	0.54	0.00			
FARO 23	0.54	0.38	0.62	0.69	0.46	0.77	0.77	0.54	0.54	0.69	0.62	0.00		
FARO 19	0.69	0.62	0.62	0.62	0.38	0.69	0.85	0.54	0.69	0.62	0.69	0.62	0.00	
FARO 02	0.77	0.62	0.62	0.38	0.62	0.62	0.77	0.69	0.62	0.62	0.69	0.69	0.54	0.00
FARO 13	0.62	0.54	0.62	0.46	0.46	0.69	0.77	0.62	0.62	0.38	0.54	0.54	0.46	0.38
FARO 04	0.62	0.62	0.62	0.31	0.62	0.69	0.62	0.69	0.46	0.62	0.62	0.69	0.54	0.38
FARO 09	0.62	0.77	0.69	0.62	0.54	0.85	0.69	0.69	0.62	0.69	0.62	0.69	0.69	0.69
FARO 18	0.69	0.62	0.69	0.62	0.62	0.77	0.62	0.62	0.54	0.69	0.62	0.62	0.77	0.62
FARO 14	0.69	0.54	0.54	0.62	0.62	0.77	0.77	0.69	0.54	0.69	0.77	0.62	0.54	0.46
FARO 15	0.85	0.69	0.62	0.62	0.54	0.77	0.77	0.62	0.69	0.62	0.69	0.77	0.46	0.46
FARO 21	0.54	0.31	0.46	0.54	0.31	0.62	0.62	0.38	0.46	0.54	0.46	0.31	0.38	0.46
FAR0 27	0.85	0.77	0.77	0.85	0.69	0.95	0.92	0.85	0.77	0.85	0.92	0.62	0.69	0.62
FARO 01	0.69	0.38	0.54	0.46	0.54	0.54	0.62	0.46	0.54	0.54	0.46	0.54	0.62	0.31
FARO 11	0.77	0.38	0.54	0.62	0.62	0.77	0.62	0.54	0.46	0.62	0.62	0.54	0.69	0.38
FARO 12	0.62	0.62	0.69	0.69	0.46	0.77	0.85	0.69	0.69	0.69	0.62	0.46	0.38	0.62
FARO 18	0.54	0.54	0.77	0.85	0.62	0.85	0.85	0.69	0.69	0.77	0.69	0.38	0.62	0.69
FARO 25	0.62	0.54	0.62	0.62	0.31	0.85	0.69	0.62	0.62	0.62	0.62	0.46	0.54	0.54

Table 5b: Similarity coefficient and genetic distance values between 27 Faro rice line varieties

OUT	FARO 13	FARO 04	FARO 09	FARO 18	FARO 14	FARO 15	FARO 21	FAR0 27	FARO 01	FARO 11	FARO 12	FARO 18	FARO 25
FARO 13	0.00												
FARO 04	0.38	0.00											
FARO 09	0.62	0.54	0.00										
FARO 18	0.62	0.54	0.46	0.00									
FARO 14	0.38	0.46	0.77	0.77	0.00								
FARO 15	0.38	0.46	0.46	0.62	0.46	0.00							
FARO 21	0.31	0.46	0.62	0.69	0.46	0.54	0.00						
FAR0 27	0.69	0.85	0.69	0.69	0.77	0.62	0.69	0.00					
FARO 01	0.46	0.38	0.62	0.54	0.54	0.54	0.31	0.85	0.00				
FARO 11	0.46	0.46	0.69	0.38	0.54	0.54	0.46	0.69	0.31	0.00			
FARO 12	0.54	0.69	0.77	0.85	0.62	0.77	0.38	0.77	0.62	0.69	0.00		
FARO 18	0.62	0.85	0.85	0.62	0.69	0.85	0.54	0.62	0.69	0.54	0.38	0.00	
FARO 25	0.38	0.62	0.62	0.69	0.54	0.54	0.31	0.62	0.54	0.54	0.46	0.54	0.00

Efficient Method of Culture Initiation for In-Vitro Propagation of *Moringa oleifera* Lam.

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ABSTRACT
Moringa oleifera Lam. is one of the tree species commonly used to checkmate desert encroachment in Nigeria. This experiment was conducted to establish an efficient method of its in-vitro culture initiation for mass production. The treatments were A (deionized distilled water), B (100 % Murashige and Skoog (MS)), C (50 % Murashige and Skoog (MS)), D (100 % Preece) and E (50 % Preece), consisted of 10 replications and laid out in completely randomized design. At 4 days after inoculation (DAI), 100 % radicle emergence was observed across the media except E with 70 %. At 7 DAI, 90 % shoot emergence was obtained in medium A > C and D (80 % each) > E (70 %) and B (20 %). At the same period, medium A had significantly ($p \leq 0.05$) longest shoot length (5.35) compared with E (3.34), C (3.12), D (2.34) and B (0.60). Similarly, medium A had significantly ($p \leq 0.05$) longer mean root lengths (4.32) than B (1.92) but comparable to C (4.09), E (3.84) and D (2.94). At 10 DAI, the average number of adventitious roots obtained from C (24.80), A (20.80), B (15.90), E (15.50) and D (12.20) showed no significant difference. From these results, M. oleifera culture was more favorably initiated and efficiently propagated in-vitro using gelled deionized distilled water under 7 days than other media used.
Keywords: Culture initiation; Deionized distilled water; Inoculation; Radicle emergence;

INTRODUCTION
Moringa oleifera of the family Moringaceae is a multipurpose tropical tree known for its numerous uses in industries, agriculture, medicine and animal feeding (Mekonnen, 2016; Tej and Tripathi, 2017). It is a fast growing, drought resistant tree species indigenous to Asia, naturalized and widely cultivated in Africa where it is rated among the most valuable economical trees (FAO, 2014). The species is majorly cultivated for its seed pods and leaves which are being used as vegetables as well as for traditional herbal medicine (Kalibbala *et al.*, 2009 and Mpagi *et al.,* 2012).

The recent advancement in world population has given rise to higher demand for food, shelter and fuel (David *et al*. 2010). These results into many forest areas been indiscriminately deforested to meet man's needs at a rate that has greatly reduced the vegetation cover. Deforestation affects soils, putting it under increasing pressure of soil erosion with dramatic consequence on food production and biodiversity loss. This situation calls for reforestation in order to restore degraded land, conserved the soil cover and forest products while sustaining ecological balanced (Jha and Kamaljit, 2006).

The uses and adaptability of *M. oleifera* to both humid and dry climate demonstrated its suitability for afforestation project in Nigeria. Nevertheless, the propagation of the species by seeds which causes its slow growth and multiplication is a limitation (Avila-Trevino *et al.*, 2017). Traditionally, some of useful forest trees can be propagated by layering, grafting and cuttings (Surendran *et al.*, 2000). Only a small quantity of plants can be produced by these means and it takes several years before enough stocks can be planted on the field. Moreover, the development of improved varieties especially in genotype evolution for disease resistance, drought and chemical tolerance, and increase rate of growth may require several years to achieve. Similarly, obtaining the hybrid of desired interest and to even propagate such may be difficult due to long life cycle of forest trees species (Manoj *et al.,* 2011 and Waghmare *et al.,* 2017). In addition, storage of seeds for a longer period of time could results into non uniform germination while germplasm preservation may be difficult (Sujata, 2013).

Alternatively, *M. oleifera* can be propagated in lesser time and in greater number through plant tissue culture. This techniques has been discovered and developed in recent years to solve the challenges being encountered by the traditional methods of propagation. It is the efficient method of mass clonal propagation of forest trees where shorter multiplication cycle can be achieved throughout the year regardless of the season and germplasm can be stored for many years later to be propagated into complete plants. (Mukund *et al.,* 2012). Notably, plant tissue culture stages include culture initiation, shoot induction and multiplication, root induction and acclimatization (Mahipal *et al.*, 2015). The positive or negative results obtained in tissue culture technology depends on the technique involves at the initiation stage. These consist of choice of explants, media used and how it is prepared (Robert, 2000). Therefore, for successful *in vitro* propagation of Moringa to be achieved, clean culture has to be initiated to provide bases for subsequent steps. While the culture of the species have been initiated through explants such as shoot and nodal cuttings from the wild (James, 2004), this study sought to establish the suitability of using seeds as explant source on different media.

MATERIALS AND METHOD

The experiment was conducted at the plant tissue culture laboratory of Biotechnology Section, Bioscience Department, Forestry Research Institute of Nigeria (FRIN), Jericho Hill, Ibadan, Nigeria. The Institute is located on the longitude 07°23'18″ N to 07°23'43″N and latitude 03°51'20″E to 03°23'43″E (FRIN, 2018).

Treatments and Experimental design

The experiment comprised deionized distilled water and two media at Full and half strength of their basal salts. These added up to five treatments with ten replications and laid out in completely randomised design. Full and half strength of each media were prepared following standard procedures (Murashige and Skoog, 1962; Preece *et al*., 1989). The pH of the media and that of deionised water were adjusted to 5.8, gelled with 4 g of agar, homogenized and dispensed at 20 ml per tube. The tubes were sterilized at 121 °C for 15 minutes.

Explant collection

Freshly collected matured and dried pods of *Moringa oleifera* were collected from tree improvement section of Sustainable Management Department in FRIN. Seeds extracted from the pod were de-coated and subjected to surface sterilization. The seeds were soaked in 70 % Ethanol for seven minutes, rinsed three times with Distilled water and washed in 10 % hypochlorite plus two drops of Tween 20 for 15 minutes and finally rinsed with distilled water for four times. The seeds were blotted on sterilized petril dish laid with filter paper and were inoculated at one seed per tube. The tubes were sealed with parafilm and placed in the growth room at 20±2 °C and 16/8 hours light/dark photoperiod.

Data collection and Analysis

Data collected include percentage radicle and shoot emergence at four and seven Days respectively after inoculation (DAI) while shoot length, root length and number of adventitious roots were assessed at seven and ten DAI. Data collected at four DAI were presented descriptively while others were subjected to Analysis of variance and significantly different means separated using LSD at $p \leq 0.05$.

RESULTS AND DISCUSSION

Radicle and Shoot emergence

Figure 1. showed the results of percentage radicle emergence of *M. oleifera* seeds at 4 days after inoculation (DAI) where treatment A (Deionized distilled water + Agar), C (MS 50 % basal salts), D (Preece hybrid 100 % basal salts) and E (Preece hybrid 50 % basal salts) gave 100% germination while treatment B gave the least (70%). This result showed that the use of deionized distilled water was as good as other media containing essential plant nutrients except MS with 100 % basal salts. The slow rate of radicle emergence obtained in the later could be due to high concentration of media salts contained compared with others. Radicle emergence is a test of seed vigor (ISTA, 2017). The observed early and high rate of radicle emergence from all the medium considered is an indication that all the seeds inoculated were viable and of good quality. This report is in agreement with Serap and Bengi (2009) who reported that radicle emergence is an indicator for the evaluation of germination of *Centaurea zeybekii*.

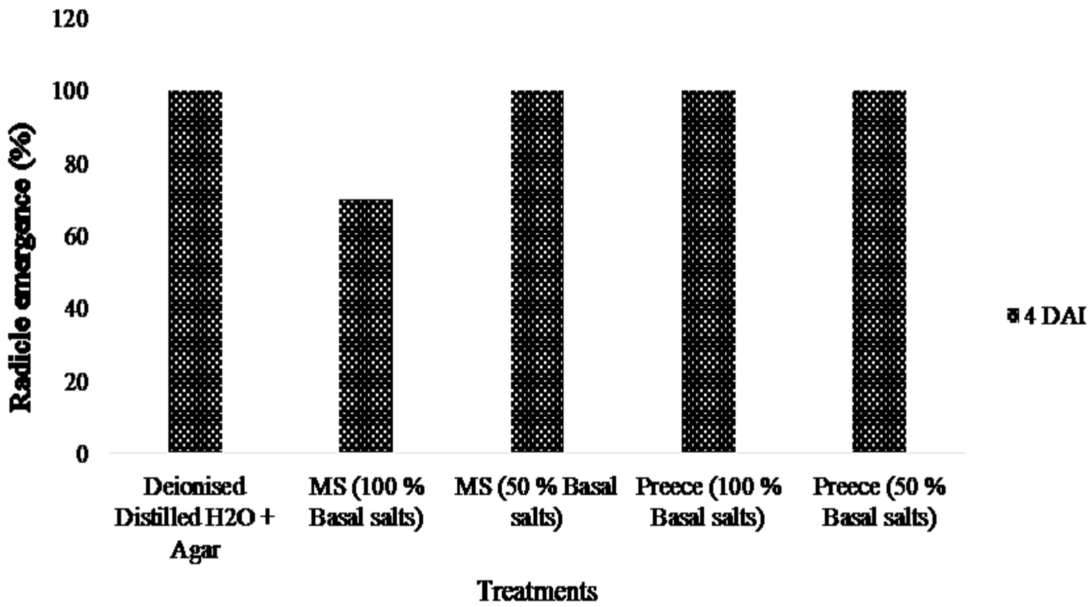

Figure 1. Percentage radicle emergence of *Moringa oleifera* seeds from different media at 4 days after inoculation (DAI) *in-vitro*

The results of shoot emergence of the species at 7 DAI is presented in Figure 2 and Plate 1 A-E. It was observed that Treatment A (Deionized distilled water) gave the highest percentage shoot emergence (90 %) while C (50 % MS Basal salts) and D (100 % Preece hybrid basal salt) had 80 % each. These were closely followed by E (50 % Preece hybrid basal salt) with 70 % while medium B (100 % MS basal salt) gave the least (20 %). The higher emergence of shoot observed in seeds inoculated on deionized distilled water could be due to the availability of water with no or less solutes. The internal water potential of a plant cell is more negative than that of pure water, this might have caused better movement of water into the seeds through the radicle thereby causing early shoot emergence from the medium. The obtained early germination results at 7 DAI from this experiment is an improvement over the findings of Afolabi *et al*., (2018) who observed highest germination percentage from Preece hybrid (100 % basal salt) medium.

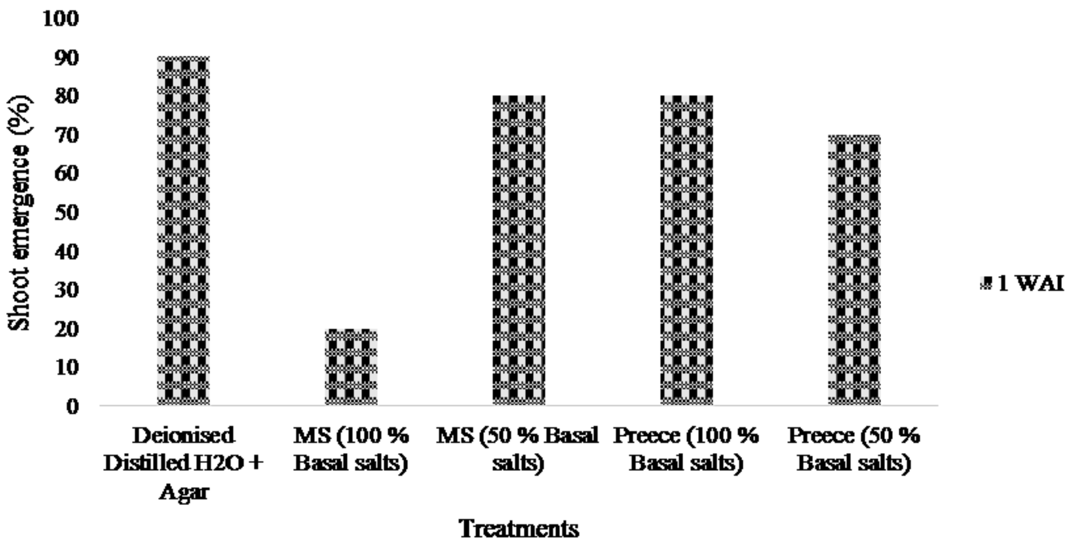

Figure 2. Percentage shoot emergence of *Moringa oleifera* seeds from different media at 7 days after in-vitro inoculation

Shoot length (cm)

Observation on shoot length of the species at 7 DAI revealed that there was significant difference ($p \leq 0.05$) among the treatment means (Table 1 and plate 1 A-E). Plantlet in treatment A has the longest shoot length (5.35) compared with others. Treatment E (3.34) and C (3.12) were similar to D (2.34) but higher than B (0.60). The results at 10 DAI showed that there was no significant difference ($p > 0.05$) between the means of shoot length. Nonetheless, the longest mean shoot length of 10.30 was obtained in medium C followed by E (9.26), A (9.09), D (8.58) and B with the least (5.77) (Table 1 and plate 2 A-E).

Root length (cm)

The results of root length showed that there was significant difference ($p \leq 0.05$) among the treatment means at 7 DAI. Medium A which produced the longest mean root lengths of 4.32 was significantly higher than treatment B (1.92) and comparable to C (4.09) followed by E (3.84) and D (2.94) (Table 3.1 and plate 3.1 A-E). Conversely, the result at 10 DAI indicated there was no significant difference ($p > 0.05$) between the treatments. As such, longest mean root length (5.86) was obtained from treatment E followed by C (5.60), D (5.52), A (5.24) and B with the least (5.03) (Table 1 and Plate 2 A-E).

Number of Adventitious root

Table 1 and Plate 2 A-E showed the number of adventitious roots of the species at 10 DAI. Analysis revealed that there was no significant difference ($p > 0.05$) among treatments. The highest average number of adventitious roots was obtained from treatment C (24.80) followed by A (20.80), B (15.90), E (15.50) and D with the least (12.20).

Table 1: Growth of *M. oleifera* seeds inoculated on different media at 10 DAI

Code	Treatments/media	Shoot length (cm)		Root length (cm)		Number of Adventitious roots
		7DAI	10DAI	7DAI	10DAI	
A	Deionised distilled water	5.35	9.09	4.32	5.24	20.8
B	MS (100 % basal salts)	0.6	5.77	1.92	5.03	15.9
C	MS (50 % basal salts)	3.12	10.3	4.092	5.6	24.8
D	Preece hybrid (100 % basal salts)	2.34	8.58	2.94	5.52	12.2
E	Preece hybrid (50 % basal salts)	3.336	9.26	3.84	5.86	15.5
	LSD @ (P≤0.05)	1.89*	3.48	1.39*	1.53	10.38

DAI: days after inoculation; * means different is significant at (p≤0.05)

The observed higher germination and growth of *in-vitro* propagated Moringa seeds at 4 to 7 Days from deionized distilled water medium showed that the seeds could made use of its endosperm nutrients and does not require additional source of nutrient such as being considered. This result underscored the report of Dawei *et al*., (2014) on the functions of the endosperm during seed germination. On the other hand, the similarity observed among the media in their support at 10 DAI could be due to the growth of adventitious roots. At day 7, the adventitious roots had just started coming out which limit the use of nutrients to that contained in the seeds. However, at 10 DAI, the availability of adventitious roots coupled with additional nutrient in other media would have aided optimal nutrient uptake and development which brought about similarity in the growth attributes of the plantlets at the stage. This result is in an accordance with the report of Bianka and Amanda (2016) on the physiology of adventitious roots. At day 10, the observed longest shoot length, highest adventitious roots and second longest root length from MS 50 % basal medium is an indication that the plantlets would performed well when sub-cultured to the medium.

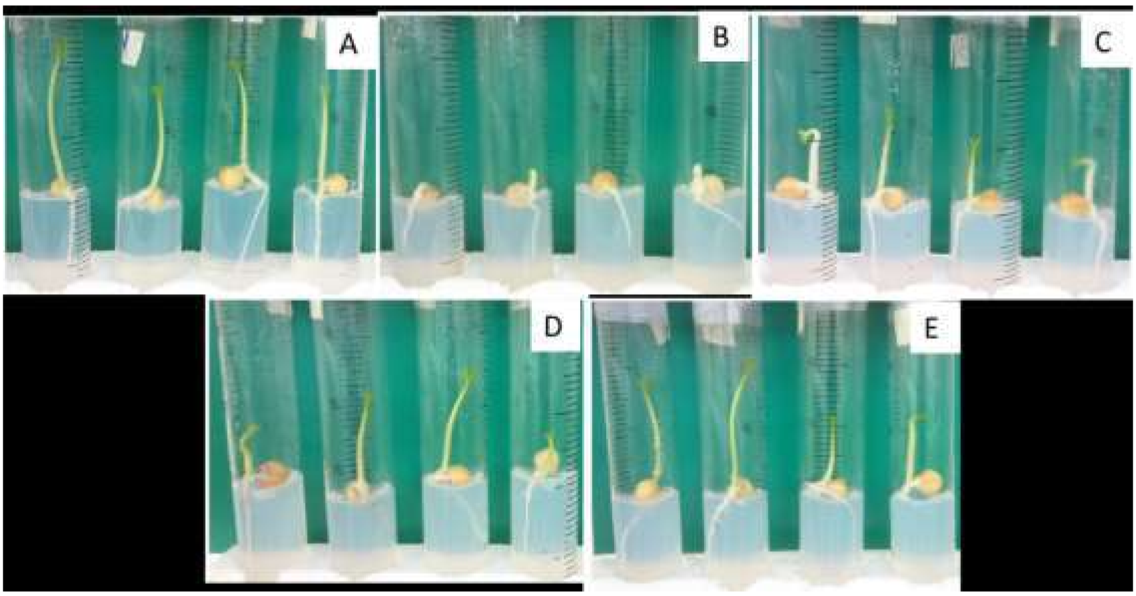

Plate 1. The growth of *Moringa oleifera* seeds on different media at 7 days after inoculation

A: Deionized distilled water and Agar; B: MS (100 % basal salts) medium; C: MS (50 % basal salts) medium; D: Preece hybrid (100 % basal salts) medium; and E: Preece hybrid (50 % basal salts)

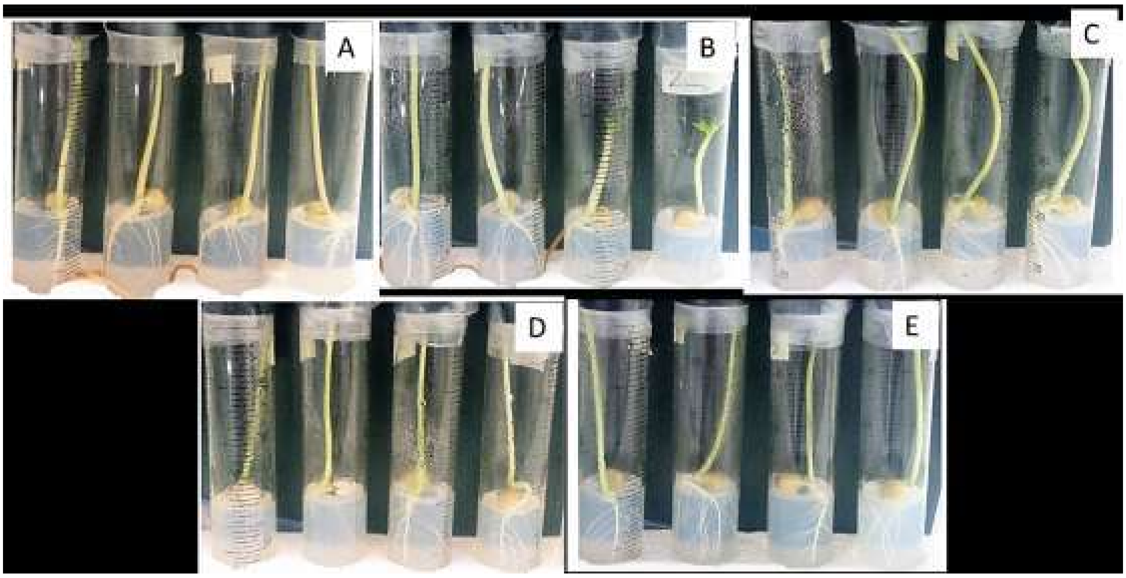

Plate 2. Growth of *Moringa oleifera* seeds at 10 DAI
A: Deionized distilled water and Agar; B: MS (100 % basal salts) medium; C: MS (50 % basal salts) medium; D: Preece hybrid (100 % basal salts) medium; and E: Preece hybrid (50 % basal salts)

CONCLUSION

The results of this study provided a basis and serve as an indication that the *in vitro* propagation of *M. oleifera* plant using seeds as explant is more favorably and efficiently supported by gelled deionized distilled water medium in less than seven days and therefore recommended for use in order to eliminate the use of costly nutrient media for culture initiation of the species.

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A Review of Bioethanol Production from the Lignocellulosic Biomass of Agro-Residues

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ABSTRACT
The conventional fossil fuels constantly polluting our environment and are non-sustainable are falling out of pecking orders. An ecofriendly alternative is our best bet to cater for the ever-increasing demand for energy as the human population and industrial activities increase. Bioethanol derived from renewable sources has proven to be the most promising as the perfect replacement for fossil fuels, as it is environmentally friendly and sustainable. Most of the traditional crops used in bio-ethanol production primarily serve as food and feed for humans and livestock, respectively, and cannot sustain the demand for global bio-ethanol production. For this reason, agricultural residues which contain cellulosic materials are employed as feedstock in bio-ethanol production, because abundant biomass is present in them. This review attempts to explain an eco-friendly and cheap alternative pretreatment method of lignocellulosic biomass engaged in the production of second-generation bio-ethanol.
Keywords: Lignocellulosic biomass, Agro-residues, Renewable source, Bioethanol, Sustainable

INTRODUCTION
Energy plays a critical and essential role in achieving industrialization, and this is necessary for economic dominance and independence on the international scene (Bailis, 2011). The world's present economy is highly dependent on various fossil energy including oil, natural gas, and coal which provide 32.6%, 23.7% and 30% of the total world energy consumption, respectively (BP, 2015). Despite the extensive utilization and application of fossil resources, these are non-renewable and will not last forever. There will be depletion in oil, natural gas and coal supplies in about 45, 60, and 120 years, respectively (IEA, 2013).

The level of greenhouse gasses in the earth's atmosphere has drastically increased (Ballesteros *et al*., 2006). In this scenario, renewable sources might serve as an alternative. It is essential to promote sustainable bioenergy production from biomass. Biomass from plant-based materials like wood and wood residue and crops residue, industrial waste, municipal solid waste, sewage, and animal manure can help generate bioenergy. First-generation biofuels can be produced from edible raw materials such as corn and soybeans, meaning that the production of such biofuel competes with the food supply. This has made second-generation biofuel obtained from non-edible sources such as agricultural residue of increasing importance.

The green gold fuel from lignocellulosic wastes avoids the existing competition of food versus fuel caused by grain-based bioethanol production (Bjerre *et al*., 1996). Lignocellulosic materials are renewable, low cost and are abundantly available. Hence bio-ethanol production could be the route to the effective utilization of agricultural wastes. Agricultural residues in terms of quantity of biomass available are rice straw, wheat straw, corn straw, and sugarcane bagasse (Kim and Dale, 2004). This review presents a brief overview of bio-ethanol production using these major agro-residues.

Biomass: Sources and Composition

Biomass, occasionally termed as stored energy, consists of organic and renewable materials mostly from plants and animals that can serve as energy sources. It constitutes carbohydrates and possesses fewer energy storage challenges when compared with renewable sources like wind and solar (Saidur *et al*., 2011). There are three classifications to the raw materials used in bioethanol production, sugars, cellulose and starches. Agro-industries wastes/Agricultural residues, municipal wastes, and energy crops cultivated purposely such as corn, wheat, sugarcane also contain biomass. Biomass from wood varyingly is made up of lignin known as lignocellulosic materials, cellulose and hemicelluloses, proteins, starches, lipids and simple sugars, and are in small quantities (Zhang *et al*., 2010). Table 1 shows the agricultural waste available worldwide with their bio-ethanol potential.

Table 1: Agro-waste biomass amount available for the production of bioethanol (Million Tons) (Khan and Dwivedi, 2013)

Agro-waste	Availability (Million tons)a	Estimated Bio ethanol Potential(GI)[a]
Wheat Straw	354.34	104
Rice Straw	731.3	205
Corn Straw	128.02	58.6
Sugarcane Bagasse	180.73	51.3

[a] Calculated from Sarkar *et al*., (2012)

Bioethanol

From the organic chemistry point of view, Bioethanol (C2H5OH) or ethyl alcohol is an alcohol component that in recent times has surfaced as renewable bioenergy, clear-colourless liquid, biodegradable, eco-friendly capable fuel to drive automotive engines, as well as a, serve a reliable substitute for petrol in road transport vehicles (Hossain & Jalil, 2015b). Most biofuels are from lignocellulosic biomass such as bioethanol, biogas, bio-oil, syngas, etc. Most times, bioethanol is produced from the alcoholic fermentation of sucrose or simple sugars of various biomass types and can include non-feedstock or feedstock sources (Gnansounou and Dauriat, 2005). Bioethanol production takes place through 5 different methods that include simultaneous and saccharification co-fermentation (SSCF), consolidated bioprocessing (CBP), integrated bioprocessing (IBP), separate hydrolysis and fermentation (SHF), and simultaneous saccharification and fermentation (SSF) (Sarkar *et al*., 2012; Jagmann and Philipp 2014). These days, the production of bioethanol from cellulosic and lignocellulosic materials, especially wastes, gives an alternative solution to present economic, environmental and energy challenges confronting the whole world (Srivastava and Agrawal, 2014).

The following steps are involved in the conversion of lignocellulosic biomass to ethanol: hydrolysis of cellulose and hemicellulose to reducing fermentable sugars, fermentation of sugars to ethanol, lignin residue separation, and finally, recovery and purification of ethanol to meet fuel specifications (Fig. 1). The lignocellulosic enzyme helps with hydrolysis, while the fermentation is by bacteria or yeasts (Singla *et al.,* 2011; Maurya *et al*., 2012).

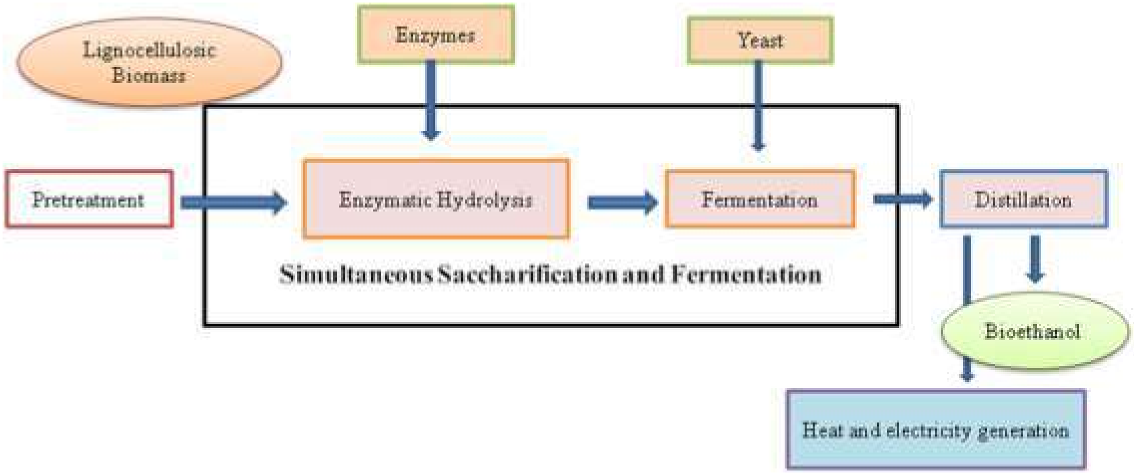

Fig. 1 Biological conversion of lignocellulosic biomass to bioethanol

Biological Pretreatment

An ecofriendly and cheap alternative pretreatment method of lignocellulosic biomass is the biological method. It is more efficient than the traditional physic-chemical methods employed in degrading lignin, which involves high energy inputs and eventually pollutes the environment (Wan and Li, 2012). The pre-treatment of lignocellulosic biomass by biological means most times is achieved using hemicellulolytic and cellulolytic microorganisms. Filamentous fungi, known to be ubiquitous and can be isolated from living plants, soil or lignocellulosic waste material, are the most commonly used microorganisms. (Vats *et al*., 2013). The most efficient microorganisms for the pretreatment of most lignocellulosic materials according to studies are the white fungi (Kumar and Wyman 2009a). White-rot fungi such as *Cyathus stercolerus, Ceriporiopsis subvermispora, Phanerochaete chrysosporium, Ceriporia lacerata, Pleurotus ostreaus, Pycnoporus cinnarbarinus* and *P. Chrysosporium* produce lignin peroxidases which is lignin-degrading enzymes and manganese-dependent peroxidases. Table 2 highlights the various microorganisms required for pretreatment and their resultant effect on different biomasses.

Advantages of the biological pretreatments method include minimal energy requirement, mild environmental conditions, low-capital cost, and no involvement of chemicals. Though this pretreatment method is fascinating, its rate of hydrolysis is too slow, and this major drawback impedes its potential consideration on an industrial scale. (Sun and Cheng, 2002). Further research is required to test and identify additional isolates like the basidiomycetes fungi for their capability to efficiently and rapidly delignify plant biomass.

Table 3: Different biological pre-treatment strategies involved for pre-treatment of lignocellulosic biomass and its advantages (adapted from Sindhu *et al.* 2016)

Microorganism	Biomass	Major effects	References
Irpex lacteus	Corn stalks	82% of hydrolysis yield	Du *et al.,* 2011
P. ostreatus/P. *pulmonarius*	*Eucalyptus grandis* saw dust	20-fold increase in hydrolysis	Castoldi *et al.*, 2014
Fungal consortium	Straw	20-fold increase in hydrolysis	Taha *et al.*, 2015
Punctualaria sp. TUFC 20056	Bamboo culms	50% lignin removal	Suhara *et al.* 2012
P. chrysosporium	Rice husk	2- to 3-fold increase in reducing sugar yield	Potumarthi *et al.*, 2013
Ceriporiopsis subvermispora	Corn stover	2- to 3-fold increase in reducing sugar yield	Wan and Li 2011
Fungal consortium	Plant biomass	Complete elimination of use of hazardous chemicals	Dhiman *et al.*, 2015
Fungal consortium	Corn stover	43.8% lignin removal/sevenfold increase in hydrolysis	Song *et al.*, (2013)
Ceriporiopsis subvermispora	Wheat straw	Minimal cellulose loss	Cianchetta *et al.*, 2014

CONCLUSION

There is an increased interest in bioenergy because of the need to mitigate climate change which has become a concern, hence, increased demand for green and safe energy.

There is considerable progress in potentially eco-friendly biofuel production from agricultural waste, and one of the likely resources for attractive bioethanol production is the lignocellulosic biomass. The sustainable re-use of agro-wastes in biofuel production might have its difficulties but would encourage biotechnological developments. Solving the challenges encountered in the conversion process of lignocellulosic biomass to bioethanol will require innovative and efficient technology if bioethanol production from agro-wastes would be fully optimized and effectively developed as an alternative to conventional fossil fuels.

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Construction of Vectors and Plant Transformation of CRISPR/Cas 9 Knocked Out *KRP 1* and *KRP1/KRP2* Double Mutant Lines

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ABSTRACT
Rice, a cereal crop is one of the most important sources of food for human consumption. In the present study, construction of vectors and rice plant transformation was carried out, using CRISPR/Cas 9. crkrp1/2 and crkrp2 mutant lines were generated in the background of Nipponbare (Oryza sativa). The results showed T0 mutants from different representative lines were employed for detailed phenotypic characterization krp2 single mutants were sequenced with a T insertion at the 1st exon of KRP2 in crkrp2-6, an A insertion at the 1st exon of KRP2 in crkrp2-12, and crkrp1/krp2 showed a T deletion at the 1st exon of KRP1 and a C insertion at the 1st exon of KRP2 in crkrp1/krp2-13, and three bases GTT deletion at the 1st exon of KRP1 and a T insertion at the 1st exon of KRP2 in crkrp1/krp2-20, resulting in premature termination by shifting the open reading frame, though the transcription level of the mutated genes was at the same level as native KRP1 or KRP2 in the wild type.
Keyword: mutant, phenotypic characterization, transcription level, wild type

INTRODUCTION
Rice, a cereal crop is one of the most important sources of food for human consumption. As at 2016, it was estimated to feed about half of the world's population (4 billion people i.e. 56% of the world population) – relied on rice every day (Maclean *et. al*., 2013, Calingacion *et. al*., 2014), more than 3.5 billion people depend on rice for more than 20% of their daily calories. Human consumption in 2009 accounted for 78% of total production for rice. Rice is also an important, model monocrop plant for biological research due to its relatively small diploid genome size, released genome sequence, ample genetic resources as well as the co-linearity with other grasses (Hou *et al*., 2017; Zhang *et al*., 2007; Xu *et al*., 2005; Keller and Feuillet, 2000; Huang *et al*., 2013). The relatively small diploid genome (430 Mb), has a rather short generation time and facilitates efficient Agrobacterium-mediated transformation (Ozawa, 2009). In the present study, construction of vectors and rice plant transformation was carried out, using CRISPR/Cas 9. To cause a detection or insertion in the KRP1 and KRP2 genes, which cause a frameshift in the protein codon thus creating a mutant/ knocked-out gene or protein.

MATERIALS AND METHOD
Using the CRISPR/Cas9 system as previously described (Bello *et al*., 2019). To prepare CRISPR/Cas9/sgRNA constructs, we generated the target-sgRNA expression cassette(s) through targetDesign and/or offTarget are transferred to primerDesign-V, which automatically outputs the primers for preparation of the sgRNA expression cassettes. Overlapping PCR Method described by (Ma et al., 2015) was used and the resultant PCR was annealed to the double-strand oligos of the gDNA sequences and then ligated into the pYLgRNA-OsU3 using BsaI site (Thermo, Waltham, MA). Recombinant plasmids were transformed into the rice variety 'Nipponbare' (*Oryza sativa* L. cv. Nipponbare) callus using the *Agrobacterium*-mediated transformation method.

RESULTS AND DISCUSSION

Generation of *crkrp1* and *crkrp2* knock-out transgenic lines

To further understand the biological roles of KRP1 and KRP2 in rice seed development, we generated *crkrp1/2* and *crkrp2* mutant lines in the background of Nipponbare (*Oryza sativa*) by using CRISPR/Cas9 technique. Sanger sequencing of the CRISPR/Cas9 target sites detected various types of deletion in the different lines, which were believed to knockout the KRP1 and KRP2 in double mutant and KRP2 in the mutant lines were generated, though *krp1* single mutant was not successful. The homozygous T0 mutants from different representative lines were employed for detailed phenotypic characterization *krp2* single mutants were sequenced with a T insertion at the 1st exon of *KRP2* in *crkrp2-6*, an A insertion at the 1st exon of *KRP2* in *crkrp2-12*, and *crkrp1/krp2* showed a T deletion at the 1st exon of *KRP1* and a C insertion at the 1st exon of *KRP2* in *crkrp1/krp2-13*, and three bases GTT deletion at the 1st exon of *KRP1* and a T insertion at the 1st exon of *KRP2* in *crkrp1/krp2-20*, resulting in premature termination by shifting the open reading frame, though the transcription level of the mutated genes were at the same level as native *KRP1* or *KRP2* in the wild type. (Table 1; Figure 1).

To shed more light on the role of KRP1 and KRP2 we downregulated the expression and activity of the genes using CRISPR/cas9 approach, we also downregulated KRP1 with KRP2 in a double mutant to compare the functionality with the overexpressed mutant and also possibly find distinct phenotype associated with the knockout mutant. The likely functional redundancies among the KRP proteins make this part of the work more challenging. However, we were unable to get any successful KRP1 CRISPR/cas9 knockout plant but luckily we got the double mutant knockout and single mutant knockout *krp2* plants

CONCLUSION

The downregulation of KRP1 and KRP2 through deletion and insertion help in understanding the expression and activity of the genes. It also can help to compare the functionality with the overexpressed mutant and also possibly find distinct phenotype associated with the knockout mutant.

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Table.1 Genotyping of *crkrp1* and *crkrp1-krp2* (double mutant) transgenic plants

SAMPLES	KRP1	KRP2
KRP1/KRP2-1	GTT DELETION (HOMO)	T INSERTION (HOMO)
KRP1/KRP2-2	G INSERTIO (HETERO)	G DELETION (HETERO)
KRP1/KRP2-3	G/A INSERTION (HOMO)	C INSERTION(HOMO)
KRP1/KRP2-4	GTT DELETION (HOMO)	A INSERTION(HOMO)
KRP1/KRP2-5	HETERO	A INSERTION (HOMO)
KRP1/KRP2-6		T INSERTION(HOMO)
KRP1/KRP2-12		A INSRETION (HOMO)
KRP1/KRP2-13	HETERO	G INSERTION (HOMO)
KRP1/KRP2-16	HETERO	T INSERTION (HOMO)
KRP1/KRP2-17		C INSERTION (HOMO)
KRP1/KRP2-20	HETERO	A INSRETION (HOMO)
KRP1/KRP2-23		CG DELECTION (HOMO)
KRP1/KRP2-26	HETERO	G INSERTION (HOMO)
KRP1/KRP2-27		T INSERTION (HOMO)
KRP1/KRP2-28	A INSERTION (HOMO)	T INSERTION (HOMO)

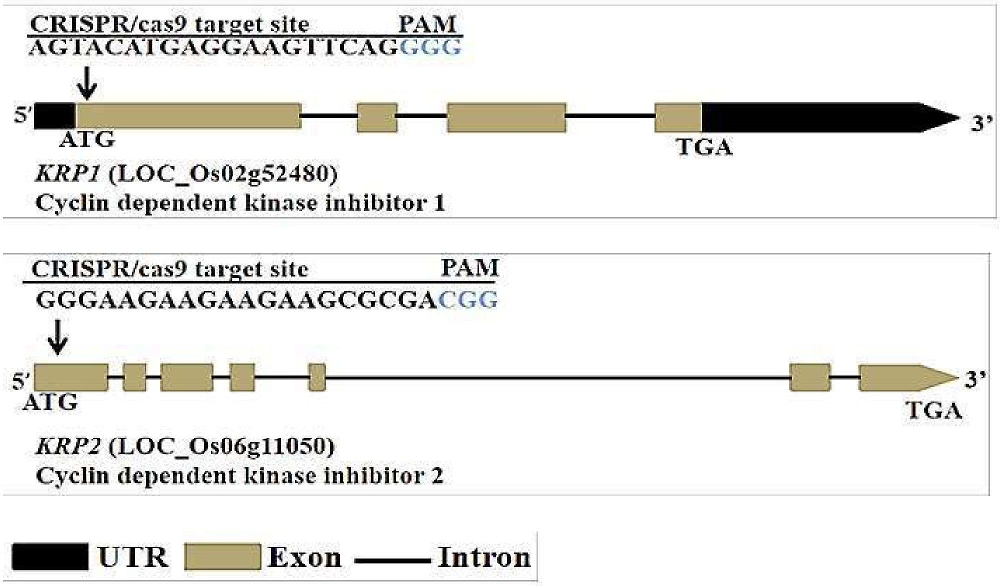

Figure 3.1 Schematic presentations of the KRP1 and KRP2 genes structures. Black box: UTR, brown box: exons; black line: introns.

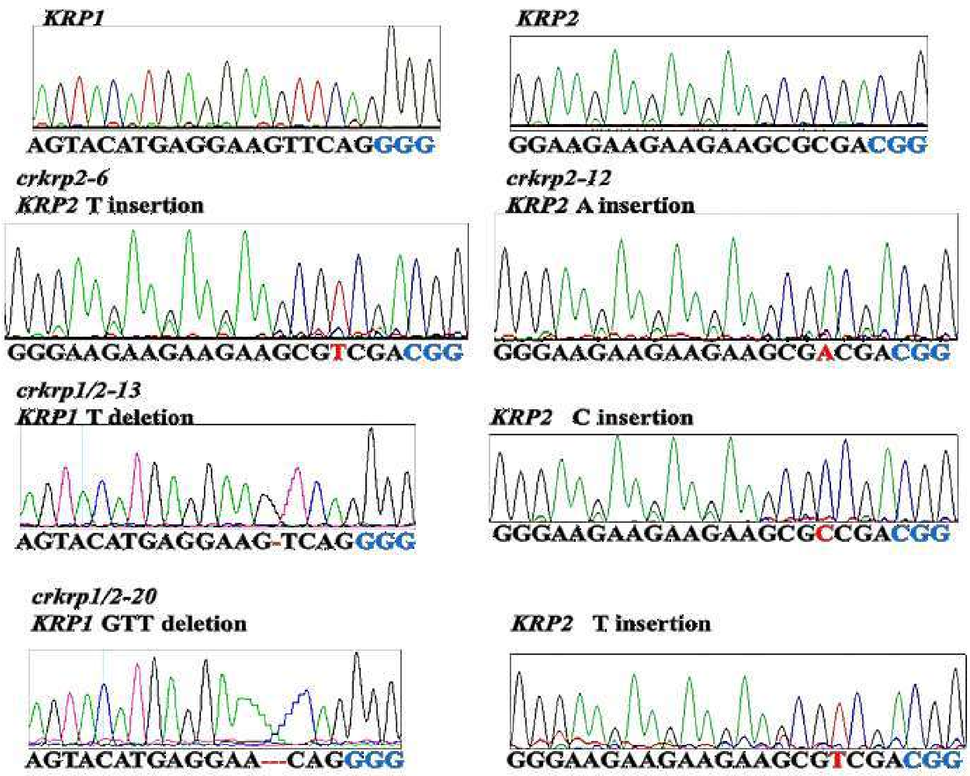

Figure 1 Sanger sequencing of the mutated sites in homozygous mutants of *crkrp1/krp2* (double mutant) and *crkrp 2* (single mutant)

Determination of Subcellular Localization of *Orysa*: *KRP1*

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ABSTRACT
The subcellular localization of KRP1 in rice protoplast was carried out. The full-length coding region of KRP1 without the stop codon was amplified and fused with eGFP in a p35S-GFP vector (nuclear maker). The recombinant proteins, which were marked as 35S: KRP1-GFP and 35S: D53-mKate, were co-transiently expressed in the rice protoplasts and incubated in PEG. The results showed that the rice KRP1 (LOC_Os02g52480) gene fused with GFP protein was co-localized with D53 a nuclear protein. The subcellular localization result showed that Oryza; KRP1 is localized in the nucleus.

INTRODUCTION
Rice is an important, model monocrop plant for biological research due to its relatively small diploid genome size, released genome sequence, ample genetic resources as well as the co-linearity with other grasses (Hou et al., 2017, Zhang et al., 2007, Xu et al., 2005, Keller and Feuillet, 2000, Huang et al., 2013). The relatively small diploid genome (430 Mb), has a rather short generation time and facilitates efficient Agrobacterium-mediated transformation (Ozawa, 2009).

Locating the position of release and action of a particular protein/ enzyme in a multicellular organism is very important to help in elucidating the possible roles and functions of such protein/enzyme. In the nucleus, ICK1/KRP1 has a distinct localization pattern and can be found in at least two subdomains, namely the nucleoplasm and at the chromocenters. Chromocenters are heterochromatic regions, often located around the centromeres. Interestingly, other cell cycle regulators are also present in these regions. Full-length ICK1/KRP1 fused to YFP/eGFP gives rise to an exclusively nuclear fluorescent signal (Ajadi et al., 2020, Weinl et al., 2005). In this experiment, we located the subcellular location of rice KRP1 to the nucleus of rice protoplast by fusing it with a nuclear protein eGFP.

MATERIALS AND METHODS
Rice protoplast was generated from rice genotype *Nipponbare (*Oryza sativa, ssp. japonica*)*. Five (5) grams rice leaf strips in 0.5 mm size were digested in 10 mL enzyme solution (1.5 % cellulose R10, 0.75 % macerozyme R10, 0.6 M mannitol, 10 mM MES pH = 7.5) for 6 h in dark with gentle shaking (40 rpm) at 28°C. The protoplasts were filtered and harvested by centrifugation, then washed with 10 mL ice-cold W5 solution (154 mM NaCl, 125 mM $CaCl_2$, 2 mM KH_2PO_4, 2 mM MES, 5 mM glucose, 500L pH = 5.7) two times, and finally suspended in MMG solution (0.4 M mannitol, 15 mM $MgCl_2$, 4 mM MES, pH = 5.8). The full-length coding region of KRP1 without the stop codon was amplified and fused with eGFP in a p35S-GFP vector (nuclear maker). The recombinant proteins, which were marked as 35S: KRP1-GFP and 35S: D53-mKate (Zhou et al., 2013), were co-transiently expressed in the rice protoplasts and incubated in PEG (0.6 M mannitol, 100 mM CaCl2, 40 % PEG4000) for 30 minutes at room temperature. The GFP signals were detected by observation using a laser confocal microscope (Zeiss LSM 700, Germany).

RESULTS AND DISCUSSION

The results showed that KRP1 (LOC_Os02g52480) gene fused with GFP protein indicating that KRP1 is specifically detected in the nucleus of rice protoplast as it was co-localized with D53 (Figure 1). This showed that KRP1 is a nuclear protein, similar to the results obtained. (Zhou et al., 2013, Yang et al., 2011).

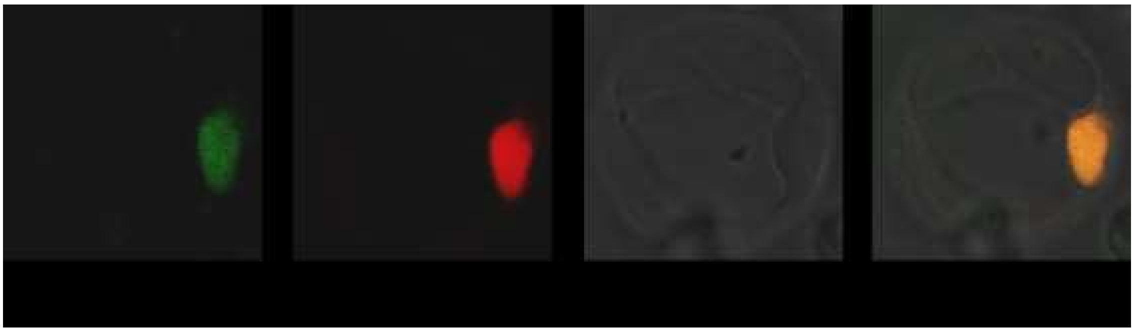

Figure 1 Subcellular localization of KRP1–GFP fusion protein in rice protoplast cells. Scale bars, 5 mm.

The Eukaryotic cells are differentiated into many different subcellular environments, and targeting subcellular is a very important process in the regulation of protein function in plants and animals (Jakoby et al., 2006, Merkle, 2003, Meier, 2005, Pemberton and Paschal, 2005). Also, localization to particular subcellular compartments or cellular regions is important for cell cycle regulators to perform their functions (Pines, 1995, Pines, 1999) thus explaining how the cell cycle regulators interact with each other. The tobacco CDK inhibitors NtKIS1a and NtKIS2 and all seven Arabidopsis KRP inhibitors are localized in the nucleus (Jasinski et al., 2002, Zhou et al., 2003, Zhou et al., 2002, Weinl et al., 2005). The Maize ZmICKs and ZmCDKA are also co-localized in the nucleus of transiently infected tobacco leaves (Xiao et al., 2017). The punctuate pattern of sub-nuclear distribution is determined by the conserved protein motif 'YLQLRSRRL', in which the third residue is variable (Bird et al., 2007, Zhou et al., 2006, Yang et al., 2011). Analyses also have shown that a sequence 'RRGTKRKL' located at residues 80–87 in the central region of ICK1 is a strong nuclear localization signal (NLS) (Zhou et al., 2006). Besides, all Arabidopsis KRPs, have been reported to be localized in the nucleus whether they have NLS or not (Torres Acosta et al., 2011, Bird et al., 2007, Zhou et al., 2006, Wang et al., 2008) and same have been reported for maize ICK/KRPs (Godínez-Palma et al., 2017). Also, Barroco et al. (2006) stated that the sequences of rice KRP1, KRP2, and KRP3 comprise nuclear localization signals (NLS). The EGFP: OsiICK1 (corresponding to KRP1) and EGFP: OsiICK6 (corresponding to KRP4) from Yang et al. (2011) work were localized in the nucleus with little fluorescence present in the cytoplasm, they also observed that while EGFP: OsiICK6 showed a strong punctuate pattern of sub-nuclear distribution in the nucleus, the subnuclear distribution of EGFP: OsiICK1 was much more homogeneous. In this study, we first validated that KRP1 was specifically co-localized in the nucleus with the nuclear marker D53 (Zhou et al., 2013) in rice protoplasts (Figure 1), which strongly implied that that KPR1 could act as a nuclear protein that interacts with the downstream targets to mediate cell proliferation and plant organ development, which is also in consistent with the conserved nuclear localization of plant KRP proteins. Additionally, KRP1 displayed a more homogeneous sub-nuclear punctuate pattern (Figure 1), partly conferred by the conserved sequence 'YLQLRSRML' located in KRP1, a similar phenomenon was also detected in the subcellular localization of *OsiICK1* in the genetic background of *Indica* rice (Yang et al., 2011)

CONCLUSION

The Orysa; KRP1 was co-localized with the nuclear protein D53in the nucleus thus confirming that KPR1 could act as a nuclear protein that interacts during the cell cycle, with the downstream targets to mediate cell proliferation and plant organ development. The realization can be exploited in gene manipulation of the cell cycle in the whole plant to give a better understanding of the gene and also can give rise to better crops

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Rufus Giwa Polytechnic, Owo Ondo State

SUB-THEME 5

Forest Resources, Ecotourism, Wildlife and Environmental Management Issues and Strategies

Hunting Pattern and Techniques used by Hunters in Ido Local Government Area, Oyo State, Nigeria

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ABSTRACT
The study was carried out to examine the hunting pattern and techniques used by hunters in Ido Local Government Area, Oyo State, Nigeria. A well-structured questionnaire was administered to obtain information from fifty hunters using a simple random sampling technique. Data were analyzed using descriptive statistics. The result showed that 96% of hunters in the study area were men. The average age of the respondents was 48years and they were married (84%). They had average of 28 years' experience in animal hunting with an average income of ₦39,025.64/month. The respondents mostly practiced individual hunting (72%), group hunting (56%) and communal hunting (26%) during dry season (82.1%) and mostly engaged in the night (88%). The result of frequency of hunting shows that the respondents preferred to hunt wild animals daily (40%). They largely employed local gun (76%) and traps (64%) as tools for hunting. There should be more enlightenment on wildlife conservation policy.
Keywords: bushmeat, community market, hunters, wildlife

INTRODUCTION
Conservation scientists study hunting to quantify its ecological impacts and contributions to livelihoods, estimate its sustainability, and predict how it might respond to changing economic, environmental, and social conditions (Dobson *et al*., 2019). Hunting constitutes one of the major hurdles for managing the biodiversity crisis in Africa (Wilkie *et al*; 2011). Kumpel *et al*., 2010 highlighted hunting as a main source of protein. Wild meat consumption remains an essential component of indigenous and rural peoples' livelihoods and culture (Bennett & and Robinson, 2000), likewise it is an occasional source of income (Angelsen *et al*., 2014). The numerous uses of faunal resources remainsremain a driving force behind hunting and is one of the most ancient human activities that is still prevalent in our society till date (Smith 1976, Leeuwenberg and Robinson 1999, Alves *et al*., 2019). Akani *et al*., (2015) submitted that wildlife hunting is one of the traditional occupations sustaining the economy of rural people and it is a business driven by great economic importance (Infield 1989, Fa *et al.,* 1995, Fa *et al*., 2003).

Hunting techniques plays a crucial role in the type and size of fauna harvested from the wild. Typically, the carcasses sold in the various markets are obtained from a variety of different hunting techniques (Akani *et al*., 2015). Luiselli *et al*., 2015 and Akani *et al.,* 2015 summed it up that the type of hunting technique utilized by a given community may profoundly influence the type and numbers of carcasses that reach the market place with consequences on the abundance of fauna resources. In the last decades, unsustainable hunting practices have largely increased driven by factors such as access to improved technology (Robinson *et al*., 1999), better road access to previously remote areas (Brodie e*t al*., 2015), and the growth in demand for bushmeat, mostly from the fast expanding African urban centers (Brashares *et al*., 2011) which has risen the monetary incentives for local people to engage in hunting (Robinson *et al*., 1999).

Where hunting is an economic activity, choices about the methods used, mode of hunting and the proportion of an individual's time spent on the activity will be influenced by an array of external factors (Dobson *et al*., 2019). Hence, the main objective of the study is to examine the hunting pattern and techniques used by hunters in Ido local government area, Oyo State, Nigeria.

METHODOLOGY

Study Area

The research was conducted in Ido Local Government Area, Oyo state, Nigeria. The Local Government has an area of 986 square kilometers and lies at latitude 7°30'44.50"N and longitude 3°47'35.00"E. It has an annual rainfall ranges from 100mm to 1800mm and average daily temperature of 24.1ºC and 28ºC. The population of Ido was 103,261 as at 2006 census (NPC, 2006). The target population for this study was hunters.

Sampling Technique and Data Collection

A random sampling technique was adopted to select the respondents for the study. A total of fifty hunters were selected from the list provided by the Hunters Association in the Local government (*Egbe Oluode Ilu Ido*). Primary data were collected through the use of structured questionnaire administered to the respondents complemented with oral interview. Information obtained from the respondents include: socio-economic profile (sex, age, marital status, years and level of education), information on hunting activities (years of experience in hunting, tools, selling prices of animals caught etc.) and challenges encountered.

***Data Analysis*:** Data were analyzed using descriptive statistics. Descriptive statistics (frequency, percentage and mean) were employed to describe socio-economic profile of the respondents and identify the constraints to hunting activities.

RESULTS AND DISCUSSION

Socioeconomic Characteristics of Respondents

Hunting of wild animals in the study area is dominated by male (92%). Hunting is predominantly a male activity in Africia (Ntiamoa-Baidu, 1997). Most of the respondents were married (84%) with average household size of six persons, showing that the respondents were mature and have responsibilities. The average age of the respondents is 48 years, indicating that the respondents were young adults. Seventy-four percent of the respondents had formal education with average hunting experience of 28 years. This is an indication that the respondents have been longadequate experinece in animal hunting. High percentage of formal education shows that the respondents are literate and can understand the policy on wildlife conservation if enlightened. The average income from hunting is ₦39,025.64 (Table 1).

Table 1: Socio-economic characteristics of hunters in the study area

Variable	Value
% Male	92.0
Age (years)	48.0 ± 17.0
% Married	84.0
% Formal education	76.0
Average household size	6.0 ± 3.0
Average years of experience in hunting	28.0 ± 15.0
Average monthly income (₦)	39,025.64 ± 19362.86

Source: Field survey, 2019.

Forms and preferred period of hunting by hunters in the study area

In table 2, the hunters mostly practiced individual hunting (72%) and group hunting (56%). This indicates that the hunters in the study area have multiple hunting strategies. On the basis of preferred seasons, the hunters enjoyed dry season (82.1%) and night hunting (88%). They claimed it is easier for them to sight games during dry season than rainy season. This agrees with the findings of Okiwelu, *et al* (2009); Okorafor *et al*, (2013); Anadu, *et al* (1988) who reported a high prevalence of wild animals during dry season. The result of frequency of hunting shows that the respondents preferred to hunt daily (40%) followed by weekly (32%) and the least being (4%).

Table 2: Forms and preferred period of hunting by hunters in the study area

[a]Forms of hunting	Frequency	Percentage
Individual	36	72.0
Group	28	56.0
Communal	13	26.0
Preferred Season of the year for hunting		
Rainy season	1	2.0
Dry season	41	82.0
Both dry and rainy season	8	16.0
[a]Preferred time of the day for hunting	**Yes**	**No**
Daytime	17(34.0)	33(66.0)
Night	44(88.0)	6(12.0)
Frequency of hunting	**Frequency**	**Percentage**
Daily	20	40.0
Weekly	16	32.0
Fortnightly	2	4.0
No response	12	24.0

Source: Field survey, 2019. [a] Multiple response allowed. The values in parentheses are percentages.

Hunting tools employed by hunters in the study area

In figure 1, most of the hunters in the study area used local gun (76%), traps (64%), snares (36%), bow and arrow (34%), dog (32%) and catapults (8%). Information from the oral interview showed that some of the hunters also used charms in addition to these tools to capture animals and for self-protection. The result is in line with the findings of Alves *et al*, (2009); Akinyemi, (2018) and Adefalu *et al*, (2013).

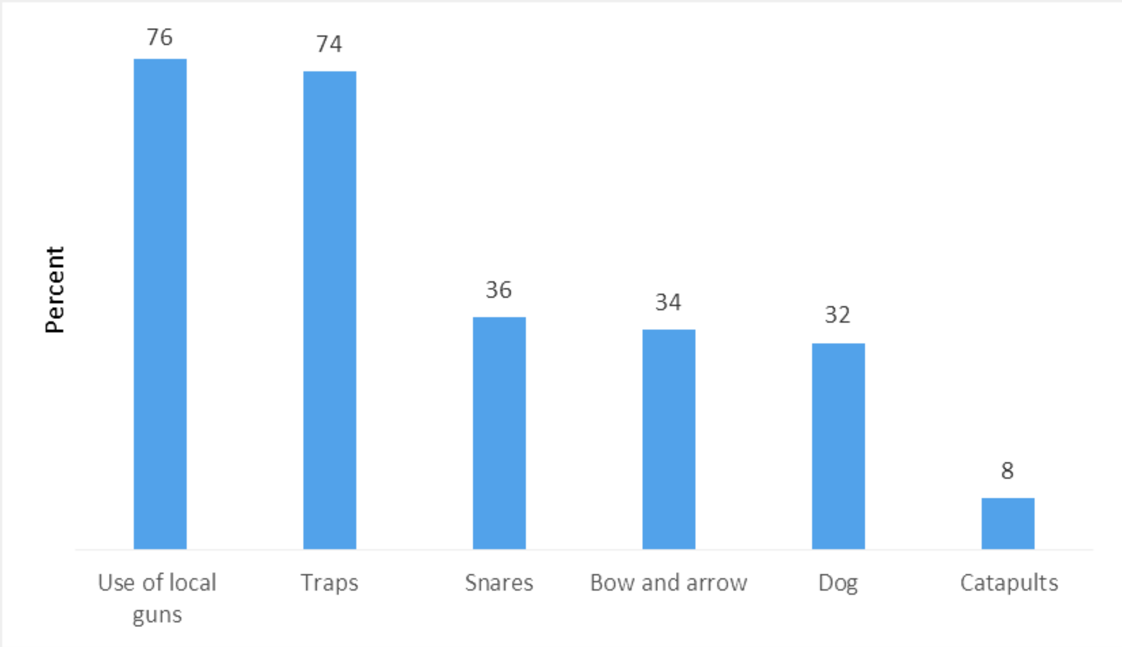

Figure 1: Hunting tools employed by hunters

CONCLUSION

The study examined wildlife hunting pattern and tools employed by hunters in Ido Local Government, Oyo State, Nigeria. Hunters killed more animals during dry season with various hunting tools and techniques. Some of the hunters used charms in addition to the tools to capture animals. Since the respondents were fairly educated, there should be more enlightenment on wildlife conservation policy so that hunters can know where and when to hunt and the types of animals to kill.

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Wildlife Law: Its Role in Conservation

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ABSTRACT
Nigeria is endowed with wild variety of plants and animal species, which ought to serve as a veritable source of wealth but they are not well regulated by law to conserve the natural resources for tourism purposes. Nevertheless, the existing variety legislation on wildlife needs coordination for effective application mechanism on the conservation of wildlife for sustainable uses for tourism, parks and efficient management of the forest for production of goods and services throughout the country. However, this paper examines the legal frameworks for wildlife conservation, regulations in wildlife and biological diversity conservation of the resources.
***Keywords**: Biological diversity, Conservation, Forest, Legal frameworks, natural resources, Wildlife, Conservation, legal , Forest and Biological diversity*

INTRODUCTION
Wildlife serves an important role in maintaining the balance of various ecosystems. The universe is depleted with indices of immeasurable contributions that wildlife species have made to human development in virtually all countries of the world. Human beings have profitably utilized several kinds of animal species for traction, power generation, clothing, research, medicine, sports, tourism and entertainment (Taylor, 2009). In spite of these innumerable pleasure mankind derives from wildlife resources, man´s inhumanity to animal species remain unceasing and unabated. Thus, these human activities such as bush burning, damming rivers, draining swamps, environmental pollution, hunting and poaching are threatening their existence. (Taylor, 2009).

In the Conservation of wildlife, their habitants, parks, reserves and sanctuaries are protected by Laws. Thus, most human activities such as grazing of minimizing are restricted or prohibited. The enabling Laws only allow recreational activities such as nature walks and bird watching. Towards compliance with these regulations, institutional bodies were set up to manage parks and reserves. In Nigeria, we have the Borgu and Yankari game Reserves, which serve as the habitants for many threatened and endangered animals to live, breed and build up their numbers (Adeniyi, 2000).

In many cases, the rights to hunt on state and communal land can be purchased by private safari hunting outfitters (Lindsey *et al*., 2007). This paper attempts to collate existing laws and regulatory frameworks for wildlife conservation in Nigeria. knowledge on the illegal hunting in savannas, and to provide insights into the underlying causes, impacts and potential solutions.

Legal and Regulatory Frameworks for Wildlife Conservation
The legal and regulatory frameworks in wildlife conservation in Nigeria dated back to the colonial era. Various legislation governs conservation of biodiversity in the country. For example, the Forestry Act and Wild Animals Act were patterned after the 1933 London

Convention for Protection of African Fauna. This has further been updated by the Conservation of Biological Diversity and International Law, 1990 UNEP, Nairobi. The situation remained the same at independence. The applicable laws on wildlife and game management remained largely universe and only being implemented in the same expropriatory and exploitative manner. These laws alienated the rural inhabitant's role in exploration of forests and hunting expeditions.

The Regulatory agencies such as the Federal Environmental Protection Agency Commission, the Environmental Impact Assessment Commission, the Urban and Regional Planning Agency and many state Environmental Protection Agencies have been established to strengthen the institutional regulation of the environment. Nigeria is a signatory to a number of international conventions relevant to biodiversity conservation. Examples are convention on conservation of biological diversity, the law of the sea convention, the African convention on the conservation of Nature and Natural Resources, the convention for co-operation in the protection and development of the Marine and coastal environment of the west and central African Region (Harris, 2009*)*.

The Law and Regulations

i. Provisions relating to the management of the environment under the Constitution of the Federal Republic of Nigeria (1999 Constitution).
ii. Policy on Environment 1988; National Environmental Standards and Regulations Enforcement Agency (NESREA Act) 2007.
iii. Federal Environmental Protection Agency Act (FEPA Act) 1988.;
iv. National Oil Spill Detection and Response Agency (Establishment) (NOSDRA Act) 2006
v. Environmental Impact Assessment (EIA Act), L12, LFN, 2004. The sector specific framework refers to legislations and regulations that are specific to a sector of the economy, such as the manufacturing, forestry, waste management, etc.

The Sector Specific Framework

The sector specific framework refers to legislations and regulations that are specific to a sector of the economy, such as the manufacturing, forestry, waste management, etc.
The sector specific legislations are classified further into two,

a. • pre-1988 laws and
b. • Post -1988 laws.

Fagbohun (1960-2010) reviewed that, the distinction is useful when analyzing the scope and focus of these laws. He argued that the pre -1988 laws were aimed at facilitating development and resource exploitation, or directed at localized problems of health and welfare and rectification of immediate problems of pollution and degradation of economically important resources while the post-1988 laws were primarily designed to focus on environmental planning, protection and impact assessment as major ingredients in resource development.

Wildlife protected area in Nigeria

- Folgore game reserve Kano State
- Chad Basin National Park
- Kainji Lake National Park
- Afi Mountain Wildlife Sanctuary
- Yankari National Park
- Okomu National Park
- Jos Wildlife Park
- Kamuku National Park
- Borgu National Park
- Old Oyo Park

Wildlife Crime and Instrument

Wildlife crime in Africa increases and the law enforcement response strategies and management needs become more complex, especially in the case of high value species such as rhinos and elephants. For example, in the case of rhino populations in Southern Africa that are currently experiencing heavy poaching threats from sophisticated international wildlife trafficking gangs, the law enforcement response involves highly trained and experienced specialists and the application of a diversity of sophisticated modern technology such as thermal imaging equipment, unmanned aerial vehicles (drones), helicopters, radar surveillance and other detection systems. These specialized human resources, techniques and equipment are inevitably very costly to maintain and operate, and the greater the extent and sophistication of the poaching threat, the higher the costs involved in delivering them. The issue of accessing sufficient and enduring financing to sustain these intensive law enforcement operations necessarily comes to the force. Fortunately, several international bilateral and private sector donors have recognized the need to invest more in law enforcement, including the European Union, USAID, the German Government, the Global Environment Facility (GEF), and a number of private sector organizations such as Africa Parks, the Buffett Foundation, and conservation NGOs such as the Frankfurt Zoological Society, the Wildlife Conservation Society, and WWF. For example, the European Union has established a special funding window aimed at combating the wildlife crime crisis under its Biodiversity for Life (B4L) Flagship Initiative.

Biological Diversity Conservation

At national level; protective measures for species and ecosystems alike are a cornerstone of conservation; but also protection alone is not sufficient; biodiversity conservation also necessitates the sustainable use of biological resources, and the control of processes which lead to the deterioration of the natural environment. In short, conservation can only be achieved through a cocktail of complementary measures (Judson, 2001), Law and legal mechanisms play an important role in achieving these goals: international obligations prescribe common commitments and measures to attain them. National legislation provides a framework to regulate certain behavior, to provide incentives to achieve certain results, and to set appropriate institutions in place. The full spectrum of legal mechanisms available for conserving biodiversity of wildlife management framework which are based on two-dimension act (Fagbohun,1960-2010).

- On species: This discusses the scope of state powers to conserve wild species and habitats, the legal mechanisms for controlling wildlife conservation, the procedures for listing species in need of conservation measures, the mechanisms for controlling trade, and the challenges of enforcement.
- This covers area based conservation at local and national level, as well as in trans-frontier protected areas and areas beyond national jurisdiction, basic instruments for protecting areas, including public ownership, voluntary agreements, and regulatory measures. It goes beyond traditional tools for protecting areas by looking at a number of innovative instruments, planning controls, incentives, disincentives and environment programme, with the financial support of USAID. It is hoped that it will assist in improving the law on biodiversity conservation, and contribute to the much needed progress in the field. (Collins, 2012).

10 wildlife protected area in Nigeria

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CONCLUSIONS

Africa is blessed with variety of flora and fauna species. Time has come for African nations like Nigeria, Kenya, Uganda, Tanzania, Zambia, Namibia and South African endowed with abundant and varied fauna to realize and appreciate the value and contribution of wild creatures to biodiversity and environmental living conditions of mankind.

The abundant tourism potentials abound nationwide with the natural feature such as lowering mountains beaches, waterfalls, museums, game reserves and National Parks needs to be harness for economic development. The updating of legal and regulatory systems, and their effective implementation, is a fundamental element for combating wildlife and forest crime. This may include creating clear definitions of illegal activities, establishing significant deterrent sanctions, and specifying relevant control and enforcement powers at every stage in the supply chain. Therefore, urgent efforts are required to raise awareness among policy-makers and the international and donor communities of the severity and urgency of the threat posed by illegal hunting and bush meat trade.

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Inculcating Forest Conservation Culture in Schools and Youths in Nigeria

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ABSTRACT
Nigeria's forest provides significant economic and ecological benefits. They play an important role in protecting soil and water resources and provide a vast array of products and services for the population. However, evidence has shown that Nigerian forest is diminishing at an alarming rate. Nigerian government aware of the problem has been putting measures in place both short term and long term to stem the decline. An area that has not been given much attention is conservation education in the youths. This paper opineopines that inculcating conservation education on these youths will leave a permanent print in their minds and make them acquire forest conservation habit early in life. Habit once acquired is difficult to change. There is also this opinion that the teaching of forest conservation should embrace all primary and secondary schools wherever the schools may be and whatever kind of students the school may be catering to. The paper recommends that forest conservation education should cover all tiers of education and in addition should include youths that are artisans, entrepreneurs, farmers and fishermen among others
Keywords: Inculcating, Forest, Conservation education, Culture, Forest, Inculcating, Youths

INTRODUCTION
The importance and value of the forest to man cannot be overemphasized. Forest contributed significantly in Nigeria, especially to rural household consumption, income and employment. Such contribution includes satisfaction of subsistence need (for instance food, fuel, building material); substitution for purchased farm inputs and opportunities to supplement cash income. Research on non-farm rural employment and income as a whole has shown that small scale production and trading activities in forest products constitute one of the largest p arts of rural non-farm enterprise employment (Nwandu, 2019). In Nigeria poverty has led to the dependence of over 90 percent of the rural population on forest for some livelihoods and economics survival (UN, 2002). Cabacungun (1980) stated that the environment holds the key not only to man's survival but to his existence as well. The forest on the other hand, holds the key to the environment. This statement clearly puts the forest at the forefront as far as natural resource conservation is concerned. It is in acknowledgement of the importance of forests for livelihoods and environmental stability that its conservation is included among the Mmillennium dDevelopment gGoals (MDG) of the United Nations. Forest conservation is defined as actions taken in management of a forest that result in maintenance of the possibilities for future related benefits (Wollenberg *et al.*, Nawir, Uluk and Kramono, 2001) In general, forest conservation in Nigeria faces great challenges hence there is an immediate and long term need to rebuild and restore the depleting forest resources in Nigeria. The long-term need could be achieved through permanent habit formation on forest conservation at early stages in life of the forest users and would be users. This can be done by introducing conservation culture in our schools and youths. Youth in Nigeria includes citizen of the Federal

Republic of Nigeria aged 18years – 29years according to the new youth policy 2019 (FGN, 2019). However, the African Youth Charter recognizes youth as people between 15 – 35years (Wikipedia, 2021). Nigeria is the most populous country in Africa with one of the largest population of youths in the world comprising 211,400,708 members with a median age of 17.9 (Wikipedia,2021). This goes to show that inculcating conservation culture in our youths will go a long way to forest conservation in Nigeria. Nigerian Government characterizes youths as ambitious, enthusiastic, energetic and promising. From the present meaning of youths, students in tertiary institutions were also included.

Primary education is the education being given in an institution for children aged normally 6 to 11 plus. The rest of the education system is built upon primary education and this makes the primary level the key to the success or failure of the whole system of education. On the other hand, secondary education is education received by the children after the primary education and before the tertiary stage. In Nigeria, secondary education is expected to expose children to diversified curricula that will be comprehensive and training intended to equip the students with necessary professional competence and value orientation that will prepare then sufficiently for useful and pleasant living within the society. It is a means of producing literate, healthy, self-reliant citizens that would create wealth and harmony for sustainable human development (Oyekan, 2008). Essentially education should prepare the individual for a changing society and should itself generate a social change. It behooves us therefore to ensure that our children are adequately prepared today so that they may find suitable answers to meet the needs and challenges of tomorrow. For instance, how to tackle the diminishing forest and its resources.

The State of Nigerian Forest

Despite the importance of forests in ameliorating rural poverty, it is common knowledge that the forest area of Nigeria just like in some parts of the world had been reduced. Their rate of replacement has not been commensurate with removal. Osemeobo and Ujor (1999) observed that although a dependable source of income and food supply in rural areas, forest is a diminishing resource. In factfact, a great percentage of Nigeria's luxurious vegetation has been removed and some species have gone into extinction (Osemeobo and Ujor, 1999). mMeanwhile FAO (2019) reported that Nigeria with a total land area of 92377,000 hectares, has less than 10% forest coverage with only 20,0000 hectares of primary forests. Having lost about 95% of its coverage to a high rate of deforestation which is annually recorded at 5% ranging from 2010- 2015 (FAO, 2019). The major causes of this rapid decline of Nigeria forests have been traced to man's mismanaged activities. The evidences of this critical depletion of our forestirst resources can be seen in pollution, floods, drought and soil erosion. Forest law violators such as illegal loggers and forest product gatherers, timbers smugglers, squatters, arsonists, poaching, cattle grazing, poverty, unemployment and ignorance have been identified as the principal problem group (Sambe, *et al* 2020).

Because of the critical situation of Nigeria forest resources, the government has utilized various approaches so as to involve every citizen of the country in reforestation and forest conservation programs. According to Nwandu (2020) some of the approaches include support for protected area networks, adopting joint forest management, improving the quality of resource information base; adopting sustainable timber harvesting; improving productivity of subsistence agriculture; promoting the use of agro-forestry; expanding the area of tree plantation; restoring degraded lands; enhancing participation in decision making and benefit sharing; investing in more research; reforming government policies and institutions; determining the social and economic value of forests; participating in National Forest Programme (NFP) and of course conservation education.

Some of these efforts were somehow successful but most carried with them inherent pitfalls that have resulted in mounting criticisms from the advocates of forest conservation. For example, the selective logging system has been implemented throughout Nigeria to maintain the forest with selected number of trees to be cut while leaving the residuals to regenerate for the next rotation. The expected effects were sustained yield and maintenance of forest for conservation of soil water and wildlife. However, the system requires loggers who are conservation oriented and skilled in making sure that unfelled trees (residuals) are not damaged in the process of felling, skidding and yarding. This has not been the case in Nigeria. Most loggers fell short of this requirement. The revised forestry regulation under the Agricultural policy banned shifting cultivation as a farming system. This law however does not seem to minimize the destruction of our forest nor aid government's campaign for reforestation. The shifting cultivators found it hard to stop this system of farming for it has become their way of life. This kind of farmers refused to plant trees. The farmers need to be first educated concerning forest protection and conservation.

Similarly, the tree planting campaign was launched in Nigeria in 1980. After the launching there has been increase in the reforestation rate as at 1980. But from then on, the survival rate of planted trees seems to decrease cumulatively each year due to inadequate tending operations from those who showed enormous "enthusiasm" at the onset of such program. These illustrations show that there is need to find a long-lasting measure to stop forest destruction and to implement forest conservation. There is need for permanent favourable attitude among the people towards reforestation and forest conservation.

Inculcating Culture of Forest Conservation in Schools and Youths

As stated earlier, the people of Nigeria lack inherent favourable attitude towards the forest. Thus the task is to develop favourable attitude in them. This can only take place through teaching and learning. Learning is behavioral changes that enable an effective learner develop this attitude so that he may apply this knowledge at his own will (Egonwan, 2002). Applied to the purpose of this paper, the learners should be able to develop that favourable attitude towards forest. In addition, the learning principle demands that they apply the knowledge to conserve our forest. This is seemingly simple in principle, but it is a great task for an inculcator. It takes time, even years and the educator have to choose the learning material suited to the mindset (determined usually by age level) of the learner. Fortunately, the task of teaching the subject could start in the lowest rung of the educational ladder. The view above is expressed by the National Policy on Education (FGN, 2004) that the primary curriculum must include rudimentary familiarity with the natural and manmade environment. AIAE (2005) specifically regards primary schools as occupying a very important role in the fulfillment of a nationwide forest conservation program. The main goal is to develop them to become sincere reforesters, forest protectors and conservationists of the future. Similarly, the first objective of a secondary school education is to continue and extend the learning acquired in the primary schools (FGN, 2004). The attitude should be developing among the pupils through the wise use of teaching strategies and learning experiences which the teachers should be well versed. The strategy is not to pour all the learning materials about forest conservation on the pupils when in primary schools. Rather, the approach should be a gradual but continuous exposure to the rationale behind forest conservation and how to attain the same. The teaching therefore has to continue in secondary and tertiary schools with more emphasis and awareness enlightenment and seminars. Furthermore, it should be observed that the adverse effects of forest destruction have permeated and will continue to permeate all sectors of the community both rural and urban. Hence the idea of teaching forest conservation should embrace all youths in their different profession., whatever curriculum they may have, wherever the school may be and whatever kinds of youths, the school may be catering to. It is also recognized that teaching methods and learning materials will vary with specific situation of the school, the kind of students and youths, the budget and the curriculum the school is offering. However, the central theme should be the same and that is making the youths know the benefits of forest conservation. Forest conservation manuals written in layman's language for easy understanding should be used for teaching. Tree planting activities should be introduced in our schools to be supervised more closely by the teachers because students usually follow what their teachers do. Unless the correct planting is employed by these youths, they will develop the wrong technique of planting trees. The inclusion of forest conservation and protection in co-curricular activities such as camping among youths, formation of forest clubs and scouts should be encouraged by school administrators.

CONCLUSION

The national campaigns for forest conservation are not short-lived. However, while immediate measures to protect and conserve the forests are being implemented, it is necessary to plan for the future. There is need to always have people with favourable attitudes towards the forest. So, while the youths are being prepared for their adult career, they should be taught to become sincere forest protectors and conservationists. The schools and youths are the foundation of what the citizens will be like tomorrow. Truly this paper did not aim at presenting a detailed curriculum for forest conservation. Our educators are well versed in that regard. Once they adopt the idea of nationwide forest conservation education among the youths, the selection of suitable learning materials and teaching methods lie in their competent hands.

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Potential of Fruit Trees for Food Security among Rural Farmers in Niger State

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ABSTRACT
The study assessed potential of fruit trees for food security among rural farmers in Niger State. A sample size of 219 fruit trees farmers was selected in the state using multi-stage sampling method. Structured questionnaire complimented with interview scheduled were used for data collection. Data were analyzed using descriptive statistics and food security index. The findings revealed that 82.2% of the respondents were male. Also, 87.7% of fruit trees farmers were food secured. The major constraints associated with fruit trees farming in the study area were long gestation period of fruit trees ($\bar{X}$ =2.83) and problem of security ($\bar{X}$ =2.83) were both ranked 1^{st} and lack of credit facilities on fruit trees production ($\bar{X}$ =2.73) ranked 3^{rd}. It is recommended that fruit farmers should embark on planting of improved varieties with short gestation period. Also, credit and other incentives should be provided for fruit farmers in order to enhance their food security in the study area

Keywords: Potential, Fruit Trees, Food Security, Farmers

INTRODUCTION
Fruits are full of nature's rich essential nutrients, antioxidants and health benefits for ready use by humans and other animals without alternation in most cases, unlike vegetables and other edible agricultural/horticultural produce that may require necessary pre-treatments, such as heating in most cases before consumption (Lapena *et al*., 2014). The tropics, more than other region of the world, is endowed with great diversity of fruit tree species that have provided humans with basic food and nourishment for ages since the domestication of beneficial wild plants (Aju, 2014). In Africa, as in many other parts of the world, trees on farms are often overlooked in research and policy making. In agriculture and livelihood studies, the focus is typically on annual crops and their effects on household income. When perennial trees such as Shea, parkia, cashew, mango trees are considered, it is mostly from a value chain perspective. As a result, contribution of trees on farms are often left out of forest-related, agricultural and sustainable socio-economic livelihood statistics and little remains known about their prevalence and economic contribution, particularly at the national scale. Fruits production in Nigeria is a business that can provide means of livelihood and enhance food security of rural dwellers of Niger State in particular and Nigeria at large. The objectives of the study area to; describe the socio-economic characteristics of fruit trees farmers, examine the food security status of fruit trees farmers and examine the constraints associated with fruit trees farming in the study area.

METHODOLOGY

The study was conducted in Niger State. The state is located in the Guinea Savannah ecological zone of Nigeria. In terms of land mass, it is the largest State in Nigeria. It covers an estimated total land area of 74,224km^2 thus accounting for about eight percent of Nigeria's land area. About 85% of it's land area is good for arable crop production (NSGIS, 2017). The State lies between Latitude 8º 20' and 11º 30'N and Longitude 38º 30'and 8º 20'E of the equator with a population of about 3,950,249 (NPC, 2006). And with a growth rate of 2.5%, the State was estimated to have a population of 6,722,378 in 2020. About 85% of the sState population are farmers. Some of the fruit crops are shea, mango, citrus, coconut, cashew, banana, pawpaw. Multistage sampling technique was adopted for the selection of the respondents for this study. The first stage involves random selection of one Local Government Area from each Agricultural zone. The second stage involved random selection of four villages in each of the three selected Local Government; This gives a total of twelve villages. At the third stage, proportionate selection of 10% of farmers from the selected twelve villages was used for this study. A total of 219 respondents were selected for the study from the sampling frame of 2160 farmers. Data were collected by the reseachers and trained enumerators using questionaire complimented with interview schedule on the socioeconomic characteristics of fruit trees farmers, food security status, and constraint to food tree production. Data were collected by the reseachers and trained enumerators using questionaire complimented with interview schedule. Descriptive statistics which comprises percentages, means and frequency counts was used to achieve objective I and III. Objective II was calculated using food security score computed for cereals and grain, root and tuber, legumes/nut, oranges vegetables, green leaf vegetable, other vegetables, orange fruits, other fruits, meant, liver/kidney/heart, fish/shellfish, egg, milk/diary products, oil/fat/butter, sugar/sweet and condiment/spices.

Calculation steps for Food Consumption Score (FCS)

- Using standard 7-day food frequency data, group all the food items into specific food groups.
- Sum all the consumption frequencies of food items of the same group, and recode the value of each group above 7 as 7.
- Multiply the value obtained for each food group by its weight and create new weighted food group scores.
- Sum the weighed food group scores, thus creating the food consumption score (FCS).
- Using the appropriate thresholds, recode the variable food consumption score, from a continues variable to a categorical variable.

Thereafter, the food security status of the respondents was determine using the below FAO Food Consumption Score (FCS) threshold

FCS Thresholds

FCS	FCS (High Oil/Sugar Diet)	Profiles
0 – 21	< 28	Poor
21.5 – 35	28.5 – 42	Borderline
> 35	> 42	Acceptable

RESULTS AND DISCUSSION

Socio-economic characteristics of fruit trees farmers

Table 1 indicated that 82.2% of the respondents were males while 17.8% were female. This indicates men were more into fruit trees production. Table 1 showed that the mean age of respondents in the study area was 48.4 years. This indicateshows that fruit farmers were within active and productive age, strong, inquisitive and risk takers. This result concurs with that of Haruna *et al.* (2018) who reported that majority of farming households in Ondo State, Nigeria are young farmers. Table1 revealed that the mean household size of the respondents in the study area was 11.0 persons.

Table: 1: Distribution of respondents according to socioeconomic characteristics' (n=219)

Variables	Frequency	Percentage	Mean
Gender			
Male	180	82.2	
Female	39	17.8	
Age			
31-40	39	17.8	48.4
41-50	101	46.1	
51-60	58	26.5	
>60	21	9.6	
Household size			
<6	16	7.3	11.0
6-10	93	42.5	
11-15	79	36.1	
16-20	23	10.5	
>20	8	3.7	

Sources: Field survey, 2021

Food security Status of Fruit Trees Farmers

Table 2 indicated that 87.7% of the respondents were acceptable while 27.3% and 5.0% were poor and borderline respectively. This finding implies that majority of the respondents were above nutritional inadequate and food secure. This finding agreed with Zubairu and Maurice (2014) who reported that majority of household in Adamawa State of Nigeria were food secured.

Table 2: Food security status of fruit trees farmers (n=219)

Food security status	Frequency	Percentage
Poor (<28)	16	7.3
Borderline (28.5-42)	11	5.0
Acceptable (>42)	192	87.7

Sources: Field survey, 2021

Constraints associated with fruit trees farming

Table 3 showed the following constraints were severe; long gestation period of fruit trees ($\bar{X}$ =2.83) and problem of security ($\bar{X}$ =2.83) were both ranked 1st, implying that the biannual nature of fruits which normally take time before producing and security problem such as theft of the produce and frequent bandit attack are major constraints faced by fruit trees farmers in the study area. This finding is line with Mohammed *et al.* (2021) who reported that banditry activities had severe effect on food insecurity in Niger State. Lack of credit facilities on fruit trees production ($\bar{X}$ =2.73) ranked 3rd. Also, lack of adequate farm land ($\bar{X}$ =2.76) ranked 4th. Land is one of the major problems confronting farmers in Niger State. This finding is in consonance with that of Dolaree *et al.* (2017) who reported that land is one of the major problem faced by farmers in Adamawa State, Nigeria. Also, financial cost of seedling ($\bar{X}$ =2.74) ranked 5th.

Table 3: Distribution of respondents according to constraints associated with fruit trees farming (n=219)

Variables	Very severe	Severe	Not severe	Sum	Mean	Decision	Rank
Lack of adequate farm land	178 (81.3)	30 (13.7)	11 (5.0)	605	2.76	Severe	4th
Financial cost of seedling	166 (75.8)	49 (22.4)	4 (1.8)	600	2.74	Severe	5th
Problem of security	182 (83.1)	37 (16.9)	0	620	2.83	Severe	1st
Lack of credit facilities on fruit trees production	170 (77.6)	49 (22.4)	0	608	2.78	Severe	3rd
Long gestation period of fruit trees	186 (84.9)	28 (12.8)	5 (2.3)	619	2.83	Severe	1st

Sources: Field survey, 2021

CONCLUSION

Based on this findings, it can be concluded that majority of the respondents were male with acceptable food security status. The major constraints associated with fruit trees farming were long gestation period of fruit trees, problem of security and lack of credit facilities on fruit trees production. It is recommended that fruit farmers should embark on planting of improved varieties with short gestation period. Also, credit and other incentives should be provided for fruit farmers in order to enhance their food security in the study area.

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The Preservative Potential of the Methanolic Extract of *Gliricidia sepium* Heartwood on *Lentinus sqaurrosulus* (fungi) using *Ceiba pentandra* and *Alstonia boonei*

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ABSTRACT
Wood is the secondary xylem in trees; defined more broadly to include the same type of tissues elsewhere such as, in trees, roots, or in plants such as shrubs. Wood preservation is the chemical conditioning of wood in order to increase its resistance to invading destructive organisms and deterioration caused by unfavorable environmental conditions, to lengthen its life span in service. This study aimed at evaluating the antifungal activities of methanolic extract of Gliricidia sepium on Lentinus squarrosulus using Ceiba pentandra and Alstonia boonei wood species. The experiment was carried out for 10 weeks and Analysis of Variance (ANOVA) was used to interpret the data collected. Wood samples of C.eiba pentandra and A.lstonia boonei were cut into eighteen (18) pieces each, smoothened using sand paper, and labeled. Specimens were soaked in extracts of different concentrations as well as the untreated (control) methanolic extract of G.liricidia sepium. The treatments used were prepared with varying concentrations of kerosene and the extract. The control group was not treated at all. Results showed that C.eiba pentandra absorbed more treatments compared to A.lstonia boonei in most concentration levels. Absorption increased with concentration levels for the species. It can be concluded that extract from heartwood of G.liricidia sepium possesses anti-fungal potential for the inhibition of fungi effect at concentration levels of 75% and 100%.

Keywords: wood, preservation, anti-fungal, Gliricidia sepium, Alstonia boonei, Ceiba pentandra

INTRODUCTION
For thousands of years, man has used wood as fuel, a construction material, for making tools and weapons, furniture and paper. Despite the importance and known advantages of wood, some defects like stain and decay can be caused by fungi; with insects, marine borers, birds and mammals also causing a lot of havoc (Bhusal, 2010). Wood bio deterioration is the undesirable change in wood properties caused by the activities of biological agents and organisms. Bio deterioration reduces the useful life of trees (Luiz *et al.,* 2019). Chemicals are generally used in industries for preserving wood in order to lengthen their life structure and generally increase the durability and resistance of such wood. Wood preservatives should however, be safe to handle and use, efficacious, cost effective, permanent and not harmful to metal or wood (Bandana and Bhupenda, 2021).

Alstonia is a widespread genus of evergreen trees and shrubs from the dogbane family (Apocynaceae). The genus consists of about 40-60 species, native to tropical and sub-tropical Africa, central America, south east Asia, Polynesia and Australia with most species in the Malaysian region. *Alstonia* trees contain major phytochemical compounds used for healing

(Oshomoh and Imoyera, 2018). The tree bark is a remedy against malaria, toothache, rheumatism and snake bites while its latex is used in treating coughs, throat sores and fever. *Ceiba pentandra* is a tall deciduous tree belonging to the family Bambaceae (Orwa *et al.,* 2009). *Gliricidia sepium* is a fast growing, deciduous, tropical, thorn-less tree. *Gliricidia* trees are used for timber, firewood, hedges, charcoal, live fences and for medicinal purposes (Kumar and Mishra, 2018).

Kingdom fungi consists of members of a large group of eukaryotic organisms which include mushrooms, morels, truffles, moulds, mildews yeasts, rusts, smuts and brackets or shelf fungi to name a few (Prescott *et al.,* 2005). Some medicinal plants and other plant products have been reported to possess anti-fungal activities which is useful in order to substitute for the expensive and sometimes hazardous conventional preservatives. The use of organic, anti-fungal extracts also lengthen the life of the wood structure and reduce the need for frequent replacement and constant felling of tress i.e., deforestation. This study was therefore carried out to evaluate the antifungal activities of the methanolic extract of *G.liricidia sepium* on *L.entinus squarrosulus* using *C.eiba pentandra* and *A.lstonia boonei* wood species.

METHODOLOGY

Wood samples of *C.eiba pentandra* and *A.lstonia boonei* were procured from the plank market. The wood samples were cut into eighteen (18) pieces each of dimension 2cm x 2cm x 6cm, after which they were smoothened using sand paper to produce a smooth surface area and labeled to avoid confusion. The specimens were weighed with a sensitive weighing balance and then oven dried for 6 hours to remove the moisture content, then weighed again to calculate the percentage moisture content. Wood specimens were soaked in extracts of three different concentrations, 100%, 75%, and 0% as well as the untreated (control) methanolic extract of *G.liricidia sepium.* They were left for 30 minutes to absorb the extract. Wood weights were taken and the absorption rate was determined. *L.entinus squarrosulus* (White rot fungi) was obtained from the pathology laboratory of Forestry Research Institute of Nigeria (FRIN) and cultured at room temperature. The treatments used were prepared with varying concentrations of kerosene and the extract. A control group was not treated at all. The methanolic extract was prepared by soaking 400g of the hearth wood of *G.liricidia sepium* 100ml of methanol for 7 days. Separation of the methanolic extract from the *G.liricidia sepium's* heartwood was done with the aid of a sieve. The extract was kept at room temperature in order for methanol to evaporate from the extract for seven days.

Table 1 Treatment composition

Treatments	Extract Concentration	Extract: Kerosene Ratio
Treatment 1	100%.	1:0
Treatment 2	75%	3:1
Treatment 3	50%	1:1
Treatment 4	25%	1:3
Treatment 5	0%	0:1

The following parameters were assessed: Absorption rate and Weight loss.

RESULTS AND DISCUSSION

Table 2 Mean absorption of *Alstonia boonie* and *Ceiba Pentandra* wood samples

Concentration level	*Ceiba pentrandra*	*Alstonia boonei*
100%	173.61	98.61
75%	48.88	39.58
50%	23.61	23.61
25%	17.01	16.67
0%	0.64	0.54

The table above shows that *C.eiba pentandra* absorbed more treatments compared to *Alstonia A. boonei* for all the concentration levels except for 50%. Absorption rate increased with concentration level for both tree species.

Table 3 ANOVA for absorption rate of *Ceiba Pentandra* and *Alstonia boonei* wood samples

S.V	df	S.S	M.S	F	S.g
C.L	5	78906.46	15781.29	68.49	0.00*
W.S	1	1795.92	1795.92	7.79	0.01*
C.L*W.S	5	6771.43	1354	5.88	0.00*
Error	24	5530.21	230.43		
Total	35	1865.92			

*: significant at ($P < 0.05$)

The result of analysis of Variance shows that there is significant difference in the absorption rate of *Ceiba C. Pentandra* and *Alstonia A. boonei* at ($P < 0.05$) with *Ceiba C. pentrandra* having the highest absorption rate.

Table 4 Mean value of preservative absorbed by *Ceiba pentandra* and *Alstonia boonei* wood samples separated by Duncan Multiple Range Test (DMRT)

	Wood Species	
Concentration Level	**C.p**	**A.b**
100% extract	173.61 ± 52.39^{c}	98.61 ± 1.40^{e}
75% extract +25% kerosene	48.88 ± 1.38^{b}	39.58 ± 0.52^{d}
50% extract + 50% kerosene	23.78 ± 3.34^{ab}	23.61 ± 1.51^{c}
25% extract +75% kerosene	17.00 ± 1.00^{ab}	16.80 ± 1.34^{b}
0% extract + 100% kerosene	0.63 ± 0.80^{ab}	0.54 ± 0.04^{a}
Control	-	-

Values are Mean ± S.D; Means with the same alphabet in column are not significantly different (P < 0.05)

Table 5 Percentage Mean weight loss of *Ceiba pentandra* and *Alsotonia boonei* wood samples

Concentration level	C.p	A.b
100%	22.25	31.43
75%	18.63	31.40
50%	31.62	34.85
25%	19.22	33.42
0%	17.53	28.30
Control	34.96	34.91

Ceiba pentandra and *Alstonia A. boonei* lost the least amount of weight when dipped in kerosene alone followed by 75% extract solution. This shows that among the extract treatments, the 75% concentration level was the best.

Table 6 ANOVA table for weight loss in *Ceiba pentandra* and *Alstonia boonei* wood samples

Source of variation	df	Sum of Square	Mean Square	F	Sig.
Concentration level	5	254.14	50.83	8.43	0.00^{NS}
Wood species	1	326.28	326.28	54.09	0.00^{NS}
Concentration level*Wood species	5	80.63	16.13	2.67	0.05^{NS}
Error	24	144.77	6.03		
Total	35	805.82			

NS; not significant at ($P \geq 0.05$)

The result of analysis of Variance shows that there is no significant difference in the percentage weight loss of *Ceiba C. Pentandra* and *Alstonia A. boonei* at ($P > 0.05$) with *ceiba C. pentrandra* having the highest weight loss

Table 7 Duncan test for weight loss by the wood species

Concentration levels	*Ceiba pentandra*	*Alstonia boonei*
100%	28.02± 3.38^{ab}	34.28± 0.50^{a}
75%	25.49± 3.40^{a}	34.10± 0.58^{a}
50%	33.85± 1.06^{bc}	36.17± 0.15^{b}
25%	25.98± 0.76^{a}	35.51± 0.73^{b}
0%	27.84± 0.7^{ab}	35.51± 0.72^{b}
Control	36.45± 0.42^{c}	38.19± 0.54^{c}

Values are Mean ± S.D; Means with the same alphabet in column are not significantly different ($P \geq 0.05$)

Table 7 shows that there is no significant difference between 100% and 0%, 75% and 25% extract effects on weight loss by *Ceiba C. pentandra*. Likewise in *Alstonia A. boonei,* 50%, 25% and 0% extract concentrations are not significantly different. 75% and 100% are also not significantly different.

Results show that the preservative is more effective on *Ceiba C. pentandra* compared to that of *Alstonia A. boonei,* with *Ceiba C. pentandra* (C.p) having 28.02% and *Alstonia A. boonei* (A.b) having 34.28% at 100% concentationconcentrations. C.p showed consistently lower weight loss values at all concentrations, including the control, when compared to A.b's values. The lowest weight loss value was recorded with the 75% extract concentration for both wood species while the highest values were consistently found under the control.

CONCLUSION

It can be concluded that the extract from heartwood of *Gliricidia G. sepium* possesses anti-fungal potentials for the inhibition of fungi effect at various concentration levels with 75% being the most effective concentration in terms of wood weight loss for *Ceiba C. pentandra* and *Alstonia A. boonei* wood species. Moreover, oil preservatives should be employed as an alternative source of preservatives for treating wood instead of synthetic preservatives which are expensive and hazardous to the environment and humans.

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Nutritional Values of Selected Parts of *Parkia Biglobosa*. Jacq. tree

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ABSTRACT

The genus Parkia (Fabaceae, Subfamily, Mimosoideae) comprises about 34 species of mostly evergreen trees widely distributed across neotropics, Asia, and Africa. While the processed seeds are eaten in Nigeria, other parts are used as medicinal ingredients, with little to no regard of their nutritional qualities. This research was conducted to study the nutritional composition of selected parts of Parkia biglobosa. Parkia biglobosa leaves and seeds (fermented and non-fermented) were focused on for nutritional analysis in order to determine and recommend the parts that have the highest nutritive content for human consumption as food or herbs. Proximate analysis was used to determine the moisture content, crude fibre, ash, protein, carbohydrate and fat in the selected parts and results showed that processed Parkia seeds have the highest carbohydrate content (51.35%), and the lowest nitrogen, protein, fat, and crude fibre content (1.79%, 12.76%, 2.14%, and 7.25% respectively). Unprocessed Parkia seeds had higher values when compared with processed seeds in terms of nitrogen, protein, ash, and moisture content (2.41%, 17.47%, 7.71%, and 17.51% respectively). Parkia leaves had equal carbohydrate content with the unprocessed seeds, the highest values of 2.88% and 20.47% for nitrogen and protein content, and the lowest percentage (6.3%) of minerals (Ash) among the samples. Processed pete (grinded, fermented, Pparkia seeds) had higher values than processed woro seeds (uncrushed, single, fermented, parkia seeds) in all ramifications except in moisture content and carbohydrate content. Unprocessed Parkia seed is more nutritious than the processed Parkia seeds because it has higher values of nitrogen, protein, fat, and moisture content, than that of processed Parkia seeds, hence can be used as a nutritious tincture alongside its herbal, and medicinal properties; Parkia leaves are also more nutritious due to higher values of nitrogen and protein. Therefore, Parkia leaves should be consumed more, either as a soup vegetable, tea leaf, tincture or decoction as it has the highest values of nitrogen and protein and second highest value of carbohydrate in all.

Keywords: proximate analysis, Parkia bigobosa, fermented Parkia seeds, Parkia leaves

INTRODUCTION

The African locust bean, *Parkia biglobosa* is a perennial tree legume which belongs to the subfamily *Mimosoideae* and family *Leguminosae*. *Parkia biglobosa* is an important tree species that provides edible products and income to rural households in West Africa (Termote *et al*., 2020). Its seeds are used as food condiments; as well as its leaves which can be used as fodder, green manure and in herbal medicine. It provides shade for livestock, protects the soil from excessive rays of sunlight and is also important in soil nutrient recycling. Its adaptation to its natural environment makes it more drought tolerant than many of the exotic trees grown as alternative tree resources. It is also a tree of utmost importance as a source of edible products and income for the vast majority of rural households. The species, known as néré in

Francophone Africa, is indigenous to sub-Saharan Africa (Termote *et al*., 2020) and has a very wide distribution range. The African locust bean, *Parkia biglobosa* is a perennial tree legume which belongs to the subfamily Mimosoideae and family Leguminosae. It grows in the savannah region of West Africa up to the southern edge of the Sahel zone 13° N (Campbell-Platt, 1993). The trees of the *Parkia* species are usually and carefully preserved by the inhabitants of the area where they grow because they are valuable sources of reliable food, especially the seeds which serve as source of useful ingredients for consumption (Campbell-Platt, 1993). *Parkia biglobosa* parts have been used not just as food (in the case of seeds, and leaves), but also as medicinal ingredients for tinctures, decoctions and pastes. Fresh seeds are used to cure fish poison, while the leaves are used as a decoction and lotion for virulent coughs, and muscular pain (Saleh *et al.,* 2021).

Processed condiments remain key constituents of human diets throughout many parts of Asia and Africa. They serve not only as nutritious non-meat protein substitutes, but also as flavor enhancers in soups and other dishes (Achi, 2005). Traditional diets in West Africa consist of large quantities of staple foods (cassava, yam and maize) which provide much needed energy calories, but are low in other food nutrients, thus necessitating the need for locally made condiments to meet these needs. In many African countries including Nigeria, protein malnutrition is a serious problem as it has been reported that the diet of most Nigerians is lacking in substantial protein due to the high costs of available protein sources such as meat and fish. Importation of food flavorings further emphasizes the significance of fermented seed proteins which have great potential as key sources of protein and as basic ingredients for food supplementation in the diet (Emmanuel *et al.,* 2017).

Parkia biglobosa pulp is a good source of energy and vitamin C, while the fermented grains contribute calcium, lipids and proteins to the diets of vulnerable populations in West-Africa (Termote *et al.,* 2020). *Parkia biglobosa* seeds are natural sources of plant proteins which give it a great potential as protein supplement (Arinola *et al.,* 2019). The yellowish powder inside the seed pods is sweet and can be eaten without preparation but is also made into a drink. Roasted, unfermented seeds are used as a coffee substitute known as Sudan coffee or café negre and ground seeds are mixed with *Moringa oliefera* leaves to prepare a sauce, and are also used to make doughnuts. The mealy pulp from the fruits is eaten or is mixed with water to make a sweet and refreshing drink rich in carbohydrate. *Parkia* leaves are sometimes eaten as vegetables, usually after boiling and then mixed with other foods and young flower buds are added to salads.

Fermentation in food processing is the process of converting carbohydrates to alcohol or organic acids using microorganisms (yeast or bacteria) under anaerobic conditions (Osuntokun *et al.,* 2020). Processing details of *P.arkia biglobosa* vary slightly between cultures but most processes involve some form of boiling, pounding, and fermentation (Okpara and Ugwanyi, 2017).

The main objective of this study was to carry out the nutritional analysis of *P.arkia biglobosa* seeds, and leaves.

METHODOLOGY

Parkia seeds and leaves were collected from Forestry Research Institute of Nigeria, and Proximate analysis tests were carried out at the Institute of Agricultural Research and Training, Moor plantation, Ibadan (IAR&T), and processed, fermented *P.arkia biglobosa* seeds were procured from the market. Proximate analyses were carried out using FAO recommended methods for proximate composition: oven drying for moisture content, Kjeldahl method with 6.25 conversion factor for crude protein, Soxhlet solvent extraction for crude fat, dry ashing for ash and (total or available) carbohydrates by difference.

RESULTS AND DISCUSSION

Table 1: Proximate analysis resultscomposition of *Parkia biglobosa*

S/no.	Tree part	Nitrogen%	Protein%	Ash%	Moisture Content%	Fat%	Crude Fibre%	CHO%
1	Unprocessed seeds	2.41	17.47	7.91	17.51	2.44	8.72	43.60
2	Processed seeds (*woro*)	1.79	12.76	7.61	17.10	2.14	7.25	51.35
3	Processed seeds (*pete*)	2.67	19.00	7.69	14.64	2.61	9.79	43.60
4	Leaves	2.88	20.47	6.30	15.82	2.49	8.48	43.64

From the table above, it wasThe result shown that the processed *P.arkia biglobosa* seeds (woro) have the highest Carbohydrate content (51.35%), and the lowest Nitrogen, Protein, Fat and Crude fibre content of 1.79%, 12.76%, 2.14% and 7.25%, respectively. The unprocessed *Parkia* seeds surpassed the processed seeds in terms of Nitrogen, Protein, Ash, and Moisture contents with values of 2.41%, 17.47%, 7.91% and 17.51%, respectively (Table 1). *Parkia* leaves had equal Carbohydrate content with the unprocessed seeds, the highest values of 2.88% and 20.47% for Nitrogen and Protein content and the lowest percentage (6.3%) of minerals (Ash) among the samples. Processed *pete* had higher values than processed *woro* seeds in all ramifications except in Moisture content. This means it is more nutritious than the *woro* seeds. The enormous benefits attached to African locust beans' seeds and leaves are proven by this study. The changes seen as a result of processing the seeds is similar to a report by Emmanuel *et al.* (2017), where an increase in fat content after seed processing was attributed to the increase activities of lipolytic enzymes, which hydrolyze fat to glycerol and fatty acid.

CONCLUSION

In conclusion, *P.arkia biglobosa* seeds (both unprocessed and processed) are very nutritious with pProcessed *pete* being more nutritious than processed *woro* seeds. Also, the unprocessed *Parkia* seeds are more nutritious than the processed *woro* seeds. *Parkia biglobosa* midrib leaves is more nutritious than the leaves which are close to the processed *pete* seeds in nutritional values. The *Parkia*leaves and are also more nutritious than the processed *woro* seeds and the unprocessed *Parkia*s seeds. It was recommended that pProcessed, blended, (fFermented) *P.arkia biglobosa* seeds (pete) should be consumed more as it is the most nutritious product of the *Parkia* tree and More research should be carried out on the *P.arkia biglobosa* leaves to process it into an eatable edible medium due to its high nutritive content. Processing it into powder is suggested.

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Impact of Logging on Floral Composition, Diversity at Onigambari Forest Reserve in Oyo State

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ABSTRACT
Illegal logging with inadequate planning, and techniques and operation that might be no longer in use are capable to cause significant damage to forest soil, trees and their seedlings. Impact of logging on floral composition, diversity at Onigambari forest reserve in Oyo State was established in this study. Two sites, logged and unlogged were selected at Onigambari Forest Reserve. A hectare each was selected for the two study sites. A plot size of 50 x 50 m² was laid resulting to four plots per hectare and eight plots in the two study sites. Diameters at breast height (dbh) were measured of all woody species. The results showed that a total of 104 and 93 per hectare were recorded in unlogged and logged sites respectively. The floristic diversity of the study sites indicated that the unlogged forest was dominated by the family Papilioniaceae and species Baphia nitida, followed by the family Sterculiaceae with Triplochiton scleroxylon and Cola gigantean as the dominant species. The logged forest sites on the other hand was dominated by the family Papilioniaceae with species B. nitida followed by the family Ulmaceae with species Celtis zenkeri as the most abundance species while the abundance of species from the family Sterculiaceae, and Olacaceae were also relatively high. The Shannon diversity indices for unlogged and logged sites were 3.28 and 3.07, while Simpson indices for unlogged and logged were 0.11 and 0.06 respectively
Keywords: Diversity pattern, Dominant species, Structure, Tree species.

INTRODUCTION
Nigeria used to have about 20% of its area covered with natural forests but, this has been reduced to about 10%. It lost about 60% of its natural forests to agricultural encroachment, excessive logging and urbanization between the 1960s and the year 2000. Logging activities in the forest involves all the operations, processes and anthropogenic activities that makes it possible for mature trees to be taken to factories or places of secondary conversion (Ogbonnaya, 2002). Tree logging, with inadequate plan, inadequate technical know-how and absence of control of operations will lead to severe damage to forest soil, forest trees and seedlings (Akay *et al*., 2006; Eroglu *et al*., 2009). The size and its diverse population in the South-West and in Nigeria in general, coupled with the socio-political and economic challenges have put much pressure on the forest as increasing number of unemployed youths have come to realize that there are opportunities in looting forest products for survival (Ola-Adams, 1983: Patterson *et al*., 2006) Over the years, Southwestern part of Nigeria has been suffering a continuous ecological damage, with floristic and edaphic changes taking place frequently (Adekunle *et al*., 2010). It was reported by Salami, A.T *et al* (2006), that the present situation in the environment takes it source from evidence that natural processes are being hindered by uncontrollable /unproductive means of forest extraction. Also, Onyekwelu and Fuwape (2008) opined that Nigeria's tropical rainforest has been in a deplorable state of depletion and

fragmentation, leaving below 5% of the country's rainforest ecosystems as undisturbed. A considerable part of Nigerian forest is also being destroyed through indiscriminate and reckless logging of timber extraction of non-timber, forest products and log transportation. Forests play important economic, social, and cultural roles in the lives of many people, especially those of indigenous communities. There is need for all to fashion out ways that the forest can continuously be conserved and this can happen when we adopt global best practices in managing forest resource.

MATERIALS AND METHODS

Onigambari Forest Reserve lies on latitude 7° 8^1 N and 7° 3^1 N longitude 3° 49^1 E and 3° 22^1 E. The plot lies within 17 km South-east of Ibadan on the Idi-Ayunre-Ijebu-Ode road, Oyo State. It was laid about 2 km away from the nearest road well obscured by some forest fallows in the neighborhood. Systematic line transect was employed for the laying of plots in the unlogged and logged forest sites. Two transects with a distance of 500 m between them was laid at the centre of each site. A sample plot of equal size (50 m × 50 m) was laid in alternate direction resulting into four plots and a total of 8 sample plots for the study sites. Using this method ensured that the forest is relatively covered. So, a total of 20,000 m^2 was sampled per study site.

Basal Area Calculation

The basal area of all trees the sample plots was calculated using the formula:

$$BA = \left[\frac{\prod D_2}{4}\right].$$

Where,
BA = Basal area (m^2), D = Diameter at breast height (cm) and π = Pie (3.142).

Volume Calculation

The volume of wood of individual tree was estimated using the equation developed for tree volume estimation in lowland rainforest ecosystem of South-west Nigeria by FORMECU (1999). This equation is expressed as follows:

$$V = e^{-8.433+2.331Ln(D)} \quad (2)$$

Where,
V = Volume of tree (m^3) and D = dbh (cm)

Tree Species Classification and Diversity Indices

This was obtained using a mathematical formula that takes into account the species richness and abundance of each species in the ecological community. The equation for the Shannon-Wiener diversity index given by Price (1997) will be used:

$$H^1 = -\sum_{i=1}^{S} p_i Lnp_i$$

RESULTS AND DISCUSSION

Distribution of hard wood species of 18 families was encountered in the unlogged site which is represented in Table 1 with twenty-seven tropical hardwood species found. The Shannon-Wiener diversity index (H^1) was 3.28 and species evenness (E) was 0.76. Tree density obtained is 10 stems/ha. Table 1 has the detailed result of tree species diversity, relative abundance, volume/ha, relative density (RD), and Shannon-Wiener diversity index values obtained. The diameter distributions of tree species into diameter classes are shown in Table 3. The result indicates that at the unlogged sites, the diameter distribution of tree species increased as diameter class increased. Therefore, more trees were found in higher diameter classes. This is an indication that the unlogged site contains more trees at higher diameter classes. The tree species volume distribution obtained at the unlogged site shows that the values vary from species to species per hectare at the unlogged site (Table 1). The Shannon index for unlogged site was found to be 3.28. A total of 25 economic timber species distributed in 14 families were encountered in the logged study site of this forest reserve (Table 2). The diameter distribution of tree species in the logged forest also increased as diameter class increased. This is an indication that the logged site contains more trees at higher diameter classes. Considering the basal area, the logged site had lower total basal area of (981.76 m2 ha^{-1}) (Table 2). The volume recorded for logged site varied from 1.34 to 1054.26 (m3 ha^{-1}) with the least from *Fagara zanto* from family Rutaceae and the highest *T. scleroxylon* from the family Sterculiaceae (Table 2). The Shannon index for logged was found to be 3.07. Simpson index were found to be 0.06. Evenness recorded for the logged site was found to be 0.76. The indices recorded for the logged site indicate that there is a lesser diverse ecosystem.

CONCLUSION

Impact of logging on floral composition, diversity and soil level at Onigambari forest reserve in Oyo State was established in this study. A total of 104 and 63 stems per hectare were recorded for unlogged and logged forest respectively. The increased wood species found in the unlogged site of the forest is an indication that the forest is relatively rich in genetic resources. Uniform distribution of individual tree species characterized the distribution pattern of the study area. The distribution of trees in terms of diameter class displays the characteristics of normal J-distribution where stem frequencies increase in Dbh, indicating stable, mature forest with health and vigor for the unlogged forest. The degree of devastation found in the logged forest is as a result of human interference and this is evidenced in the low stem density obtained. Evidence shows from the study that some species are threatened, in which some are near extinction.

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Table 1: Species Composition of the Unlogged Area in Onigambari Forest Reserve

Family	Tree Species	Density/ (ha)	BA/ha (m^2)	Volume/ ha (m^3)	Dbh (m/ha)	H-index	RD	Simpson index	Pi	Lnpi pi.lnpi	pi.lnpi
Apocynaceae	*Funtumia elastic*	4	0.83	71.21	1.54	0.14	3.85	0.0001	0.05	-3.09	-0.1545
	Astonia booneii	4	19.40	6.06	1.45	0.14	3.85	0.0021	0.05	-3.09	-0.1545
	Aningeria robusta	1	12.07	3.06	1.03	0.05	0.96	0.0001	0.01	-4.48	-0.0448
Boraginaceae	*Cordia millenii*	6	15.07	55.31	4.38	0.12	2.89	0.0248	0.03	-3.38	-0.1014
Capparaceae	*Boscia angustifolia*	4	25.43	93.33	5.69	0.14	3.85	0.0021	0.05	-3.09	-0.1545
Combretaceae	*Terminalia superba*	3	4.79	17.59	2.47	0.12	2.89	0.0012	0.03	-3.38	-0.1014
Euphobiaceae	*Bridelia micrantha*	1	1.09	4.01	1.18	0.09	1.92	0.0005	0.02	-3.78	-0.0756
	Ricinodendron heudelotii	4	10.29	37.78	3.62	0.14	3.85	0.0021	0.05	-3.09	-0.1545
Leguminoseae	*Daniellia ogea*	3	12.19	44.75	3.94	0.09	1.92	0.0005	0.02	-3.78	-0.0756
Maliaceae	*Trichilia monadelpha*	2	24.28	89.12	5.56	0.09	1.92	0.0005	0.22	-3.78	-0.8316
Mimosoideae	*Albizia zygia*	1	108.82	399.36	11.77	0.05	0.96	0.0001	0.01	-4.48	-0.0448
	Piptadeniastrum africanum	1	6.16	22.60	2.80	0.09	1.92	0.0005	0.02	-3.78	-0.0756
Moraceae	*Treculia Africana*	2	22.31	81.59	5.32	0.09	1.92	0.0005	0.02	-3.78	-0.0756
Myristicaceae	*Pycnanthus angolensis*	10	65.48	240.30	9.13	0.18	5.77	0.0047	0.07	-2.69	-0.1883
Olacacaceae	*Strombosia pustulata*	9	16.55	60.74	4.59	0.20	6.73	0.0063	0.08	-2.53	-0.2024
Papilionoideae	*Baphia nitida*	14	64.76	237.68	9.08	0.27	1.54	0.0186	0.13	-1.99	-0.2587
Phyllanthaceae	*Bridelia micrantha*	3	0.50	1.85	0.80	0.12	2.89	0.0012	0.03	-3.38	-0.1014
Rutaceae	*Fagara macropylia*	2	0.64	2.34	0.90	0.09	1.92	0.0001	0.02	-3.78	-0.0756
	Fagara zanto	1	0.64	2.34	0.90	0.05	0.96	0.0005	0.01	-4.48	-0.0448
Sapotaceae	*Chrysophyllum albidum*	6	19.09	70.07	4.93	0.16	4.81	0.0032	0.06	-2.87	-0.1722
Sterculiaceae	*Cola gigantean*	2	58.91	216.20	8.66	0.09	1.92	0.0005	0.02	-3.78	-0.0756
	Cola millenii	2	0.60	2.18	0.87	0.09	1.92	0.0005	0.02	-3.78	-0.0756
	Sterculia Africana	3	6.11	22.44	2.79	0.12	2.89	0.0011	0.03	-3.38	-0.1014
	Sterculia oblonga	2	5.11	3.18	1.05	0.05	0.96	0.0001	0.01	-4.48	-0.0448
	Sterculia tragacantha	4	0.87	18.75	2.55	0.12	2.89	0.0012	0.03	-3.38	-0.1014
	Triplochiton scleroxylon	4	514.79	1889.26	25.6	0.23	8.65	0.0105	0.10	-2.28	-0.2280
Ulmaceae	*Celtis zenkeri*	5	35.05	128.64	6.68	0.16	4.81	0.0032	0.05	-2.87	-0.1435
Caesalpinioideae	*Erythrophylleum ivorensis*	1	3.57	15.67	3.66	0.12	1.34	0.0186	0.02	-2.28	-0.0574
Total		**104**	**1055.4**	**3837.41**	**132.94**	**-3.28**	**82.70**	**0.1054**		**3.8581**	**3.8581**

Table 2: Species Composition of the logged Area in Onigambari Forest Reserve

Family	Tree Species	Density /ha	BA/ha (m^2)	Volume/ ha (m^3)	Dbh (m/ha)	H-index	RD	Simpson index	Pi	Lnpi	pi.lnpi
Apocynaceae	*Funtumia elastic*	4	0.83	71.21	1.54	0.11	3.18	0.0010	0.03	-3.45	-0.1035
	Pricralima nitida	1	1.65	5.23	1.15	0.07	1.59	0.0003	0.02	-4.14	-0.0828
	Astonia booneii	4	19.40	6.06	1.73	0.11	3.18	0.0010	0.03	-3.45	-0.1035
Boraginaceae	*Cordia millenii*	3	15.07	55.31	1.93	0.07	1.59	0.0003	0.02	-4.14	-0.0828
Capparaceae	*Boscia angustifolia*	4	25.43	93.33	2.91	0.15	4.76	0.0023	0.05	-3.04	-0.1520
Euphobiaceae	*Bridelia micrantha*	2	1.09	4.01	0.59	0.07	1.59	0.0003	4.14	-1.59	-0.2226
	Ricinodendron heudelotii	4	10.29	37.78	1.91	0.07	1.59	0.0003	0.02	-4.14	-0.0828
Meliaceae	*Entanrophagma angolensis*	3	2.69	9.87	1.40	0.07	1.59	0.0003	0.02	-4.14	-0.0828
Mimosoideae	*Albizia zygia*	1	108.82	213.36	1.00	0.07	1.59	0.0003	0.02	-4.14	-0.0828
	Piptadeniastrum africanum	2	6.16	20.60	6.52	0.11	3.18	0.0010	0.03	-3.45	-0.1035
Myristicaceae	*Pycnanthus angolensis*	9	65.48	222.30	3.50	0.11	3.18	0.0010	0.03	-3.45	-0.1035
Olacacaceae	*Strombosia pustulata*	7	16.55	48.74	1.82	0.18	6.35	0.0040	0.06	-2.76	-0.1656
Papilionoideae	*Baphia nitida*	10	64.76	202.68	9.08	0.24	11.11	0.0124	0.11	-2.20	-0.2420
Phyllanthaceae	*Bridelia micrantha*	3	0.50	1.85	1.06	0.11	3.18	0.0010	0.03	-3.45	-0.1035
Rutaceae	*Fagara macropylia*	2	0.64	2.34	0.55	0.07	1.59	0.0003	0.02	-4.14	-0.0828
	Fagara zanto	1	0.64	1.34	0.45	0.07	1.59	0.0003	0.02	-4.14	-0.0828
Sapotaceae	*Chrysophyllum albidum*	5	19.09	59.07	4.00	0.11	3.18	0.0010	0.03	-3.45	-0.1035
Sterculiaceae	*Cola gigantean*	2	58.91	211.20	3.86	0.15	4.76	0.0023	0.05	-3.05	-0.1525
	Cola millenii	3	0.60	2.18	4.47	0.07	1.59	0.0003	0.02	-4.14	-0.0828
	Sterculia Africana	3	6.11	20.44	2.89	0.15	4.77	0.0040	0.05	-3.05	-0.1525
	Sterculia tragacantha	4	0.87	18.75	1.05	0.11	6.35	0.0124	0.06	-2.76	-0.1656
	Triplochiton scleroxylon	5	514.79	1054.26	7.65	0.15	4.77	0.0023	0.05	-3.05	-0.1525
	Pterogota macrocarpa	4	5.77	43.57	1.05	0.07	1.59	0.0003	0.02	-4.14	-0.0828
	Nesogordonia papaverifera	1	0.57	2.30	1.84	0.07	1.59	0.0003	0.02	-4.14	-0.0828
Ulmaceae	*Celtis zenkeri*	6	35.05	123.43	12.84	0.22	9.52	0.0091	0.10	-2.35	-0.2350
TOTAL		**93**	**981.76**	**2531.21**	**76.79**	**3.07**	**96.9**	**0.0581**			**3.0893**

Deforestation and Extinction of Tree Species in Okpon Forest Reserve Obubra, Cross River State

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ABSTRACT
The purpose of this study was to investigate deforestation and extinction of tree species in Ookpon forest reserve Obubra, Cross River State, Nigeria. One null hypotheses was formulated to guide the study. The research design used for this study is the longitudinal research design. Checklist and questionnaire served as the major instruments for this work, was used for the study to capture the commonality/reality status as well as the frequency of specie loss in the area. The sample of the study was 400 respondents. Systematic random sampling technique was used to select a sample of 400 respondents. The result of the test of hypotheses showed that there is a significant relationship between deforestation and extinction of tree species loss in Okpon forest. While some of the species are still in abundance, several others have been threatened. It was recommended among others that the Government should put in place proper enforcement parameters so that forestry laws could be enforced.
Keywords: Deforestation, extinction, forest reserve, tree species

INTRODUCTION
There is considerable economic and political interest today in how the tropical rain forests are used. While some would preserve them in their current state, others would use the trees and other forest resources for economic gain (Enger and Smith, 2002). And since tropical rain forests are located in countries in which there are large numbers of poor people, there are strong pressures to exploit forests for economic benefits. For instance, it is estimated that more than 80% of the inhabitants of Africa generally use wood for cooking. No wonder fire wood is such a lucrative business in so many African countries including Nigeria. It is also on record that Africa has the highest population growth rate; as a result, the territory around most African villages and towns have been stripped of trees and other vegetation, since a majority of the citizens depend on their environment simply for survival. And most of the economic uses of the rain forest results in its destruction or reduction in forest biodiversity.

Deforestation is the conversion of forested areas to non-forest land use such as arable land, urban use, logged area or wasteland. According to FAO (2010), deforestation is the conversion of forest to another land use or the long-term reduction of tree canopy cover below the 10% threshold. Deforestation can result from deliberate removal of forest cover for agriculture or urban development, or it can be an unintentional consequence of uncontrolled grazing (which can prevent the natural regeneration of young trees). The combined effect of grazing and fires can be a major cause of deforestation in dry areas. Deforestation implies the long-term (>10years) or permanent loss of forest cover.

Deforestation defined broadly can include not only conversion to non-forest, but also degradation that reduces forest quality - the density and structure of the trees, the ecological services supplied, the biomass of plants and animals, the species diversity and the genetic diversity. Narrow definition of deforestation is: the removal of forest cover to an extent that allows for alternative land use.

According to Bisong (2014), unregulated commercial-scale exploitation of trees is an indication of the extent of threat to various trees species. Bisong and Enuoh (2015) also asserts that Nigeria has lost over 90 percent of her forest resources due to the hydria headed and enduring problem of deforestation hinging on timber logging, establishment of agricultural plantations in hitherto intact forest reserves, construction of high ways and mining of solid minerals. Africa forest resources account for nearly 23 percent of the world's total forest resources. Its per capita forest area (0.7 hectares) when compared with other continents in the world is higher than that of Asia (0.1 hectares) but lower to that of Europe (1.3 hectares) north central and South America with per capita figures averaging 3.7 hectares (FAO, 1999). Sub-Saharan Africa exhibits annual population growth rate, large rural population, accelerated urbanization and low per capita income. These factors combine with others to exert destructive pressure on forest to supply fuel wood, poles and food to meet the teeming population. It is estimated that 70-90 percent of total energy consumption is derived from wood and thus dependence on forest is likely to increase as a result of income and poverty situation of people in Africa (FAO, 1999). Commercial logging in Nigeria has been more widespread and intensive than other developed economies while poor harvesting techniques have led to severe ecological degradation (Geist and Lambin, 2002). Deforestation in Nigeria is not due to the pursuit of economic development alone, but also as a result of lack of sound environmental policies which are supposed to address poorly defined property right and underpricing of forest products. Deforestation is also attributed to unsustainable land use system; the farmer, forest communities and government illegally encroaching upon forest estates in search of fertile land for crop production (Kapos, 2000). It is against this background that this paper intends to investigate Deforestation and extinction of tree species in Okpon forest reserve Obubra, Cross River State.

Statement of the Problem

In Okpon forest, biological resources (vegetation, soils, wildlife and fisheries) are subjected to excessive exploitation consequent upon rapid population growth. The rate at which tropical forests are being cleared for cultivation of crops or pasture is truly unprecedented. Both small holder agriculture hinged on shifting cultivation and plantation development are proximate drivers of deforestation in Nigeria. Logging together with excessive non-timber forest product extraction are the proximate determinants of forest degradation (Gbadegesin, *et al.*,Abua & Bisong, 2008;, Bohringer, 2001).

High percentage of timber species are seriously threatened and near extinction due to plantation agriculture (Burtler, 2005). The rapid rate of timber species loss in Nigeria, can be attributed to the unrestricted conversion of the natural forest to other land uses like agriculture (Obasanjo, 2000). Okpon Forest is suffering from high rates of deforestation and forest degradation. Drivers such as conversion for large scale agriculture, uncontrolled logging, unsustainable harvest of fuel wood, overgrazing, incessant bush burning and high rate of population growth contribute towards the loss and degradation of more than 3,500km^2 of forest annually (Nilson, 2001). However, the population of the study area has increased drastically from 6,477 persons in 1991, 8334 persons in 1996 to 12,179 in 2013 using 2.9% growth rate (National Population Commission, 1991). Arising from the above statistics, it follows that if 3,500km^2 of forest is loss annually, therefore, from 1991 to 2013 (13 years) interval, about 45,500km^2 of forest would have been lost. Furthermore, while seventeen (17) percent of the Okpon forest is technically under some form of protection, only three (3) percent of the area is conserved for biodiversity purpose (Arufor, 2011; Federal Environmental Protection Agency (FEPA), 1992). This means there is a great urgency to develop payment for ecosystem services (PES) experience and capacity in the area (Baldascini, 2002). The statement of the problem therefore put in question form is: what is the effect of deforestation on the extinction of tree species in Okpon forest reserve?

Statement of hypothesis

H_1: There is a significant relationship between deforestation and extinction of tree species loss in Okpon forest.

Ho: There is no significant relationship between deforestation and extinction of tree species in Okpon forest

Study Area
The study area is Okpon Forest Reserve located in Obubra/Yakurr Local Government Area and has an area of 315.72km^2 representing 31,572ha. Obubra Local Government Area of Cross River State, Nigeria, is located in south-eastern Nigeria. The area is situated between longitude 8^{0}3' and 9^{0}32'E, and latitude 5^{0}45' and 6^{0}20N of the equator. Obubra is bounded in the north by Yala Local Government Area, northeast by Ikom Local Government Area, in the east by Etung Local Government Area, in the south by Akamkpa Local Government Area, southwest by Yakurr Local Government Area and in the west by Ebonyi State. It has an area of 1,115km^2 and a population of 172,444 by the 2006 census. Obubra which is situated along the rainforest region of Nigeria experiences both rainy and dry season. The rainy season is between the months of May and October. The highest amount of rainfall occurs around September with estimated rainfall of 325 mm. November to April account for the least rainfall which is estimated at 15mm which gives rise to dry season. The area has an average amount of 1964mm of rainfall annually. Temperature range between 26^{0}c – 30^{0}c.

The topography of the study area is gentle rolling land with elevations of 106-300 metre above sea level. The major physiographic features found within the area are rivers, hills, lowlands and swamps. The nature of the terrain enhances a number of agricultural activities such as the cultivation of rice, oil palm, cocoa yam, cassava and other economic activities such as hunting and fishing. The soil type is loamy soil. The main occupation of the people is farming. They cultivate crops such as yam, cassava, cocoa etc. Hunting is also a source of income for the people. These activities are the major drivers of deforestation in the Reserve. This involves large scale removal of the forest canopy through slash and burn system. This study area is typical of rainforest with the structural characterization of the three layerthree-layer canopy with the emergent trees. It is a closed canopy forest and consist of larger broad-leaf evergreen tree species (60-100 species per square kilometer) the canopy height of this forest is between 30-60m tall with emergent trees up to 100m.

MATERIALS AND METHOD
The research design used for this study is the longitudinal research design. Hence, longitudinal research design is chosen as it enables the researcher to make inferences about the relationship that exist between the variables in the study. This research is intended to reach out and design a framework that will enable data collection realistic and make interpretation possible. This will involve the collection of data on the phenomena with representation sample by the use of questionnaire, interview, and participatory rural appraisal (PRA) approach.

The decision on the level of commonality of the species of trees was adopted based on Pascal's model of special commonality. Pascal (2000) presented the scale below as rating for determining the rarity and commonality of tree species on primary and secondary forests:

Abundance	-	-	(A)	-	-	Above 50 trees per hectares
Common	-	-	(C)	-	-	21-50 trees per hectares
Frequent	-	-	(F)	-	-	11-20 trees per hectares
Occasional	-	-	(O)	-	-	5-10 trees per hectares
Rare -	-	-	(R)	-	-	0-4 trees per hectares

Both the primary and secondary sources of data were used for the study. The primary sources included, gathering of data through questionnaire administration, interviews, direct observation and measurements to obtained the necessary information in the field. The secondary sources basically included data on satellite imagery, residential map, and existing literatures, journal articles, textbooks, magazines and gazettes.

Checklist and questionnaire served as the major instruments for this work. The checklist was employed to obtain data on deforestation causes, rate, number of trees, species felled, sizes of farmland/plantation among others. The aerial extent of the farm sizes/plantation was measured with the aid of the measuring tape and GPS. On the other hand, all other relevant data which are more subjective in nature, and not easily measurable, was obtained via questionnaire administration. The rate of deforestation was determined using Geographic Information System (GIS) and remote sensing approach via satellite imageries of different years.

RESULTS AND DISCUSSION

From the frequency of rarity/commonality status in Table 1, 6 trees of Afzelia can be found per hectrehectare of in the Okpon forest reserve, which shows that the specie is near extinction, 30.6 per hectrehectare of *Brochytegia* Spp (Achi) is found which shows that the specie is still in abundance, 11.3 per hectrehectare of *Celtis Zenkeri* is found in the reserve which shows that if deforestation of this specie continues it will soon go extinction. Four (4) per hectrehectare of *Lovea trichiliodes* (Ceedar) is currently found in the reserve which shows a high rate of vulnerability of the specie and nearness to extinction. For *Terminalia Superba* and *Phycnathus*, 48.3 trees and 50 trees respectively are still found within every hectrehectare which shows that the species are still in abundance. The species with the low number in the table shows that rate at which they are been threatened and the tendency for them to go extinction if measures are not taken.

The result of hypothesis one revealed that there is a significant relationship between deforestation and extinction of tree species loss in Okpon forest. This finding is in line with Burtler (2005) who found out that the period 1990, 2000 and 2005 has witnessed an unprecedented rise in deforestation trend in Nigeria. The total forests landscape area in the country dropped from 17,234,000 hectares in 1990 to 13,137,000 hectares in 2000. In the ensuing five years, the numbers dipped further to about 11,089,000 hectares in 2005. As if these dismal figures are not enough, the country further saw its other wooded land area of 9,717,000 hectares fall to 6,902,000 hectares, and 5,495,000 hectares under a fifteen yearfifteen-year span of 1990 through 2005. The author explained thate Even other variables like primary forests that were not spared of the catastrophic scale of change seemed visibly plundered. The primary forest area estimated at 1,556,000 hectares in 1990 fell to 736,000 and 326,000 hectares respectively in the periods of 2000 through 2005. Notwithstanding, the meagre rebounds of 251,000, 316,000 to 349,000 hectares prompted by the forest plantations during the fifteen yearfifteen-year period of 1990 through 2005, Nigeria appeared to have squandered her forest estates considering the recurrent pace of losses.

For a very long time, forestry in Cross River State has been seen as the responsibility of government alone. Government has now realized that it cannot manage all the footrests forest in the state (outside the National Park) without the help of the people who live in or near the forests. It is on record that Cross River State is very rich in natural resources and the most important of these is the forest. So if the people of Cross River State are to improve their lives they must use the forest more wisely and sustainably. Why so?Thus, Pproper management of forest resources by the communities could result in the following benefits:

- forest resources including timber and non-timber forest products are often given in exchange for short term benefits to greedy and sometimes inexperienced loggers (Otu, 2001). This will cease.
- local communities are often cheated as they derive little or nothing for the extensive exploitation of their forest resources. These benefits will start accruing to them since they will now be involved in the management of the forest resources.
- participation of communities could serve as a means of checking connivance between some dubious forestry officials and illegal resource extractors.
- community involvement could create a far reaching impact in influencing the attitude, perception and activities of the rural people towards the forest and its management.
- it renews and sustains the rapport built between the Forestry Commission and the communities.
- it avails the communities the opportunity of discussing with logging companies from a position of strength and understanding of the value of their forest resources.

Table 1: Frequency and Rarity / commonality specie in Okpon

Species	A Edondon	B Okori	C Iyamitet	Total	Average	Status
Afzelia	4 trees/ha per hectares	10 trees/ha per hectares	4 trees/ha per hectares	18 trees/ha per hectares	6 trees/ha per hectares	R
Brochytegia Spp (Achi)	21 trees/ per haectares	21 trees/ha per hectares	50 trees/ha per hectares	92 trees/ha per hectares	30.6 trees per /hahectares	C
Celtis Zenkeri	4 trees/ha per hectares	10 trees/ha per hectares	20 trees/ha per hectares	34 trees/ha per hectares	11.3 trees /haper hectares	O
Diospyros Ellioctic (Ebony)	4 trees/ha per hectares	4 trees/ha per hectares	10 trees/ha per hectares	24 trees/ha per hectares	8 trees/ha per hectares	F
Khaya Ivorensis (Mahogany)	4 trees/ha per hectares	10 trees/ha per hectares	4 trees/ha per hectares	18 trees/ha per hectares	6 trees/ha per hectares	O
Lovea trichiliodes (Ceedar)	4 trees/ha per hectares	4 trees/ha per hectares	4 trees/ha per hectares	12 trees/ha per hectares	4 trees/ha per hectares	O
Milicea excelsia (Iroko)	10 trees/ha per hectares	4 trees/ha per hectares	4 trees/ha per hectares	18 trees/ha per hectares	6 trees/ha per hectares	R
Naukea	10 trees/ha per hectares	4 trees/ha per hectares	10 trees/ha per hectares	24 trees/ha per hectares	8 trees/ha per hectares	O
Terminalia Superba	50 trees/ha per hectares	45 trees/ha per hectares	50 trees/ha per hectares	145 trees/ha per hectares	48.3 trees/ha per hectares	O
Piptadenia strum	10 trees/ha per hectares	10	10 trees/ha per hectares	30 trees/ha per hectares	10 trees/ha per hectares	C
Phycnathus	50 trees/ha per hectares	50	50 trees/ha per hectares	150 trees/ha per hectares	50 trees/ha per hectares	C
Tryploclynton	20 trees/ha per hectares	15	20 trees/ha per hectares	55 trees/ha per hectares	18.3 trees/ha per hectares	F

Source: Researcher's Field work

CONCLUSION

In Cross River State, the absence of a policy compelling exploring and extracting industries to reinvest and repair the soil appears to be one area calling for attention. In essence, mismanagement of the environment leads to a fall in production and productivity, a fall in income generating capacity of the people and impaired ability of the economy to generate increased employment, inadequate industrial materials and lowered ability for investment in the economy. All these translate into lack of growth. Nevertheless, efforts to stop or slow deforestation have been attempted for many centuries (without success) because it has long been known that deforestation can cause environmental damage sufficient in some cases to cause societies to collapse. In Cross River State for instance the state Forestry Commission and the Forestry Management Committees are some of such bodies set up in an attempt by government to forestall the illegal deforestation of the state forest and to encourage the sustainable sourcing of forest resources.

Stemming out of the requirements needed for improvement in the forest volume, the following suggestions are proffered:

i. Education of the populace and the citizenry ofn the need to conserve the remaining endangered species and the need to increase the ratio of regeneration from the present ratio of one to two to a ratio of one to four, that is, cut one tree and plant four as replacement. Coppicing should not be the major way of enriching the volume of the forest but just a supplement. Direct planting and plantation establishment is of paramount importance.
ii. Government should put in place proper enforcement parameters so that forestry laws could be enforced.
iii. Encouragement should be given to private developers of forests. Incentives could be through free seedling distribution and free land holding.
iv. Government should create greater awareness and sensitize the local communities through radio and television jingles; to drive home the point that if forest is destroyed, those who live there will lose the context of their culture as their habitat disappears. Let the farmers who cut the forest for croplands know that they will ultimately face economic ruin because most of the rain forest soils cannot sustain their farming for more than two years.

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A Survey of Endangered Tree Species in Okomu National Park

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ABSTRACT
The degradation, fragmentation and conversion of forests to other forms of land uses in Nigeria are currently progressing at alarming rates which had resulted in an increase in the number of threatened species and the need for identification and monitoring of species under threat. This research aimed to survey the endangered tree species in Okomu forest reserve with a view to ascertaining them. This study was carried out in Okomu National Park, Edo State, Sample plots of (100x100m^2) was demarcated in the forest reserve and sub-divided into smaller units of (25m by 25m^2). Using 50% sampling intensity, data were collected from eight (8) plots. Tree species were identified via their botanical names. To identify endangered species, the species found were compared with International Union for Conservation of Nature (IUCN) listed endangered tree species. A total number of twelve (12) endangered species falling into six (6) families were found in the Park. Okomu National Park is a potential biodiversity hotspot if improved conservation management efforts are employed. Therefore, conservation efforts should be stepped up in the forest reserves to prevent the endangered species there from being extinct.
Keywords: conservation status, deforestation, diversity index, endangered species, forest reserve.

INTRODUCTION
The global forest area as reported by FAO (2016) declined by 1.8 billion hectares within the past 5,000 years. Evidence indicated that much of this forest loss was associated with population growth and demand of forest land for farming, grazing and conversion to other land-use forms (Adekunle *et al*., 2013; Aigbe and Omokhua, 2015; Ogwu *et al*., 2016). Nigerian forest contains thousands of plant and animal species and is home to many culturally diverse indigenous people (Aigbe *et al.,* 2014). The natural forest reserves according to a study conducted by Nigeria Population Commission (NPC), (2006) occupies about 10 million hectares which accounts for about 10% of the land area. However, the land area identified as forest lands has been decreasing steadily due to the industrial and social development which competes for the same pieces of land upon which the forest stand (Alamu and Agbeja, 2011). According to FAO, (2010), deforestation has been attributed to be the end result of various activities of man in the bid for economic development which is business as usual. The stock of the forest as stated by Alamu and Agbeja (2011) is depleted by agents such as saw millers and fuel wood gatherers which constitute 42% of the agents of deforestation. Several other factors that are responsible for the drastic reduction of the rich forest stock of Nigeria are, illegal activities in the forest, declining/manpower and capacity in Forestry Department, inadequate forest patrol, stoppage of the payment of annual royalty (formerly 5 % of total income) from what accrued from logging activities to rural communities and outdated forestry laws and regulations (Adekunle *et al*., 2013).

The Red Data Books (RDBs) complied by The International Union for Conservation of Nature (IUCN) are a global database of threatened species intended to serve as basis of setting conservation priorities. RDB is based on a quantitative threshold used to categorize species at various levels of threat status. Plant species in many parts of the world are in danger of extinction. Particularly, target species face harvesting pressure which are therefore considered threatened but are unlisted because little is known about the threat status of such species to document them on an individual basis (Joseph *et al*., 2009; Bisong and Buckley, 2014). The more critical pattern for local level threat analysis is that the IUCN's criteria may only be appropriately applied for whole taxa at global scales and is unsuitable at national and local levels (Rylands et al., 1995). There had therefore been serious need for flexible approaches in determining regional and local estimates of species threat status for national and sub-national territories, particularly for top forest conservation areas. It is also important to adopt this criterion to suit regional or county level analysis of threat. In view of the aforementioned, this research seeks to survey the endangered tree species in Okomu National Park with a view to ascertaining them.

METHODOLOGY

Study area

This research was carried out in the largest forest reserve by size in Edo state which falls in the rainforest ecosystems. This study was carried out in Okomu National Park, Edo State in the Southern part of Nigeria. The Okomu Forest Reserve is a forest block covering an area of 1081 km^2 in Ovia South-West Local Government Area of Edo State, Nigeria. The Okomu Forest Reserve was originally established by the British colonial government in 1912. Okomu National Park lies within the forest reserve. Okomu National Park was established by Decree 46 of 1999 and located between Latitude 6^0 15'N and 6^0 25' N and longitude of 5^0 90'E and 5^0 23' N. The Park covers an area of 202.24 km^2 (Okomu National Park, 2010). The topography is gentle ranging between 30 m and 60 m above sea level. Rainfall is between 1,524 and 2,540 mm. The park's dry season occurs from December to February and the wet season lasts from March to November (Soladoye and Oni, 2000). Vegetation is Guinea Congo lowland rain forest, including areas of swamp-forest, high forest, secondary forest and open shrub (Okomu National Park, 2010).

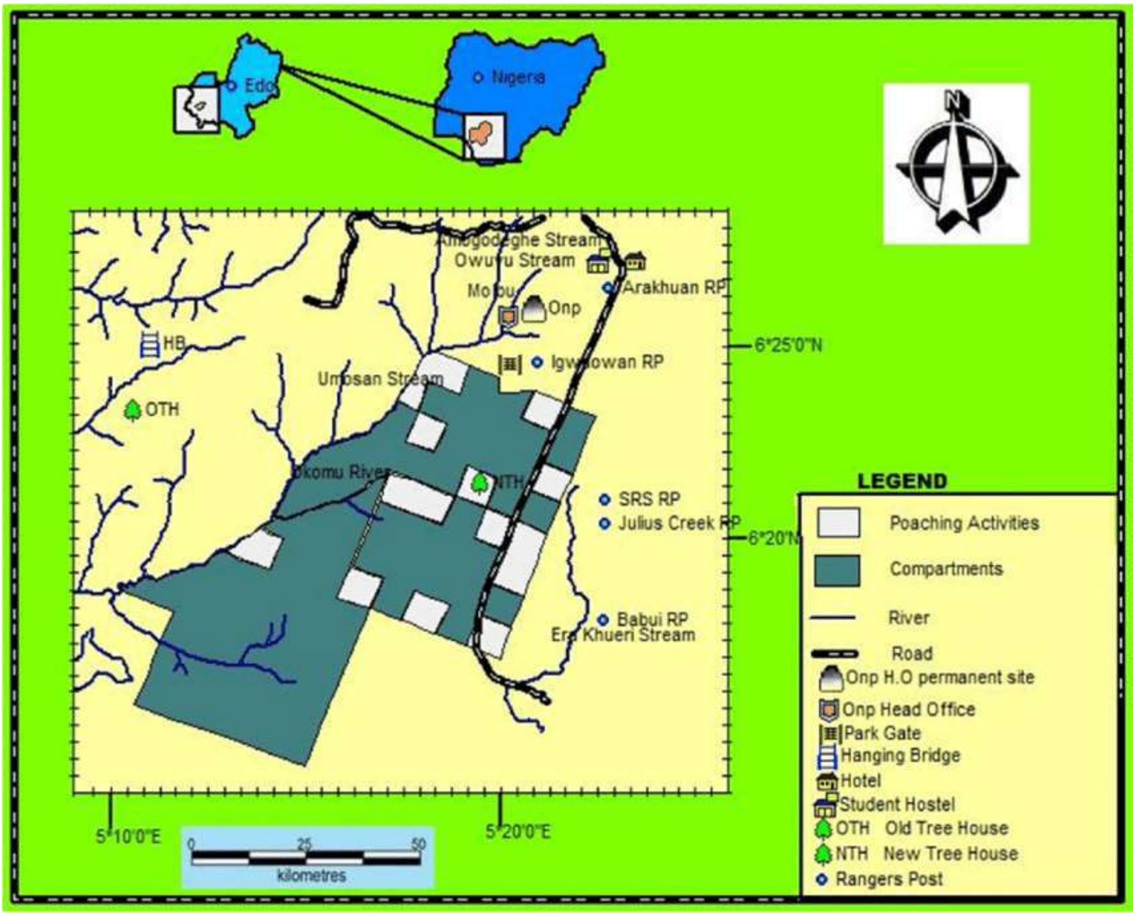

Figure 1: Map of Okomu National Park (source: Nwankwo, 2016)

Methods of Data Collection

This study was carried out to access the abundance and diversity of tree species in Okomu National Park, Edo State. Sample plots of (100 x100 m^2) was demarcated in the forest reserves and sub-divided into smaller units of (25 m by 25 m). Using 50% sampling intensity, eight (8) plots were randomly selected in the forest reserve. Tree species in each plot was numbered and identified. The botanical names of trees encountered in the sample plots of each marked areas was recorded. The species that are found to be less abundant in the forest reserve (i.e. if the species is less than 10 individuals) were specifically noted. The IUCN Red List of Threatened Species versions 2020.2 (IUCN, 2021) were screened to compile the names and details of plant species that were recorded from Nigeria. The names, family, conservation status, distribution range and growth habit of the identified threatened plants were noted and compared with the records obtained from the field to be able to identify endangered species found in the studied forest reserves. Since IUCN is a database based on global information and may not take into account details from local level, to aid further determination of the endangered species, literatures on global IUCN listed endangered tree species both globally (Olfield *et al*, 1998) and the IUCN listed endangered species that was specifically made for Nigeria (Borokini, 2014) were consulted, also literatures on tree species abundance in the studied forest reserve were also consulted to determine the species that had reduced in abundance with about 80% since the last ten years at least and those with projected extinction of at least 20% within 20 years (IUCN, 2004).

Method of Data Analysis

All data on tree species and family abundance in the studied site were presented in frequencies. Data analysis was done using Microsoft Excel.

RESULTS AND DISCUSSION

The endangered species encountered in the National Park was shown in table one. From the table, based on IUCN categorization, ten different endangered species distributed within five families were encountered while categorizing the endangered species based on the information derived from other literatures, twelve species from six families were seen to be endangered in Okomu National Park.

Table 1: Endangered Species in the three Forest Reserves under study

Family	Species	IUCN Conservation Status	Category by other litratures
Ebenaceae	*Diospyros crassiflora*	VU	E
Meliaceae	*Entandrophragma angolense*	VU	E
Meliaceae	*Entandrophragma cylindrcum*	VU	E
Apocynaceae	*Funtumia elastica*	LC	E
Meliaceae	*Guarea cedrata*	VU	E
Meliaceae	*Guarea thompsonii*	VU	E
Meliaceae	*Khaya Africana*	VU	
Meliaceae	*Khaya ivorensis*	VU	E
Meliaceae	*Lovoa trichilioides*	LC	E
Rubiaceae	*Nauclea diderrichii*	NT	E
Sterculiaceae	*Steculia rhinopetala*	LC	E
Combretaceae	*Terminalia ivorensis*	VU	E
Combretaceae	*Terminalia superba*	DD	E

VU = vulnerable, LC = least concerned, DD = data deficient, NT = near threatened, E = Endangered

FORMECU (1999) reported that 58 (10.4%) of 560 tree species in Nigerian forests are endangered. A total of ten (10) endangered species falling into six (6) families were encountered in the National Park based on the IUCN categorization of Species conservation status (2021) while twelve (12) species from six (6) families based on the local categorization (based on literatures). This is lower than what was recorded for queen's forest (16) and Oluwa forest (15) but higher than what was recorded in Omo Forest Reserve (Oyekwelu *et al*, 2008) The high number of endangered species is an evidence of long history of overexploitation of forest products especially in the tropical African rainforest for their economic values without recourse for conservation. Oyekwelu *et al*, (2008) noted that a high number of trees in rainforest ecosystems of Nigeria are currently endangered. Burgess et al., (2005) reported that rainforests of West and Central Africa are among the most important areas of threatened species across Africa. The difference in the number of endangered species between the two methods of categorization engaged showed that a lot of threatened species in the developing countries were unlisted in the IUCN Red List because little is known about the threat status of such species for their individual documentation. Rylands *et al* (1995) had argued that the IUCN's criteria may only be appropriately applied for whole taxa at global scales and is unsuitable at national and local levels. The role the Red List plays in identifying species threatened with global extinction is critically important, but is undermined by accuracy problems (Webb, 2008). Webb (2008) described the information given by the IUCN Red List not to be appropriate for the conservation status of certain species as the conservation status assigned for them by IUCN had been found to be different from the what is obtainable in the field by local researchers even when the IUCN criterial were used by the local researchers.

CONCLUSION

The results of this study revealed the biodiversity conservation status in the Okomu National Park paying special attention to the endangered tree species. This forest is a potential biodiversity hotspot if improved conservation management efforts, and intensive research of all the biodiversity indicators are employed. The result of this study revealed that the Okomu National Park being tropical rain forest is home to several endangered tree species which could become extinct if proper conservation and management measures are not taken to protect them. This research work will serve as baseline data that could be helpful in the appraisal of plant resources of the tropical rainforest ecosystem for its effective management. In view of the aforementioned, conservation efforts should be stepped up in the forest reserve especially because of the species considered to be endangered to prevent them from going into extinction.

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Reforestation through *in vitro* Propagation of *Cedrela Odorata*

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ABSTRACT
Cedrela odorata is a mahogany in the family Meliaceae with industrial and medicinal uses. Due to loss of viability and the recalcitrant nature of the seeds of this tree, seed-borne pathogens, over exploitation and eventually deforestation, it is threatened. An alternative vegetation through in vitro propagation methods, to enhance reforestation and mitigate the effect of global climate change through the green process is imperative, to raise healthy plantlets, mass propagate and conserve the germplasm. Plantlets were raised from seeds disinfected using the single and double disinfection method. Carbendazim (10% w/v) was used to disinfect the seeds with immersion rates; 1, 3, 5 hours and overnight (18 hours) followed by inoculation in Murashige and Skoog (MS) medium. Plantlets were subcultured in MS medium, supplemented with plant growth regulator (PGR); (BAP: IBA- 1.5:0.0; 2.0: 0.5; 2.5: 1.0 and 0.0: 0.0) mg/l). It was observed weekly for growth and presence of contaminants. Data were collected; on number of leaves, roots and shoot length were collected and analyzed using ANOVA (SAS 9.0 version) and differences in treatment means were separated using LSD ($P < 0.05$). Probable identified contaminants were Collectotrichum spp. and Fusarium sp. There were no significant differences in the contamination rate considering the hours of disinfection with highest level of contamination (0.75^a) observed in 3 and 5 hours and lowest in overnight immersion (0.38^a), 3 and 5 hours however, supported growth with highest shoot length of at 3 hours (1.59 cm) and least at 5 hours (0.90 cm). Apical and nodal cuts germinated with leaf and root formation after 13 days in PGR free medium. Shoot development was highest in medium containing 1.5: 0.0 mg/L of BAP: IBA.
Keywords: Reforestation, Cedrela odorata, in vitro propagation and plant growth regulators

INTRODUCTION
Cedrela species are also known as Spanish cedar, Cedro, cedarwood is in the family Meliaceae, or mahogany, and comprises seven species native to tropical South and Central America (Styles, 1981). It is a large tropical tree that produces light and valuable timber; with industrial and medicinal uses. The wood is valued owing to its quality, ductility and durability (Orwa *et al*., 2009; Orozco *et al*., 2010). Although it is threatened (IUCN 2013), interest in *C. odorata* as a source of plywood for furniture, medicine, and beekeeping, qualifies it, as economically valuable (Orozco *et al*., 2010).

The demand for timber high in resistance to pests and decay is on the rise. Mass propagation of economically viable trees such as *C. odorata* becomes necessary to raise a plantation for its immense benefit as viable seeds of this species can germinate rapidly (Valverde-Cerdas *et al*., 2008). There is a need to fill this gap not only for the economic value desired but also to mitigate against the current trend in climate change which globally is becoming a threat. I*n vitro* method is used and also helps to raise disease-free plants (Orwa *et al*., 2009; Orozco *et al*., 2010). This study aims to develop a protocol for the *in vitro* propagation and disinfection of *C. odorata.*

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MATERIALS AND METHOD

Sample collection/ collection of explants

Explants (seeds) were collected from Forestry Research institute of Nigeria (FRIN) arboretum. Shoots as explants were obtained from the *in vitro* raised plantlets at biotechnology Laboratory of FRIN.

Media preparation

Media used were Murashige and Skoog -MS (1962) and woody plant medium (WPM). Standard procedure for media preparation was used and autoclaved at 121°C and 15psi for 15 minutes. Glass wares were sterilized at 160°C for 3 hours in a hot air oven. Four different stock solutions of macronutrient, micronutrient, micro-iron and vitamins were prepared and stored. Stock solutions of salts were prepared using distilled water and the required volume made up to with a standard volumetric flask. Iron stock solution was stored in amber bottle to prevent photolysis. Myo-inositol, cytokine and auxin stock solutions were prepared fresh and used when needed. Stock solutions of macronutrients, micronutrients, iron and vitamins were also prepared for WPM. The stock solutions were stored at 4°C. The medium preparation required stock solutions mixed thoroughly with the desired quantity of distilled water using a magnetic stirrer. Three percent (3%) sucrose (30g/l), 0.01% myo-inositol (100mg/l) and required quantity of plant growth regulators (PGR) were added and the pH was adjusted to 5.8±0.2 using 0.1N HCl (hydrochloric acid) or 0.1N NaOH (sodium hydroxide) before sterilization.

Disinfection

Surface disinfection of the seeds was by using 70% ethanol for 5 minutes, decanted and washed with three changes of sterile distilled water, 10% and 5% sodium hypochlorite with three (3) drops of polyoxyethylene sorbitan monolaurate (Tween 20) for 20minutes and 10minutes respectively (single and double disinfection), rinsed in three changes of sterile distilled water.

Chemical disinfection

Seeds were soaked in 10%w/v of the fungicide (carbendazim) for 1, 3, 5hours and overnight (18hours). Rinsed thoroughly in five changes of sterile distilled water and inoculated on MS and WPM.

Experimental Design

In the first experiment, the seeds were aseptically inoculated into full-strength MS and WPM media without plant growth regulators (PGR). In the second experiment, PGR (BAP and NAA) were added to the media to enhance the shooting and rooting of the subculture made from the in-vitro raised plant from seeds using five PGR levels and ten (10) replicates

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Subculture of *in vitro* raised plantlets

Shoots regenerated from seeds were aseptically removed, cut into 2 and inoculated on MS medium supplemented with plant growth regulators (BAP and IBA) with blank media used as control. The culture tubes were kept under 16/8h (light/dark) photoperiod at 25 ±2ºC.

Data collection and Statistical analysis

Data were analyzed using ANOVA (SAS 9.0 version) and difference in mean separated using LSD ($P < 0.05$)

RESULTS AND DISCUSSION

The percentage of disinfected explants (seeds), shoot and root development were evaluated. The rate of seed survival surfaced disinfected singly and doubly, followed by soaking in carbendazim (10%w/v) with varied time exposure is shown in Table 1

Table 1: Evaluation of different disinfection time and growth after 4weeks of Inoculation.

		Percentage of Survival (%)			
Disinfection time {Hour(s)}		1	3	5	Over night
Type of	S	42.85	57.14	85.71	71.43
Disinfection	D	57.14	57.14	71.43	71.43

Key: S- Single disinfection D- Double disinfection

In Woody Plant Medium (WPM), the seeds of *C. odorota* did not grow. In as much as they grew in MS, contamination was observed in few tubes. Plantlets were stunted in 5hours and overnight exposure to carbendazim. Table 2 shows the survival of the seeds after surface disinfection and treatment with the fungicide carbendazim

Table 2: survival of *cc .o Odorota* seeds treated with carbendazim

Disinfection Time	Growth		No growth		Contaminated	
{Hour(S)}	S	D	S	D	S	D
1	3	5	3	2	1	1
3	5	4	2	—	1	3
5	6	5	—	1	1	2
Over night	6	6	1	1	—	1

Figures down the column represents number of survivors

Table 3 :Growth rate of seeds of *C. odorata*

Week	№ of replicates	Root Length (cm)	Shoot Length (cm)
1	56	0.60^{b}	0.64^{b}
2	56	1.02^{b}	0.73^{b}
3	56	2.44^{a}	2.24^{a}
4	56	0.70^{b}	2.60^{a}

Means with the same alphabets down the column are not significantly different from each other at 5% level of probability.

The plants were allowed to remain till four weeks after sowing, removing contaminated vials following fungicide treatment. The plantlets were sub-cultured, into MS medium supplemented BAP and IBA in the following concentrations. The treatment variation is shown in table 4.

Table 4: Distribution of Plant Growth Regulators (PGR) Applied to *C.odorata*

PGR	Concentration (mg/l)			
	A	B	C	D
BAP	1.5	2.0	2.5	0.0
IBA	0.0	0.5	1.0	0.0

Contamination was not observed in any of the subcultured tubes following mass propagation which yielded 101 explants from 40 plantlets cut into parts as shown in table 5. However, the developments observed showed that all tubes responded morphogenically between seven (7) days to thirteen (13) days after inoculation. BAP and IBA used in combination resulted in the formation of leaves, no root was observed in any of the BAP: IBA combinations used. Treatment A (only shooting hormone BAP). The shoot developed leaves ranging from 4 to 15 leaves after four weeks with stem elongation and no visible root development. See fig.1.

Figure1: Plantlets growing in MS media supplemented with BAP only

However, treatment D which was free of PGR resulted in plantlets developing shoots and roots after 13day s after inoculation see fig 2

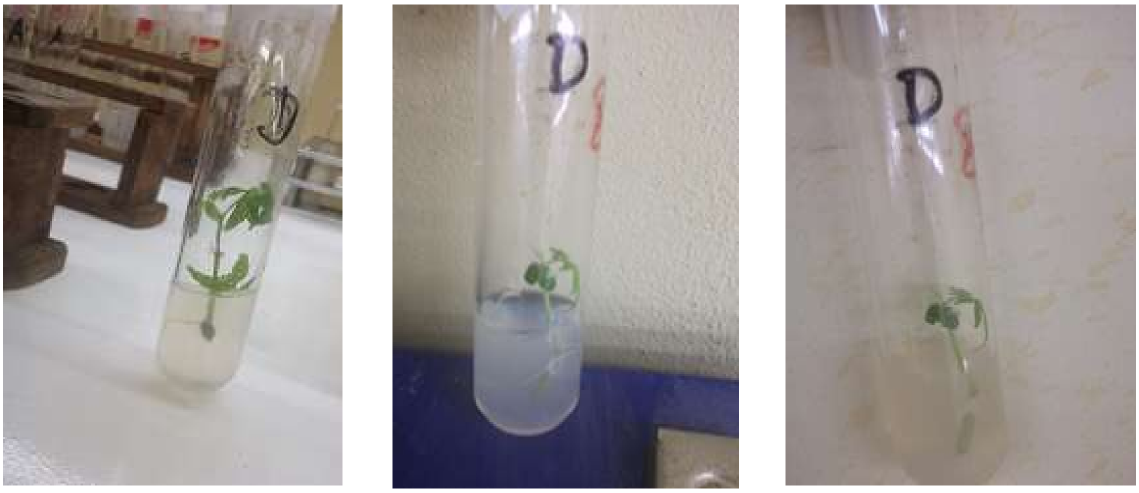

Fig 2: *C.odorata* subcultured on PGR free media showing shoot and root development

Table 5a: Yield of plantlets from mass propagation of *C. odorata*

Part of plant	Root	Shoot	Stem	Total
A	8	10	12	30
B	7	7	11	25
C	7	7	9	23
D	6	6	11	23
Total	28	30	43	101 tubes

Table 5b: Growth Rate of *C. odorata* nodal cuts over a period of four weeks

Week	№ of Roots	Shoot Length (cm)	№ of Leaves	№ of Nodes
1	0.06^a	2.26^a	3.78^a	1.58^a
2	0.09^a	2.41^a	5.84^a	2.00^a
3	0.08^a	2.50^a	5.64^a	2.33^a
4	0.09^a	2.44^a	6.38^a	2.33^a
S.E.	0.04	0.12	0.91	0.31

SE represents standard error. Means with the same alphabets down the column are not significantly different from each other at 5% level of probability.

Table 6: Effect of Plant Growth Regulators on the Micro-propagation of *C. odorata*

Treatment	№ of Roots	Shoot Length(cm)	№ of Leaves	№ of Nodes
A	0.00^b	3.01^a	10.45^a	3.70^a
B	0.00^b	2.15^b	2.52^c	1.14^b
C	0.00^b	2.34^b	2.66^c	1.33^{bc}
D	0.33^a	2.11^b	6.02^b	2.06^c
S.E.	0.03	0.42	0.91	0.31

SE represents standard error. Means with the same alphabets down the column are not significantly different from each other at 5% level of probability.

Germination of *Cedrela odorata* had its radicle emerging on the thirteenth (13) day and a complete expansion of the cotyledon ten days after. This finding aligns with Díaz-Quichimbo *et al.,* (2013), who observed radicle emergence 10-30 days after in MS media and not WPM supporting its growth.

In vitro propagation of *C. odorata was* achieved mainly from seeds as observed (Garcia-Gonzales *et al.*, 2011). An attempt to propagate *C. odorata* using nodal cuts from young plants raised with topsoil in the nursery proved difficult with oxidation and death of the explants after surface disinfection and exposure to 1%w/v of carbendazim for 15minutes and 30minutes respectively, and inoculation in MS supplemented BAP and IBA (phytotoxicity), This is in line with findings of Garcia-Gonzales *et al.*, (2011); Díaz-Quichimbo *et al.,* (2013) as treatment with sodium hypochlorite and fungicides such as carbendazim resulted in tissue depigmentation and discolouration.

The survival of the seeds was very low owing to the microbial contamination. Disinfection using carbendazim increased germination rate and reduced the number of contaminated test tubes. Orwa *et al*; (2009) reported that the pathogen *Fusarium sp.* was implicated in wilting as observed in the findings.

Contamination of plantlets has been a constraint to tissue culture. Reports have it that seeds of *C. odorata* possess seed-borne pathogens, which often manifest after days to weeks of regeneration, plantlets wilt and eventually die off (Orozco *et al*., 2010). Die-back was possibly a clue that the root system suffered from insufficient aeration, nutrient depletion in the media or that growth conditions were not optimal for the plantlet. A phenomenon reported by Orwa *et al*., (2009) and Orozco *et al*., (2010), found to occur in healthy 1-2-year-old stands. This phenomenon is common in Central America and the Caribbean where is native to and characterized by poor crowns going out of leaf at frequent intervals, dead-looking bark and die-back from the top linked to pathogens. This was however, not observed in the surviving stands of *C. odorata*.

Pathogens that hindered the survival/viability of the seeds were cultured from contaminated tubes with probable identity as *Fusarium verticilloides*, *Collectotrichum sp., Aspergillus sp.* It is in line with the finding of Orwa *et al.,* (2009) as a mixed colony of organisms in the seeds. Subculture of plants in Murashige and Skoog media supplemented with BAP and IBA (Figure 2 and Table 5a, 5b, and 6) showed *C. odorata was* regenerated successfully in PGR free medium. This finding is in line with that of Garcia-Gonzales (2011). PGR is not required, and now they are expensive. Hence, this finding drastically reduces the cost of *in vitro* production of *C. odorata* with pure clones.

CONCLUSION

Plants are part of our ecosystem. Healthy interaction of plants and microbes to prevent losing them to the harmful activities of some microorganisms that causes diseases is imperative. Successful regeneration of *C. odorata* from seeds was achieved through disinfection using carbendazim. *In vitro* techniques has helped to raise high-quality plantlets which can be made available to farmers. However, recalcitrance observed *in vitro* culture due to fungi and bacteria, the oxidative response of tissues after disinfection, slow response of explants gives room for more research into *in vitro* culture techniques.

Seed collection and storage would be a challenge since the plant fruits between February and March. Its propagation all year round through proper storage is required. It is an insight into further study on seed collection and storage conditions for different forest tree species.

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Early Growth Response of *Tectona grandis* Linn. F. (Teak) Seedlings to Varying Levels of Organic and Inorganic Fertilizer

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ABSTRACT

The use of organic and inorganic fertilizer is a way of providing adequate nutrition to growing seedlings while improving their quality, resistance and adaptation. Seedlings of Tectona grandis Linn. F were evaluated for fertilizer preference in a greenhouse experiment. Uniform seedlings, raised from mature seeds were selected and transplanted into pots containing 2kg of top soil. Two grades of compost manure (CMA: Fortified organic fertilizer and CMA^3: Organomineral) and Urea at three rates were applied to the seedlings. There were 10 treatments including a control, laid in a completely randomised design (CRD) with 5 replicates. The stem height, root collar diameter and leaf area were measured monthly to assess the seedling growth while Biomass accumulation of each seedling was also investigated. Though, there was no significant difference (P>0.05) between the treatments as observed from the analysis of variance at the end of the experimental period, the seedlings response to fertilizer application were however not the same. Seedlings treated with 30 kg Urea/hectare (T_7) gave the best performance in plant height (38.00±12.27 cm) while Treatment 8 (50 kg Urea/hectare) did best in terms of stem diameter (11.62±2.44 mm) whereas control had the least (10.00±2.37 mm). The broadest leaf area (445.22±154.14 m^2) was observed on plants with T_8 compared to others. At 6 months after application, T_7 was observed to have the highest total dry matter yield (23.16±6.40 g/pot) while T_6 had the lowest (19.46±9.43 g/pot). As deduced from this experiment, application of organic fertilizer such as compost manure solely may not improve plant growth within a short period of time while the application of inorganic fertilizers for instance, Urea (30-50 kg/hectare) only on Teak seedlings could supply immediate need of the plant but may not sustain it for a longer period.

Keywords: Compost manure, Fertilizer, Tectona grandis, Urea

INTRODUCTION

Tectona grandis is one of the three species in the genus *Tectona*. The species is placed in the family Verbenaceae. It is a large, deciduous tree that is dominant in mixed hardwood forests. It has small, fragrant white flowers and papery leaves that are often hairy on the lower surface (Nayeem *et al*., 2010). *Tectona T. grandis* is native to south and southeast Asia, but is naturalized and cultivated in many countries in Africa and the Caribbean (Ball *et al*., 1999). It is sometimes known as the "Burmese Teak". Its timber is particularly valued for its durability and water resistance, and is used for boat building, exterior construction, veneer, carving, turnings, and other small wood projects. Teak is often an effective material for the construction of both indoor and outdoor furniture. Its high oil content, high tensile strength and tight grain makes it particularly suitable for this purpose. It is very resistant to termite attacks and highly resistant to rot, fungi and mildew. Due to the high demand for this timber and the reasonably short growth period of teak trees, sustainable teak production should therefore be encouraged. To achieve this would partly involve raising seedlings from a well-drained and fertile soil. It has been stated that, the rate of growth and the quality of teak is largely dependent on the type and quality of the seeds; the physical and chemical characteristics of the soil, as well as environmental factors and on management techniques (Kaosa-ard *et al*., 1998). Teak like all other plants need adequate supply of all the essential nutrients in order to grow and produce quality wood and when nutrients are inadequate or deficient, growth is hindered. Although deficiencies in nutrients are not generally found among trees growing on their natural habitat nonetheless, this does not guarantee growth at their maximum rate. The primary purpose of forest nurseries is to produce and supply quality seedlings to form new forests and re-forest overexploited forest stands (Stoeckeler and Jones, 1957). Improving the fertility of nursery soils is essential to guarantee the production of high quality seedlings for nursery establishment (Rafiqul *et al*., 2004). The potentials of soils to supply nutrients for the growth of trees depend on the physical and chemical properties of the soil. Therefore, intensive tree farming inevitably requires a comprehensive knowledge of the nutrient requirements of forest trees species (Gbadamosi, 2006). Organic manure is an eco-friendly, economically viable and ecologically sound material that also played a significant role in soil biology, chemistry and physics (Surindra, 2009). The proper application of this commercial and organic fertilizer to forest nursery soils is therefore of considerable importance since it may profoundly influence the value of seedlings produced (Focho *et al*., 2011). In the past, studies have shown that tree species either in the nursery or in their natural habitat responds positively to higher levels of soil fertility (Awodola, 1991). Focho *et al* (2011) examine the effect of organic and inorganic fertilizers on early growth characteristics of *Khaya ivorensis* Chev (African mahogany) in nursery. Effects of fertilizer on the early growth of *Tetrapleura tetraptera* was also examined by Offiong *et al*., (2010). He recommended that the use of NPK (15: 15: 15) at high rate or in combination with compost manure could be used to raise vigorous seedlings in nurserie**s**. *Enantia chlorantha* Oliv. was also reported to show a positive response to fertilizer additions as studied by Gbadamosi (2006). Until recently, there has been little or no established information about the response of *T. grandis* to fertilizer amendment in the nursery in order to enhance its proper growth and sustain its production. Hence, this study was conducted.

MATERIALS AND METHOD

The study was conducted in the greenhouse of Soil and Tree Nutrition Department of Forestry Research Institute of Nigeria (FRIN) Ibadan, located between latitude 07°23'18″ N to 07°23'43″N and longitude 03°51'20″E to 03°53'43″E, south west, Nigeria. The top soil (0-15 cm depth) used for the study was collected from FRIN Arboretum. The bulk topsoil collected was air spread and sieved through 2 *mm* sieve after which 2kg of it each was filled into polythene pots of dimension 10 cm by 20 cm while a sub-sample of the bulk topsoil was taken to Institute of International and Tropical Agriculture (IITA) Soil Laboratory for physical and chemical properties analysis. Seeds of *Tectona grandis* were obtained from the seed section of FRIN and pre-treated to overcome dormancy by alternate wetting and drying method for 14 days after which the seeds were then pre-germinated in washed and sterilised river sand (Robertson, 2002). At six weeks, seedlings of near uniform height were selected and transplanted into potted 2kg top soils. The compost manure used as well as its analysis was obtained from the Institute of Agricultural Research and Training (IAR&T), Moor plantation, Ibadan. After two weeks of seedling adaptation, amendments which were two different types of compost manure (CMA: Fortified organic fertilizer and CMA_3: Organomineral) and an inorganic fertilizer (Urea) at three levels each were applied to the seedlings with five replicates in each treatment. A control treatment with no fertilizer application was also set up. The amendments description with their varying levels was shown in (Table 1) below. The experiment was laid out in a completely randomized design (CRD) with 10 treatments replicated five times to make a total of 50 experimental units.

The seedlings were allowed to grow for six months during which plant height, root collar diameter and leaf area were measured monthly. The height was measured with a metre rule; root collar diameter with a Digital venire calliper while the leaf area was determined through the grid method (Oni, 1989). At 6 month of growth, the seedlings were harvested and separated into leaves, stem and root. Each root was placed in a bowl of water while the attached soil was carefully washed off. The fresh weight of the specimen (leaves, stems and roots) were recorded and thereafter parked in different envelopes which were labelled with reference to their treatment. Then they were oven dried at 65°C until constant dry weights were obtained. The weights of the leaves, stems and roots were recorded and were added up to obtain the total dry matter yield. Data obtained were subjected to statistical analysis of variance and means separated by Duncan's multiple range test (Duncan, 1955) at 5% probability level, using SPSS 17th Edition.

Table 1: Fertilizers and different rates used in the experiment

Treatments	Amendments	Rates/hectare
1	CM A	2 tons
2	CM A	4 tons
3	CM A	6 tons
4	CM A_3	2 tons
5	CM A_3	4 tons
6	CM A_3	6 tons
7	Urea	30kg
8	Urea	50kg
9	Urea	70kg
10	Control	No application

Treatment 1- 6 = Organic fertilizer, Treatment 7- 9 = Inorganic fertilizer, CM= Compost manure, A= Fortified organic fertilizer and A_3= Organomineral

RESULTS

As presented in (Table 2), the result of the pre planting soil physical and chemical analysis shows that the soil total N (0.131%) falls below the critical value of (0.15%). The available P (32.4 mg/kg) was very high while the total K (0.35 %) was medium ranged (Olusola, 2009). The pH value (6.4) of the soil indicated it was slightly acidic. The compost manure (A) was fortified with some metallic elements while compost manure (A_3) was enriched with some trace elements.

Table 2: Initial properties of soil and the Amendments analysis

Parameters	Soil	CMP(A)	CMP(A_3)	Urea
pH(H_2O)	6.4	6.75	6.46	-
Organic C (%)	1.32	23.26	29.76	-
Total N (%)	0.131	3.5	3.54	46
Avail P (mg/kg)	32.4	3.0	1.68	-
C/N	-	6.65	8.41	-
K (%)	0.35	2.0	-	-
Ca (cmol/kg)	7.17	2.77	-	-
Mg (cmol/kg)	1.96	0.19	-	-
Na (cmol/kg)	0.17	35	-	-
Mn (ppm)	186.23	93.34	-	-
Fe (ppm)	93.71	71.52	-	-
Cu (ppm)	1.84	14.97	4.2	-
Zn (ppm)	35.99	1.53	3.28	-
Cd (ppm)	-	-	1.36	-
Cr (ppm)	-	-	11.18	-
Ni (ppm)	-	-	9.3	-
Textural class	Sandy loam	-	-	-

There was no significant difference (P>0.05) in the mean height of the *T. grandis* seedlings among the fertilizer applied at the end of the six month duration. Nevertheless, the highest mean height (38.00±12.27 cm) of the plant was obtained from the seedlings treated with 30 kg Urea/ha (treatment T_7) as shown on Table 3. While tTreatment 8 (50 kg Urea/hectare) did best in stem diameter (11.62±2.44 mm), though the data analysis shows no significant difference (Table 4). Similarly, in Table 5, the broadest leaf area (445.22±154.14 m^2) was observed in treatment 8 follow by treatment 1 compared to others. At 6 months after application, Treatment 7 was observed to have the highest total dry matter yields (23.16±6.40 g/pot), while, T_6 (6 tons compost manure/hectare) had the lowest (19.46±9.43 g/pot). Though, analysis of variance shows no significant difference between the treatments (Table 6).

Table 3: Effect of organic and inorganic fertilizer on the mean Height (cm) of 24 weeks old *Tectona grandis* seedlings

TR	Week 4	Week 8	Week 12	Week 16	Week 20	Week 24
1	24.10±8.3	24.34± 8.15	25 .20±7.98	27.20±7.3	28.00±9.35	32.30±17.6
2	25.74±8.7	26.30±10.3	26.40±10.0	27.50±9.7	28.00±9.30	28.40±9.84
3	26.98±5.7	29.20±5.64	29.20±6.50	30.40±6.5	30.60±7.77	31.80±6.30
4	29.60±6.1	30.96±7.17	31.50±7.04	32.20±6.8	32.40±5.94	34.10±7.68
5	23.64±3.4	25.10±2.79	30.50±9.80	24.90±2.8	26.30±2.82	26.70±3.03
6	23.94±7.7	26.16±7.46	27.10±7.30	27.70±7.6	27.30±6.42	31.60±12.2
7	29.02±8.4	29.84±8.84	32.30±7.84	33.90±8.8	35.60±11.0	38.00±12.2
8	26.38±5.3	28.56±5.95	29.60±6.07	30.30±6.2	29.92±5.22	31.50±7.53
9	22.40±8.1	22.70±7.55	23.30±6.30	25.90±5.0	26.80±5.53	27.60±6.35
10	26.04±6.3	26.10±6.23	27.10±5.92	28.30±5.2	28.90±4.77	27.10±4.56

Means within each column were not significantly different (p> 0.05)

Table 4: Effect of organic and inorganic fertilizer on stem diameter (mm) of 24 weeks old *Tectona grandis* seedlings

TRT	Week 4	Week 8	Week 12	Week 16	Week 20	Week 24
1	4.76±1.26	6.69±1.53	8.47±2.25	9.35±2.05	9.97±2.26	10.27±2.31
2	5.07±1.85	7.21±1.40	8.46±2.13	9.08±2.08	9.90±1.52	10.81±1.05
3	5.04±0.89	7.29±1.60	9.46±1.07	9.92±0.97	10.94±2.75	10.93±1.06
4	4.95±1.03	7.23±1.11	9.31±0.90	11.01±1.06	10.57±0.54	11.13±0.47
5	5.30±0.88	6.51±3.04	9.90±1.38	9.39±2.50	10.43±1.73	10.55±1.85
6	4.95±1.20	6.90±1.83	8.73±2.86	9.42±2.95	9.65±3.16	10.01±3.19
7	4.92±0.88	7.06±1.18	7.63±1.90	8.59±1.74	9.63±1.22	10.21±1.57
8	4.54±1.14	6.81±1.54	8.74±1.10	9.64±1.82	10.97±2.76	11.62±2.44
9	5.26±1.95	7.97±2.83	8.51±3.67	11.53±2.88	10.61±3.42	11.08±2.56
10	5.19±1.26	7.67±2.40	9.07±2.54	9.56±2.79	10.13±2.45	10.00±2.37

Means within each column were not significantly different (p> 0.05)

Table 5: Effect of organic and inorganic fertilizer on leave area (m^2) of 24 weeks old *Tectona grandis* seedlings

TR	Week 4	Week 8	Week 12	Week 16	Week 20	Week 24
1	224.18±42	316.81±36.1	365.56±34.	415.11±70.	298.05±63.	440.56±114
2	199.41±46	270.62±90.9	337.22±56.	387.26±118	313.04±164	418.50±123
3	242.18±61	254.96±92.5	335.56±89.	310.58±58.	301.02±144	434.86±188
4	219.03±28	331.71±50.6	378.25±79.	347.05±143	293.04±60.	434.86±51.
5	233.08±58	323.76±62.2	323.76±110	258.81±108	239.29±98.	297.10±81.
6	189.01±45	333.97±82.2	323.78±90.	292.13±188	328.19±176	365.62±125
7	190.56±42	292.93±68.8	343.92±98.	345.26±70.	241.42±134	420.20±41.
8	205.24±42	338.05±29.1	341.67±41.	342.93±63.	344.07±46.	445.22±154
9	219.04±67	366.40±104.	275.29±35.	306.03±87.	309.03±88.	404.70±197
10	199.54±39	305.49±29.7	329.01±45.	336.40±69.	290.91±79.	424.88±183

Means within each column were not significantly different (p> 0.05)

Table 6: Effect of organic and inorganic fertilizer on the Biomass (g/pot) of 24 weeks old *Tectona grandis* seedlings

TRT	Leave	Stem	Root	Total dry matter
1	6.20±4.26	4.42±2.74	11.40±7.72	22.02±12.65
2	5.60±2.19	4.16±2.07	10.18±4.65	19.94±8.27
3	4.94±2.57	5.06±1.47	12.34±2.16	22.34±3.99
4	6.08±2.20	4.62±1.48	10.70±1.90	21.4±3.89
5	3.48±1.18	3.88±1.01	14.72±8.18	22.08±10.19
6	4.04±2.71	4.24±2.40	11.18±6.00	19.46±9.43
7	5.68±3.26	4.66±1.51	12.82±6.94	23.16±6.40
8	5.38±2.28	4.58±2.36	11.66±6.27	21.62±9.93
9	4.86±2.37	3.72±0.93	13.66±8.22	22.24±7.87
10	4.38±2.14	3.70±1.49	12.38±5.83	20.46±7.93

Means within each column were not significantly different (p> 0.05)

DISCUSSIONS

As observed from this study, response of teak seedlings to fertilizer applications were not significantly different in terms of the parameters assessed from one another. Reason is because the organic matter contained in the compost treatment decomposes very slowly (Dan, 2008) and in turn lowers the rate of its mineralization in the soil. The rate of mineralization in soil depends upon the "digestibility" of manure organic matter, its carbon to nitrogen ratio (C: N), the composition and the experimental period. Application of the compost even at higher rate (Table 1) did not show any significant influence on plant growth parameters assessed. This suggests that even at such a rate, the compost manure used did not supply enough nutrients early. It should be noted that, the maximum mean height observed in (Table 3), the highest mean stem diameter shown in (Table 4), the largest mean leave area reported in (Table 5) and the highest dry matter (Table 6) were all recorded from seedlings applied inorganic fertilizer treatments compared to compost manure treatments and control. This result correlates to that of Zahir *et al.*, (2006) who stated that Farm yard manure alone did not prove as effective as urea alone on the straw yield under the given experimental condition. It is as well similar to that of Gagnon *et al.*, (1998), who reported that Compost applications resulted in lower soil inorganic N contents than in the Ammonium Nitrate treatments at equivalent total N. Equally, less than 7 % N availability from applied composted dairy manure was observed and higher wheat grain yield was obtained with inorganic N fertilizer in (1997) by Gagnon and concluded that Farm composts did not significantly contribute to soil inorganic N enrichment throughout the season he observed.

CONCLUSION

Information about the nutritional requirement of plants is essential for proper management of trees in the Nursery. As deduced from this experiment, application of organic fertilizer such as compost manure solely may not improve plant growth within a short period of time while the application of inorganic fertilizers for instance, Urea (30-50) kg/ha only on Teak seedlings could supply immediate need of the plant but may not sustain it for a longer period. Adjustment of organic fertilizers with Nitrogen fertilizer is therefore recommended in order to supply the initial *T. grandis* nutrient requirements at seedling stage.

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Influence of Acid Pre-treatments on Germination and Early Growth of *Parkia biglobosa* (Jacq.)

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ABSTRACT

This study was carried out at the Department of Forestry Technology nursery site of Federal College of Agriculture, Akure, Ondo State, Nigeria to investigate the effectiveness of acid pre-treatment on germination, early growth of Parkia biglobosa seeds. The seeds were subjected to four (4) different durations of pre-treatments, namely: A- Seed soaked in H_2SO_4 for 1 minute, B- Seed soaked in H_2SO_4 for 3 minutes, C- Seed soaked in H_2SO_4 for 5 minutes, D – Control (seed without soaking in acid). At the end of the germination experiment, the highest cumulative germination was recorded for seeds soaked in H_2SO_4 for 5 minutes which had 90%, followed by seeds soaked in H_2SO_4 for 1 minute with 75% and seeds soaked in H_2SO_4 for 3 minutes and control had 65%. Seedlings selected for seeds soaked in H_2SO_4 for 3 minutes had the highest total height while seedlings selected from seeds without soaking in acid had the lowest total height growth rate. Seedlings selected for seeds soaked in H_2SO_4 for 3 minutes had the lowest collar diameter while other seedlings selected had the same value. The seeds soaked in H_2SO_4 for 5 minutes produced the highest numbers of leaves followed by seed without soaking, then seed soaked for 1 minute and seed soaked for 3 minutes produced the least. Seedlings selected from seeds soaked in H_2SO_4 for 5 minutes produced the highest numbers of branchlet followed by seeds soaked for 3 minutes, then seeds without soaking and seeds soaked for 1 minute produced the least number of branches.

Keywords: Seed, dormancy, germination, treatment, indigenous species.

INTRODUCTION

Parkia biglobosa is found in a wide range of environments in Africa including Nigeria (Dau *et al*., 2016). It is a dicotyledonous angiosperm, belonging to the family *Fabaceae* (Alabi, 2005). The pods of the tree, commonly referred to as locust beans, are pink in the beginning and turn dark brown when fully mature (Elly and Joseph, 2012). The pods are about 30- 40cm long on average, while some of the pods reach lengths of about 45cm in length, and its contains up to 30 seeds per pod. *Parkia biglobosa* species has several uses, including fodder, food, medicine, green manure, fuel wood, timber and economic purposes (Elly and Joseph, 2012). The yellow pulp, which contains the seeds, is naturally sweet and is processed into a valuable carbohydrate food known as Sikomu and Daddawa among the Yoruba and Hausa people of Nigeria (FAO, 2013). The cultivation of the tree can be seen as an important economic activity for many in Africa both among men and women (Teklehaimanot, 2004). Indigenous healers in Africa use different parts of the locust bean tree for health benefits (Dau, 2016). More attention has been given to economic important species of tree plants especially *P. biglobosa* in recent years for a sustainable use and integrated management due to an increasing recognition of its contribution to fulfill basic needs of people, household economics, food security and conservation of natural resources (Joshi and Joshi, 2009). *Pakia. Biglobosa* (Jacq) Benth is a common species in agro-forestry, it plays a vital role in food security, supply of timber, firewood, fodder, drugs, and dyes as well as restoration of fertility (Okunlola *et al.,* 2011). Latiff *et al.*, (2002) reported that forest resources directly contributed up to 180% of the livelihood of the people in the country living in extreme poverty. The species provides food, income and employment to the people (Tee and Popoola, 2007; Tee and Verinumbe, 2007). This species provides protein, starch, vitamins and essential materials to human diet. It also, provides income and employment opportunities to rural and urban households (Tee *et al*., 2009). The root, bark, leaves, stem, flowers, fruits and seeds of the tree species are all used for medicinal purpose to treat a range of ailments including diarrhea, ulcers, pneumonia, burns, coughs, jaundice etc (Sacande and Clethero, 2007). However, *P. biglobosa* possesses an exogenous dormancy in which the hard seed coat prevents its germination hence posing silvicultural problems that discourages farmers from raising the plant at nursery stage (Hall *et al*., 1997). This problematic basis despite its numerous economic importance of plant makes it imperative to intervene in its domestication and conservation to save this important tree from extinction. Thus, this study is set up to device an easier and faster means towards the propagation of *P. biglobosa*.

MATERIALS AND METHOD

Site Description: The experiment was conducted at the Departmental nursery site of Forestry Technology Department of Federal College of Agriculture, Akure, Ondo State, Nigeria. The annual rainfall of the college ranges between 1100mm and 1500mm per annum, while the relative humidity is about 70% and the temperature ranges from 25°C and 30°C respectively.

Nursery Practice

The sowing medium (top soil) was collected from a virgin land at the base of the rock and mixed with poultry droppings and also treated with pesticides to guide against pest and disease infestation. The polythene bag was cleaned and perforated for proper drainage. Watering was done once daily and when it rains wetting is not done until the soil is dry. More so, insecticide was used to control and prevent the infestation of pest and diseases.

Pre cropping Soil Analysis

Soil samples collected were analyzed using standard procedures. All the soil samples were air-dried and then sieved using a 2-mm sieve. Particle sizes larger than 2mm were weighed as gravel content and expressed as percentage:

$$\frac{\text{Weight of gravel}}{\text{Total weight of soil sample}} \times 100\%$$

Treatment Combination

Concentrated H_2SO_4 was used as the acid pretreatment.

A- Seeds soaked in H_2SO_4 for 1minute.

B- Seeds soaked in H_2SO_4 for 3minutes.

C- Seeds soaked in H_2SO_4 for 5minutes.

D – Control (seeds without soaking in acid).

Method of Data Collection and Data Analysis

Immediately after sowing the days of germination were recorded and germination count started from the first day the seeds germinated also till stable germination was noticed. Ten seedlings were selected from each treatment and data was collected at the interval of 2 weeks on number of leaf, plant height, Collar diameter and plant branches. All data collected was subjected to Analysis of Variance (ANOVA) and the means were separated with the use of Duncan Multiple Range Test (DMRT) at 5% probability.

RESULTS AND DISCUSSION

Table 1: Result of Soil Test before Planting

Parameters	Values
Soil Ph	5.67 (1:2 H_2O)
Organic Carbon	2.12%
Organic Matter	3.7%
Nitrogen	0.12%
Phosphorus	3.8 mg/kg
Potassium	2.91 cmol/kg
Sodium	0.14 cmol/kg
Calcium	1.09 cmol/kg
Magnesium	0.58 cmol/kg
Cation Exchange Capacity	8.43 cmol/kg
Exchangeable Acidity	0.1 cmol/kg
Sand	58%
Silt	30%
Clay	12%
Textural class	Sandyloam

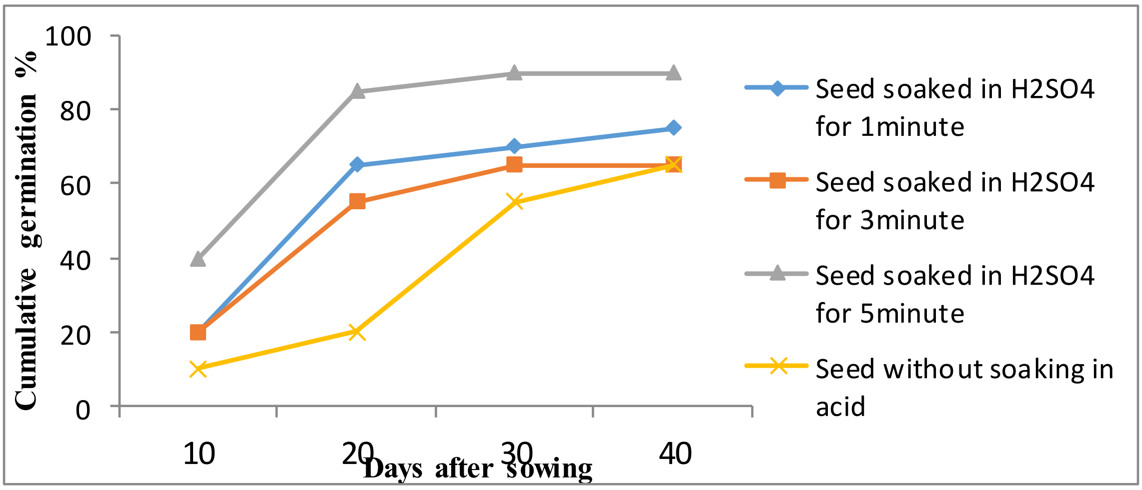

Figure 1: Showing the Cumulative Germination % of *Parkia biglobosa*

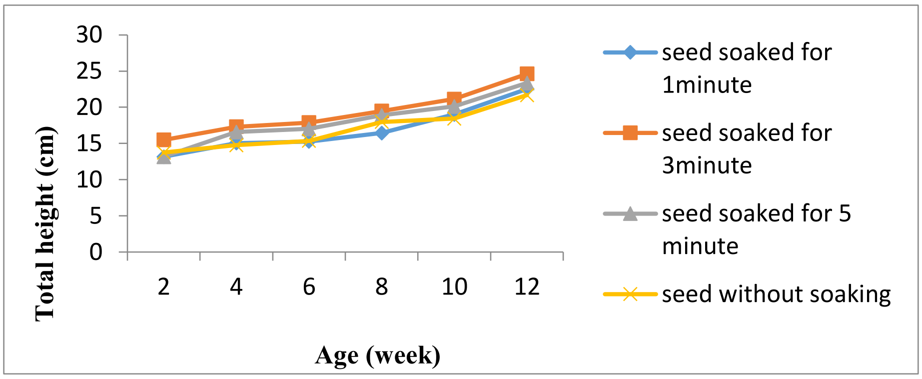

Figure 2: Effect of Acid Pretreatment on Total Height (cm) of *Parkia biglobosa*

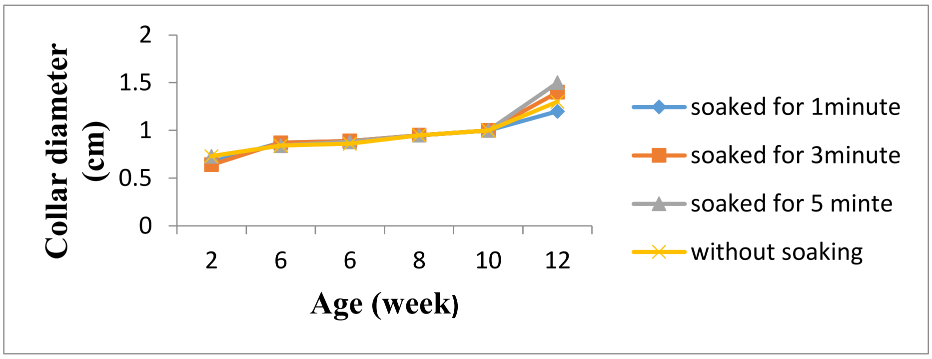

Figure 3: Effect of Acid Pretreatment on Collar Diameter (cm) of *Parkia biglobosa*

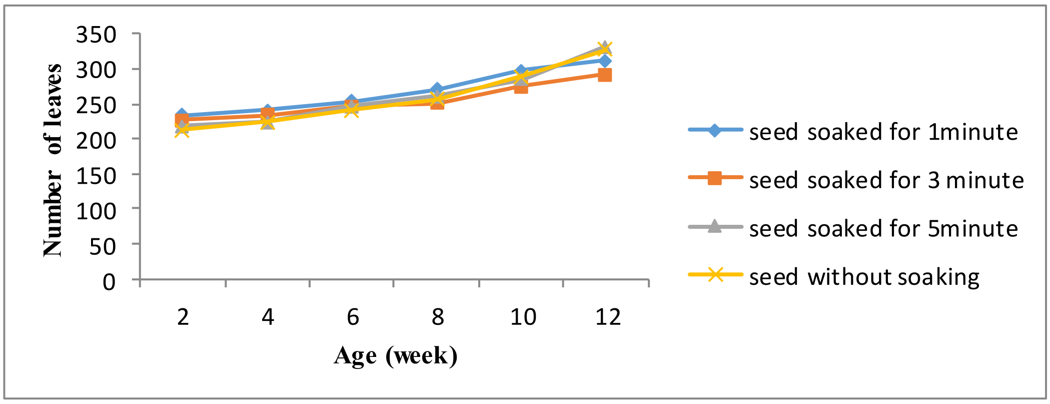

Figure 4: Effect of Acid Pretreatment on Numbers of Leaves of *Parkia biglobosa*

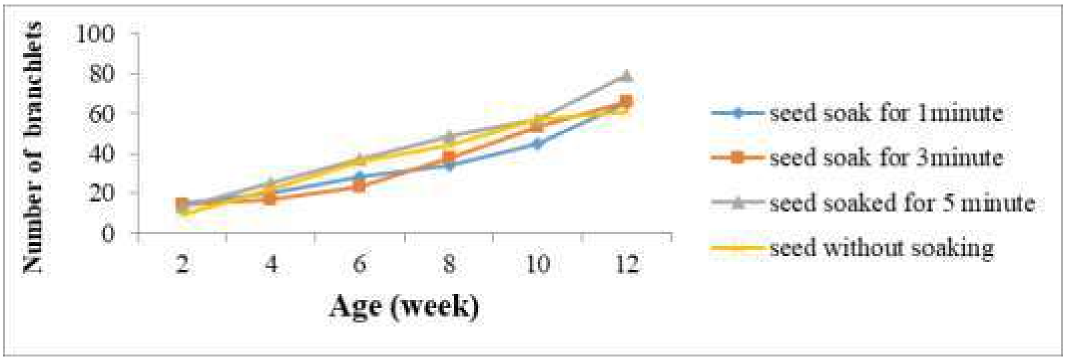

Figure 5: Effect of Acid Pretreatment on Branchlet of *Parkia biglobosa*

Table 2: Result of Analysis of Variance (ANOVA) for the Effect of Acid Pretreatment on Seed Germination and Early Growth Characteristics of *Parkia biglobosa* Seedlings

Treatment	Seed germination %	Total height (cm)	Collar diameter (cm)	Numbers of leaves	Numbers of branches
Soaked for 1 minute in H_2SO_4	75^b	22.36^c	1.48^a	137.34^d	16.38^c
Soaked for 3 minutes in H_2SO_4	65^c	26.94^a	1.46^a	140.37^c	20.43^b
Soaked for 5 minutes in H_2SO_4	90^a	24.61^b	1.48^a	176.05^a	22.75^a
Without soaking in acid	65^c	20.53^d	1.48^a	146.14^b	18.53^c

Values followed by similar alphabets along the same column are not significantly different ($p>0.05$)

The result of the physico-chemical properties before the experiment is shown in (Table 1), where the pH value was 5.67, this indicates that the soil is slightly acidic. The Organic Carbon content is 2.12%, Organic Matter is 3.7%, total Nitrogen is 0.12%, and available Phosphorus 3.8mg/kg. The Exchangeable Cations; Potassium, Sodium, Calcium, Magnesium contents are 2.91cmol/kg, 0.14cmol/kg, 1.09mol/kg, and 0.58 cmol/kg respectively. The soil contained 58% Sand, 30% Silt and 12% Clay which makes the soil texturally classified as sandy loam.

The germination of *P. biglobosa* seed planted was monitored for 6 weeks until there is no further germination of seed again. The results showed that there was rapid germination of seed from the ninth day to the fourteenth day after sowing for soaked seed in H_2SO_4 under 1 minute and further germination was slow till the thirty-fifth day after sowed. Also seeds soaked in H_2SO_4 for 3 minutes had rapid germination between the ninth days to thirteenth day after sowing, after which further germination was slow till the twenty-sixth day. The seed soaked in H_2SO_4 at 5 minutes had rapid germination at the eighth day to sixteenth day after sowing, and further germination was slow till the twenty-fourth day after sowing and seed not soaked in H_2SO_4 has a rapid germination from the eighth day to the tenth day and further germination was slow till the thirty seventh day after sowing. At the end of the germination experiment, the highest cumulative germination was recorded for seed soak in H_2SO_4 for 5 minutes had 90%, followed by seed soak in H_2SO_4 for 1 minute with 75% and seed soak in H_2SO_4 for 3 minutes and control had 65%. The result of the experiment shows that soaking *Parkia biglobosa* seed in H_2SO_4 for 5 minutes produces high germination percentage when compared to other treatment used which is in conformity with the observation of Amonum *et al*., (2016) which says immersion of seed in concentrated tetraoxosulphate (iv) acid helps to disrupts the seed coat and expose the lumens of the macrosclereids cells, permitting inhibition of water (Amonum *et al*., 2016). This enhanced seed germination with increasing time was also reported by Awodola (1994), Aduradola and Shinkafi (2003), for *Parkia biglobosa* (Jacq) Don. and *Tamarindus Indica* Linn. In addition, this is also similar to the report by Duguma *et al*. (1988) that germination percentage increased with longer treatment time of acid.

At the end of the germination, ten (10) seedlings of relatively uniform height were selected from each of the treatments under consideration. The selected seedlings were used to monitor the total height (cm), numbers of leaves, numbers of branches and collar diameter (cm). The measurement of these growth parameters was done every two (2) weeks for twelve (12) consecutive weeks. The result of the total height of *Parkia biglobosa* seedling as influenced by acid pretreatment is shown in Figure 2. At the end of 12 weeks, the mean total height growth from *Parkia biglobosa* seedlings as influenced by acid pretreatment ranged from 20.53cm – 26.94 cm. Seedlings selected for seed soaked in H_2SO_4 for 3 minutes had the highest total height while seedlings selected from seed without soaking in acid had the lowest total height growth rate. Statistically, there were significant differences between the height growths of the seedlings raised under the various treatments. Total height growth of *P. biglobosa* seedlings from seed without soaking shows statistically that seedlings are significantly lower than seedlings from seed soaked in H_2SO_4 for 5 minutes , seedlings from seed soaked in H_2SO_4 for 1 minute and seedlings from seeds soaked in H_2SO_4 for 3 minutes. The results of the present study is in accordance to the study of Levitt (1994), who reported that immersion of seed in highest concentrated sulphuric acid disrupts the seed coat. Aliero (2004), also reported that 98% concentrated sulphuric acid gave the highest percentage of germination and within the shortest period as compared 90%, 70% and 50% respectively. The result of collar diameter of *P. biglobosa* seedling as influenced by acid pretreatment is shown in Figure 3. At the end of the 12 weeks of growth, the mean collar diameter of *P. biglobosa* seedling influenced by acid pretreatment ranges from 1.46 cm – 1.48 cm. Seedlings selected for seed soaked in H_2SO_4 for 3 minutes has the lowest collar diameter while other seedlings selected has the same value. Statistically, there were significant differences between the height growths of the seedlings raised under the various treatments. The collar diameter of *P. biglobosa* seedlings from the treatments shows statistically that seedlings has no significant difference in collar diameter. The result of the number of leaves of *P. biglobosa* seedling as influenced by acid pretreatment is shown in Figure 4. There was variation in the mean numbers of leaves produced by the seedlings of *P. biglobosa* at the end of the 12 weeks of growth and development. Depending on treatment, the numbers of leaves produced ranged from 137 -176.

The seedlings with the highest numbers of leaves were those selected from seeds treated with H_2SO_4 for 5 minutes. There was a significant difference between the treatments from the seedling selected and the seed soaked in H_2SO_4 for 5 minute produced the highest numbers of leaves followed by seed without soaking, then seed soaked for 1 minute and seed soaked for 3 minutes produced the least. The result of the number of branchlets of *P. biglobosa* seedling as influenced by acid pretreatment is shown in Figure 5. There was variation in the mean numbers of branchlet produced by the seedlings of *Parkia biglobosa* at the end of the 12 weeks of growth and development. Depending on treatment, the numbers of branchlet produced ranged from 16-18. The results revealed that it is evident that seedlings raised from seeds soaked in Tetraoxosulphate (vi) acid with increasing exposure regime from 1 to 5 minutes had the best vegetative characters (stem girth, stem height and leaf counts) which concurred with the result of El-Juhany *et al*. (2009) on the seedlings of *Juniperus procera.*

CONCLUSION

Germination of seeds is vital to all sowers, whether silviculturist, botanists, agriculturists. It is therefore essential to determine the best time for soaking seed pre germination treatment to quicken their germination rate and growth. It is obvious that soaking seeds in H_2SO_4 for 5 minutes gave the highest germination percentage (90%). It is therefore recommended that soaking *P. biglobasa* seed in H_2SO_4 for 5 minutes should be used because of its effectiveness in breaking dormancy and improvement in seedlings vigour which in turn enhances the domestication and cultivation of these valuable seeds in the environment.

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PROCEEDINGS

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Rufus Giwa Polytechnic, Owo Ondo State

SUB-THEME 6

Fisheries and Aquaculture, Production, Nutrition, Genetic Improvement and Post-Harvest Technology

Analysis of Management Systems and Constraints in African Catfish (*Clarias gariepinus*) Production in Ebonyi State, Nigeria

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ABSTRACT
This study analyzed the management system and constraints in African catfish production in Ebonyi state, Nigeria. The specific objectives were to, describe management systems adopted by African catfish producers in Ebonyi State and also to examine constraints to African catfish production in the study area. Four Local Government Areas were purposively chosen, from each of which two communities were purposively selected and out of which twenty African catfish producers were randomly selected to give a total of eighty respondents for the study. Descriptive statistical tools were used in analyzing the objectives. Most of the African catfish producers (44.40%), adopted the intensive management system, they preferred keeping their fish in fishponds at homes, while few of them, (17.1%), practiced the extensive management system whereby they rear their fish in streams, rivers, lakes and ponds constructed outside their homes.
Keywords: African Catfish Management, African Catfish Production, Ebonyi State

INTRODUCTION
Management of natural resources all over the world is of paramount importance to the sustainability of natural resources in developing countries like Nigeria. Sarch, *et al*. (2007) identified and distinguished three main typologies of management systems of fishery, namely: Traditional systems - classified as management systems operated by the administration of traditional authorities; Mixed systems - involve the participation (either intentionally or inadvertently) of both the traditional and the modern government administrations; Modern systems include those operated by the administrations of the central government where fisheries regulations are enforced by officers of the Fisheries Departments. All the three management systems operate in Nigeria (Ladu, *et. al*., 2000; Neiland *et. al.* 2002).

The various management systems described above have also contributed to the sustainability of the fishery industry. While the mixed system is dominant, the traditional management system is pervasive and appears to be working very effectively in regulating fishing activities for the benefit of both primary stakeholders (fishers, processors, etc.) and the resource itself (Ovie and Raji, 2006). Fish farming is the principal form of aquaculture which includes raising fish commercially in tanks or enclosures, usually for food. It is also a system developed to supplement specie from going extinct. Ebonyi State has a fair share of vast fishery resources. These include rivers, dams, and ponds where many fishing activities take place. Despite these considerably high potentials, local fish production has failed to meet the country's domestic demand (FAO, 2016). The fish industry remains the most virgin investment in Nigeria compared with the importation of frozen fish in the domestic market (Ndu, 2006). A sure means of substantially solving the demand -supply gap is by embarking on widespread homestead/small scale fish production. However, the sources of this effort must be anchored on analysis of fish production (FDF, 2008). Catfish of the family *Claridae* is the most commonly cultivated fish in Ebonyi State. The fish species cultivated are *Clarias gariepinus*, *Tilapia* spp and *Heterobranchus spp*. Catfish is largely cultivated because of its high preference, good market ability, fast growth rate, good feed conversion rate, high resistance to disease, low mortality rate and ability to survive in both running and stagnant water, thus many farm focus on catfish, as they can have a marked value size of two to three times that of tilapia.

Despite the popularity of African catfish and its great market potentials in Ebonyi State, the production level is still not sufficient enough for consumers in the state, and this is due to several factors influencing its productivity negatively. Inadequate supplies from local fish farmers due to the use of poor quality fingerlings, inadequacy of catfish production information, high cost of feeds, small size of holdings, inefficient resource use, poor infrastructural facilities, lack of credit facilities, lack or inadequate of extension agents, lack of veterinary doctors (fishery specialists) and lack of fish production equipment and low capital investment were posited by literature for the consistent decline (Inoni, 2007). There is less emphasis on proper management of fishery and other aquatic resources in Ebonyi State. This is due to lack of sensitization and enlightenment of the rural dwellers who are closer to such natural resources. In general, therefore, fisheries management systems in Nigeria can be described as variable and hindered by poor financial support for policy implementation. Hence, this study was undertaken to assess the management and constraints encountered by African catfish farmers in the study area.

METHODOLOGY

This study was based on primary data, obtained from a cross-sectional survey of African catfish farms in Ebonyi South agricultural zone, Ebonyi State. The study area is one of the three zones that make up the state in the rainforest area in southeastern Nigeria, the others being Ebonyi North and Ebonyi Central. The study area, Ebonyi South Agricultural Zone of Ebonyi State, comprises five local governments areas (LGA), namely: Ivo, Afikpo North, Afikpo South Ohaozara and Onicha. The required information was obtained through personal structural questionnaires administered to a target sample of eighty (80) catfish producers. Farms were selected using a two-step sampling process. In the first stage, four (4) LGAs, namely Ivo, Afikpo South, Onicha and Ohaozara, were selected due to the intensity of catfish production in these areas. During the second stage, twenty (20) African catfish farms were selected in each of the four local government areas based on their population. Descriptive statistical tools were employed in realizing objectives.

RESULTS AND DISCUSSION

Management System Adopted by Respondents in the Study Area

Catfish management system adopted by the respondents in the study area is shown in Table 1. From the result, majority of the respondents (44.4%), adopted the intensive catfish farming system. These catfish producers preferred keeping their fish in fishponds at home, supplying feeds and drugs to fish intensively thereby keeping them away from thieves, predators as well as monitor the output on daily bases. Few of them, (17.1%), practiced the extensive catfish management system whereby they reared their fish in streams, rivers, lakes and ponds constructed outside their homes. This may be due to the fact that most fish farmers in the study area were engaged in one occupation or the other to earn extra income to aid them augment their income which might be insufficient to cater for their needs. This consolidates with Filli *et al*. (2016). However, 38.5% adopted both the intensive and extensive systems.

Table 1: Catfish Management System in the Study area

Management System	Percentage
Extensive Farming System	17.10
Intensive and Extensive Farming System	38.50
Intensive Farming System	44.40

Source: Computed from survey data, 2021

Constraints to Catfish Production in the Study Area

The factors affecting fish production are shown in Table 2. The result obtained indicates that, the most important constraint encountered in fish production were capital, power supply, water supply, diseases and pests as indicated by as many as 88.75, 72.50,72.50 and 62.50% of the respondents respectively. Poor power supply lead to high cost of water supply. With respect to marketing, the farmers indicated that, they faced the problem of lack of organized fish marketing system which resulted in all the farmers selling their live fishes at the farmers' farm gate. Fish production was affected positively through effective delivery of fingerlings/juveniles leading to high mortality rate and feeds to the fish farmers. Furthermore, fish was sold live and therefore storage/preservation did not constitute any major problem.

Table 2: Constraints encountered in fish production (N = 80)

Constraints	**Number of respondents with problems**	**Percent of respondents**
Sk*illed labor	74	92.5
Supply of fingerlings/ juveniles	4	5.00
Availability of feed	4	5.00
Water supply	58	72.50
Capital/finance	71	88.75
Disease and pest	50	62.50
Lack of organized market	48	60.00
Transportation	4	5.00
Storage	2	2.50
Power supply	58	72.50

Source: Computed from survey data, 2021

CONCLUSION

It could be deduced from the study, that most of the African catfish producers in Ebonyi State, Nigeria, (44.40%), adopted the intensive catfish management system, they preferred keeping their fish in fishponds at home, while few of them, (17.1%), practiced the extensive catfish management system. The challenges of finance, input costs, infrastructural challenges and other economic factors faced by catfish farmers in Ebonyi state appear to be similar to those found elsewhere. Scarcity of viable fingerlings and small pond sizes are also operational challenges that require serious attention in the area. It is therefore imperative to address this issues, focusing on the peculiarity of some, in order to promote catfish production in the area. To this end, credit facility or grants should be made available by financial institutions to the catfish farmers at low interest rates to address the issue of inadequacy of capital. Such empowerment will assist in the acquisition/construction of larger pond, in addition to the procurement of other inputs. Furthermore, research into local feeds source and monitoring of local feeds production to improve their qualities, will minimize the need to import feeds at high cost and ultimately will reduce the total cost of production. Also, government support, through viable extension service will help train African catfish farmers on climate change mitigating strategies. This will have to be achieved through training, motivation and monitoring of extension personnel. Finally, government support may also be in the form of addressing infrastructural challenges like those of power and water as well as training. For instance, improved power supply and water quality, in addition to availability of skilled manpower will improve access to viable fingerlings as this may encourage the establishment of certified hatcheries in the area. It will also aid in transportation as well as processing and storage of products

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Ornamental Fish Composition and Potentials of Yewa Lagoon, South-West Nigeria

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ABSTRACT
A study of the ornamental fish composition and potentials of Yewa Lagoon was carried out for a period of two years (April 2017 to March 2019). Fish samples were purchased from local fisher-folks operating in the lagoon who used different kinds of fishing gears such as cast nets, set nets, gill nets, circling nets, bamboo traps, baskets, drums, hook and lines as well as fencing with acadja. Ornamental fish species were sorted and identified with relevant identification guides. 33 ornamental fish species belonging to 20 families were encountered in this study. Chrysichthys nigrodigitatus was the most important ornamental fish recorded and it found throughout the study period. The least abundant fishes included Dagetichthys lakdonensis, Dormitator lebretonis, Malapterurus electricus, Parentropius buffei. Highest abundance was recorded in the rainy season (63%) compared to dry season (37%). Highest abundance of fish was highest in April 2017 (242) and least in November 2018(17). 30 species out of the total taxa occurred in the rainy season while 18 were recorded in dry season and 15 species were found in the two seasons. Yewa lagoon has the potentials and capabilities to support ornamental fisheries sustainably with best conservation and management practices put in place.

Keywords: Ornamental, fish composition, occurrence, potential, Yewa Lagoon

INTRODUCTION
Nigerian waters are sufficiently blessed with a lot of fish species, ornamental fishes inclusive. Ornamental fishes are species of fishes with special characteristics such as size (big or small), unusual and striking shapes, appendages, attractive colours and marks as well as desirable qualities such as hardiness, longevity, ability to be held in captivity and commands aesthetic values (Ukaonu *et. al*., 2011 and Mbawuike *et. al*., 2014). They are not limited to fish fauna alone as they may include other aquarium organisms like invertebrates (corals), crustaceans (crabs and shrimps), molluscs (snails, clam, scallops) (Ukaonu *et. al*., 2011). The interests in ornamental fishes and fisheries have been on the increase as a result of its foreign exchange earnings and global marketing opportunity. Globally, ornamental fish business and its associated industries have been a lucrative part of the economic sector of fisheries which have earned millions of dollars to the participating individuals and the countries at large (Andrew, 1991; Areola, 2004; Ukaonu *et al*., 2011). In Nigeria, over 100 species have been identified and listed in the export trade and all these are mainly got from the wild with their sustainability and degree of exploitation not well established and documented (Koroye, 2010; Areola, 2004; Ukaonu *et. al*., 2011). The aquaculture aspect of ornamental fishery has not been fully attained as most of the stakeholders still source for species from the wild. The ornamental fishes trade in Nigeria have started over 50years ago (Areola, 2004). Ukaonu *et. al*. (2011) have reported the volume and value of ornamental fish in the Nigerian export trade. Majority of the documented and exported ornamental fish species are freshwater species which are generally dull coloured but highly sought due to its hardiness (Mbawuike *et. al*., 2012; Areola 2004). Yewa Lagoon is close to the boundary between Republic of Benin and Nigeria. It lies

approximately within latitudes $6^{0}22'$ to $6^{0}36'$ North and longitudes 2^{0} $50'$ to 2^{0} $54'$ East of the Greenwich Meridian. Located around Yewa Lagoon are several villages such as Doforo, Iyafinlsalu, Panko Tofa, Itohun, whose inhabitants are mostly artisanal fisher folks from Awori, Egun, Ijaw, and Ilaje tribes. Few works are available for Yewa Lagoon and they include the work of Effiong and Inyang (2015) on the epiphytic algae on aquatic macrophyte (Water Hyacinth) in Yewa lagoon and their possible use as indicator. Bamidele *et al* (2015) worked on the diversity of Tilapia in Yewa Lagoon. The aim of this study is to provide information on the ornamental fish status and potentials of Yewa Lagoon. There is dearth of information on this subject matter, hence the motivation and desire borne in order to bridge the information gap as well as provide baseline data for future exploitation and formulation of management policies for the sustainability of the ornamental fish resources of Yewa lagoon.

MATERIALS AND METHODS

Yewa Lagoon is a trans-boundary lagoon between Republic of Benin and Nigeria. It lies approximately within latitudes $6^{0}22'$ to $6^{0}36'$ North and longitudes 2^{0} $50'$ to 2^{0} $54'$ East of the Greenwich Meridian. The basin has a total catchment area of approximately 5000 km^2 and it is located within the West African tropical climate, which is under the influence of the tropical continental air mass and the tropical maritime air mass. Yewa River is the major sources of water to Yewa lagoon, while it is drained by Badagry Creek (Nigeria) and Port Novo Creek (Benin Republic) in the south which empties into the Atlantic Ocean via Lagos Harboùr (Figure 1). The lagoon is known for fishing, logging, sand mining boating and transportation activities which make Yewa Lagoon of great economic importance to the surrounding villagers and beyond. Yewa Lagoon is inhabited by several plants; its major flora includes sedges (*Cyperu sarticulatus, C. papyrus*, and *Paspalum vaginatum*); ferns (*Achrosticum sp, Marsilea sp, Cyclosorus sp*, and *Ceratopleris* sp)'. Fish samples were purchased from the artisanal fishermen and fish mongers operating in Yewa lagoon every month from April 2017 to March 2019. Various types of gears and crafts were used for catching of fish in the lagoon which include hook and line, gill net, cast net, circling net, set nets, fencing, traps (bamboo, basket, drum) etc. The fishes were kept in iced chest and transported to the laboratory. The fish specimens were transferred to deep freezer with collection records showing on the sacks for further analyses.

Laboratory procedure

In the laboratory fish samples were sorted, counted and identified accordingly to species using fish identification guide by Reed *et al* (1967), Idodo-Umeh (2003), Olaosebikan and Raji (2013), and FAO (2016). The morphometry of the fish was done using a fish measuring board and kitchen weighing scale. Total length of each fish was measured from the tip of the snout to the tip of the caudal fin while the weight of individual fish species was measured using a sensitive weighing scale to the nearest gram (Electronic kitchen scale model- WH-B20).

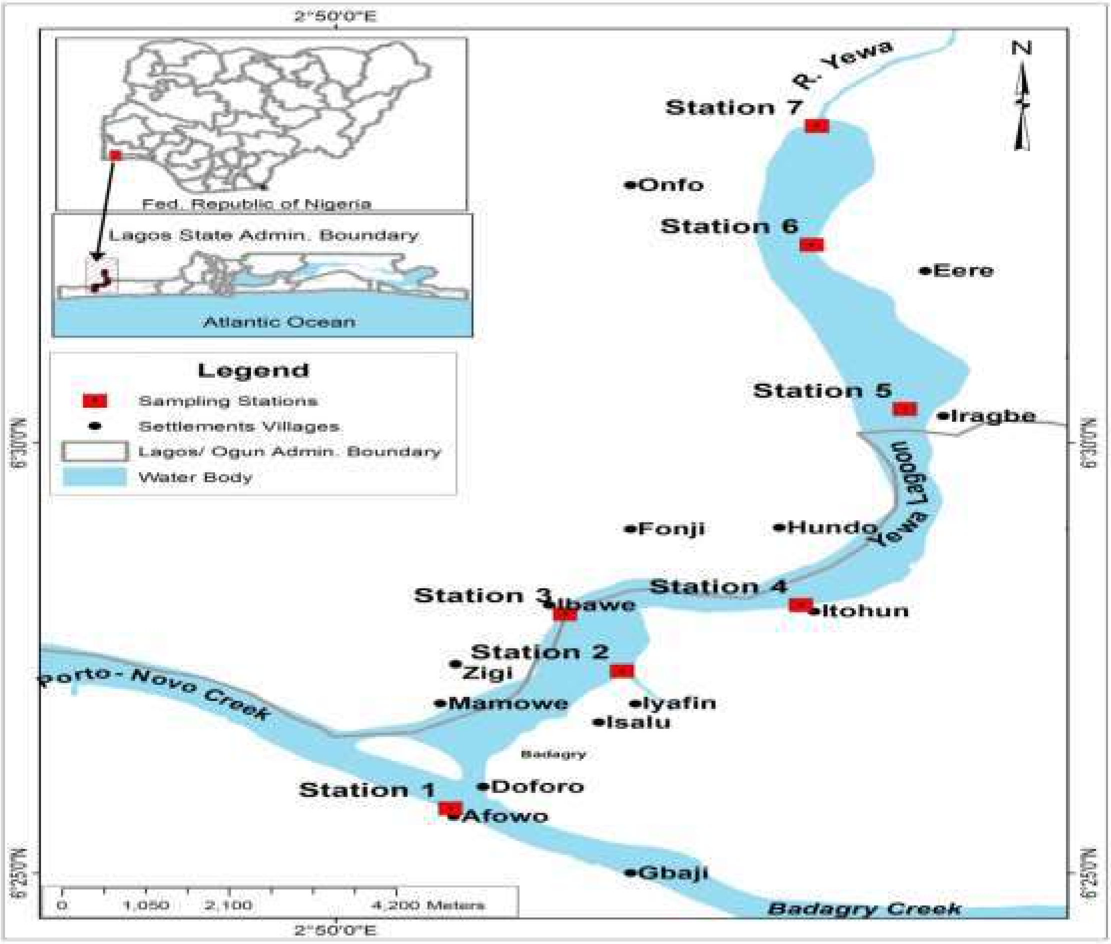

Figure1. Map of Yewa lagoon showing the study area

RESULTS AND DISCUSSION

Table 1 shows the species composition and percentage abundance of ornamental fish species of Yewa lagoon during the study periods. 33 species of ornamental fish species belonging to 20 families were encountered in this present study. Similar result was reported by Ekpo (2013) in ikpa River, Akwa Ibom state. The family Cichlidae had 5 species, schilbidae and mormyridae recorded 4 species each, gobidae and clupeidae 2 each while the remaining families' recorded 1 species each. The high species richness recorded in the present study is quite encouraging and expected of a tropical water bodies which are known for their high taxa abundance (Adebisi, 1988; Odum, 1995, Ita, 1993). *Chrysichthys nigrodigitatus* was the most important fish species as it recorded the highest (70.19% - overall; 70.97%-wet season and 68.85%-dry season) abundance while the least abundant fish were *Pareutropius buffei, Malapterurus electricus, Dormitator lebretonis* and *Dagetichthys lakdonensis* with value 0.05% each. The least (0.07%) abundant species in the wet season are *M. electricus, D. lebretonis*, *Eucinostomus melanopterus* and *D lakdonensis* while the least (0.13%) in the dry season were *P buffei, Xynomystus nigri and Epiplatys infrafasciatus*. The high abundance and dominance of *C. nigrodigitatus* may be as a result of food availability (especially the gastropods which is their major food item), soft or muddy sediment as well as the prevailing water quality. Meanwhile, occurrence and abundance of fish fauna in the tropics have been attributed to some factors such as depth (Chapman and Kramer, 1998), migration (Adebisi, 1988), water quality (Agremier and Kar, 1983, Fagade and Olaniyan, 1974), nature of bottom deposit (Odum, 1995) as well as availability of food (Edward, 2010; Winemiller and Jepsen, 1998). The result of this work also shows that ornamental fish species were higher in the wet season (63%) than dry season (37%). Table 2 and figure 2 shows the seasonal occurrence and abundance of ornamental fish species of Yewa lagoon during the study period. In the combined season 15 species were recorded while 30 species were seen only in the wet season and 18 occurred in the dry season. The high abundance recorded in the wet season could be attributed to the reproductive activities which are higher in the wet season for most fishes; hence, the increased population during this period (Idodo-Umeh, 2003). Monthly, the ornamental fish abundance varied significantly (figure 3) the highest abundance was recorded in the wet season month of April 2017 while the least was recorded in the dry month of November 2018. This may be attributed to the onset of wet season with its consequent influx of organic material from the adjoining land and river.

CONCLUSION

The family claroteidae is the most important fish species in Yewa lagoon and serves as both food fish and aesthetic purposes. 33 ornamental fish species belonging to 20 families were encountered in the present study with higher abundance in the wet season than the dry season. With the high degree of species richness observed in the lagoon stakeholders in the ornamental fisheries should explore the socio-economic potential for maximum sustainability. By way of recommendation, there is need to map out strategies (like pen and cage cultures) for effective utilization and management of the lagoon for optimum fish production. Awareness on the economic potentials of ornamental fisheries as a means of foreign exchange earnings is very key and should be taken up by stakeholders especially the extension and Liaison services. More research on the biology and culture of these species by students, researcher and institutions should be encouraged and supported by governments. Yewa lagoon has varying habitat patterns hence the availability of various species. So if well managed and harnessed the lagoon can support sustainable ornamental fish production which will supply export section of the ornamental fisheries industry thereby boosting foreign exchange earnings and our economy at large. This being a base line study, there is need for further studies into the other aspects of the entire fisheries in this water body.

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Table 1: Species composition and percentage abundance of Ornamental fish fauna of Yewa Lagoon during the study period (April 2017-March 2019)

Family	Species	% -Overall	%-Wet Season	%-Dry Season
Schilbeidae	*Schilbe intermedius*	1.44	2.27	0.00
	Schilbe mystus	0.93	1.32	0.25
	Parailia pellucida	3.25	0.00	8.83
	Pareutropius buffei	0.05	0.00	0.13
Claroteidae	*Chrysichthys nigrodigitatus*	70.19	70.97	68.85
Malapteruridae	*Malapterurus electricus*	0.05	0.07	0.00
Clupeidae	*Laeviscutella dekimpei*	0.09	0.15	0.00
	Pellonula leonensis	0.56	0.88	0.00
Alestidae	*Brycinus longipinnis*	0.23	0.37	0.00
Hepsetidae	*Hepsetus odeo*	0.09	0.15	0.00
Polypteridae	*Polypterus senegalus*	1.02	0.66	1.64
Arapaimidae	*Heterotis niloticus*	0.32	0.29	0.38
Notopteridae	*Papyrocranus afar*	0.70	1.10	0.00
	Xynomystus nigri	0.32	0.44	0.13
Mormyridae	*Mormyrops anguilloides*	0.09	0.15	0.00
	Hippopotamyrus psittacus	1.44	0.73	2.65
	Marcusenius brucii	2.32	3.23	0.76
	Marcusenius senegalensis	5.01	4.55	5.80
Gymnarchidae	*Gymnarchus niloticus*	0.46	0.59	0.25
Cichlidae	*Hemichromis fasciatus*	1.25	0.66	2.27
	Thysochromis annectens	0.14	0.22	0.00
	Thysochromis ansorgi	0.28	0.44	0.00
	Oreochromis niloticus	0.74	1.17	0.00
	Tilapia mariae	0.19	0.00	0.50
Gobiidae	*Bathygobius soporator*	4.17	4.03	4.41
	Gobiodes sagitta	0.28	0.44	0.00
Eleotridae	*Dormitator lebretonis*	0.05	0.07	0.00
Channidae	*Parachana obscura*	0.88	0.73	1.13
Monodactyliidae	*Monodactylus sabae*	0.42	0.51	0.25
Gerreidae	*Eucinostomus melanopterus*	0.65	0.07	1.64
Ophichthidae	*Dalophis boulengeri*	0.09	0.15	0.00
Nothobranchiidae	*Epiplatys infrafasciatus*	2.27	3.52	0.13
Soleidae	Dagetichthys lakdoensis	0.05	0.07	0.00

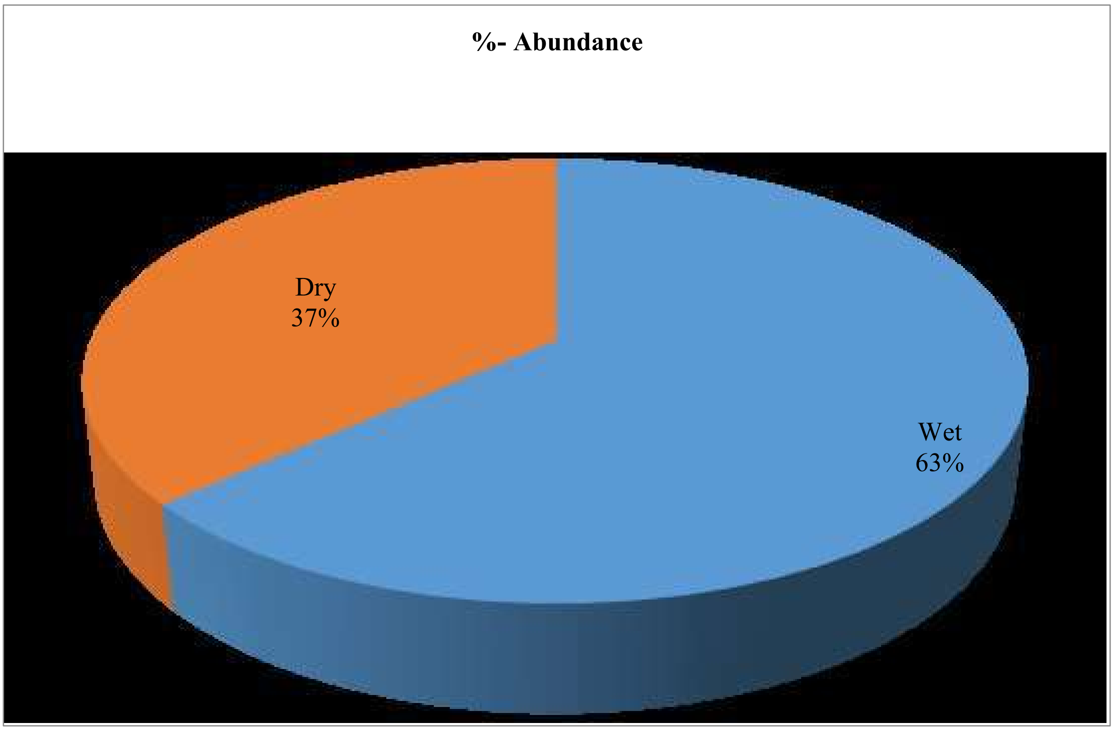

Figure 2: Seasonal variation in ornamental fish species during the study period

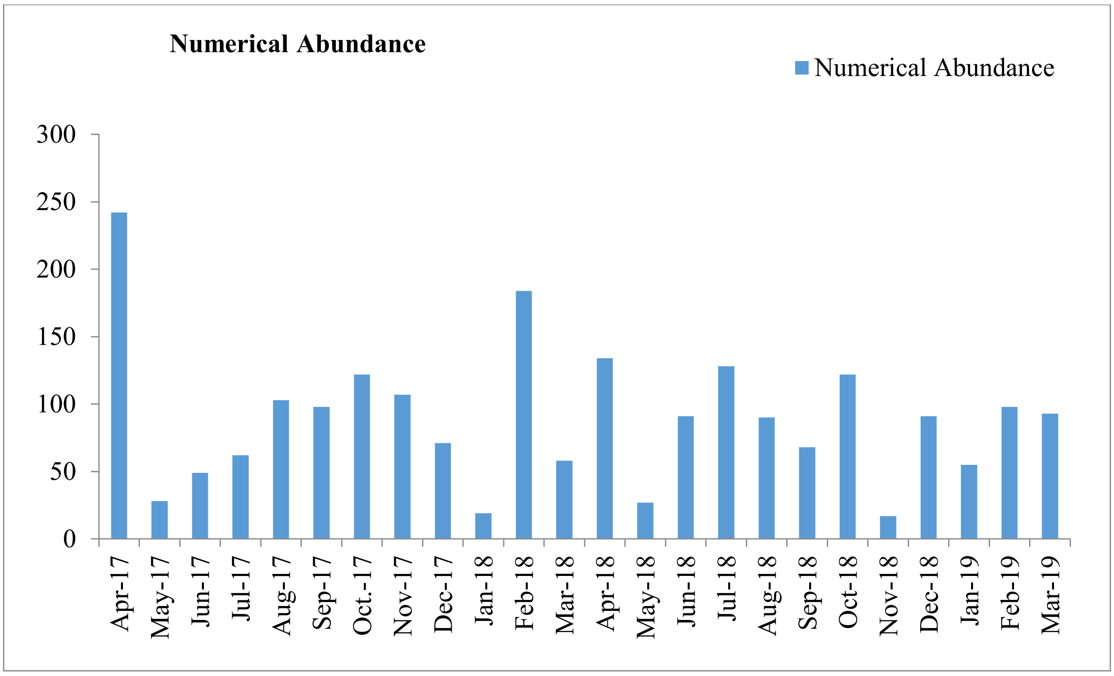

Figure 3: Monthly variation of ornamental fish abundance in Yewa lagoon

Table 2: Seasonal Occurrence of Ornamental fish species during the study period (April 2017 – March 2019)

Family	species	wet season	dry season
Schilbeidae	*Schilbe intermedius*	+	-
	Schilbe mystus	+	+
	Parailia pellucida	-	+
	Pareutropius buffei	-	+
Claroteidae	*Chrysichthys nigrodigitatus*	+	+
Malapteruridae	*Malapterurus electricus*	+	-
Clupeidae	*Laeviscutella dekimpei*	+	-
	Pellonula leonensis	+	-
Alestidae	*Brycinus longipinnis*	+	-
Hepsetidae	*Hepsetus odeo*	+	-
Polypteridae	*Polypterus senegalus*	+	+
Arapaimidae	*Heterotis niloticus*	+	+
Notopteridae	*Papyrocranus afar*	+	-
	Xynomystus nigri	+	+
Mormyridae	*Mormyrops anguilloides*	+	-
	Hippopotamyrus psittacus	+	+
	Marcusenius brucii	+	+
	Marcusenius senegalensis	+	+
Gymnarchidae	*Gymnarchus niloticus*	+	+
Cichlidae	*Hemichromis fasciatus*	+	+
	Thysochromis annectens	+	-
	Thysochromis ansorgi	+	-
	Oreochromis niloticus	+	-
	Tilapia mariae	-	+
Gobiidae	*Bathygobius soporator*	+	+
	Gobiodes sagitta	+	-
Eleotridae	*Dormitator lebretonis*	+	-
Channidae	*Parachana obscura*	+	+
Monodactyliidae	*Monodactylus sabae*	+	+
Gerreidae	*Eucinostomus melanopterus*	+	+
Ophichthidae	*Dalophis boulengeri*	+	-
Nothobranchiidae	*Epiplatys infrafasciatus*	+	+
Soleidae	*Dagetichthys lakdoensis*	+	-

Key: + present; - Absent

Assessment of household consumption pattern and constraints on fresh and smoked *Clarias* and *Tilapia species* in Lokoja, Kogi State, Nigeria

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ABSTRACT

Fish is generally regarded as a primary source of protein for many poor African fishing villages. Most of the fish consumed in the fishing villages in Nigeria consists of freshwater species such as Clarias and Tilapia species. This study focused on the assessment of household consumption pattern and constraints on fresh and smoked Clarias and Tilapia species in Lokoja, Kogi State, Nigeria. The study involved a random selection and analysis of data from 150 respondents from Lokoja Local Government Area. Data collected were analyzed through the use of frequency, percentage and mean score. Results showed that 68.7% respondents preferred Clarias spp The reason for high consumption preference of Clarias spp (68.5%) was because of flavor, but on a general reason for consuming fish of both species as fresh or dried was because of the nutrient it supplied (45.3%), 30.0% consumed fish trice a week and 66.00% purchased the fish consumed from open market. Respondents believed that fish prices are generally affordable ($\bar{X}$ = 2.52) and that fish is not likely to pose health challenge if not killed through poison (($\bar{X}$= 2.33). Constraints faced by the respondents in the consumption of fish include price instability ($\bar{X}$= 3.20), perishability ($\bar{X}$ = 2.94), inadequate marketing information ($\bar{X}$= 2.86) and low product quality ($\bar{X}$= 2.73). It is recommended that efforts should be made by Government to increase capital investment in the fishery sector so as to create enable environment for increase in fish production that will make fish to be adequately supplied at an affordable price. It is not only fish farmers that should engage in fish farming, households with backyard spaces can raise fish by constructing ponds, earthen or concrete tanks for small scale fish farming, this will help in making fish to be available for consumption.

Keywords: Assessment, consumption, fresh, house hold, smoked

INTRODUCTION

Fish is one of the most important sources of animal protein available all over the world for human consumption. Fish, among all other important protein foodstuffs (such as eggs, milk, meat and other animal products), constitute an excellent source of protein of high biological value (Aromolaran, 2014). Fish is an essential source of food and relatively cheap source of animal protein to many people across developing nations, especially Nigeria. People in some communities in various regions and states in Nigeria derived their livelihood from fishing and related activities as a result of their closeness to oceans and seas (Adeola *et. al.,* 2016) Fish is an important part of the diets of people in these regions. It has been reported that fish consumption accounts for about 35% of animal protein consumption in Nigeria and this could mean that fish farming is a vibrant and dynamic commercial sector in Nigeria, ripe with investment and employment opportunities (USAID, 2014). Fisheries are considered to be an important economic activity for generating income and gainful employment and to ensure nutritional security of rural masses. (Das *et. al.,* 2013). Utilization of fish varies for food and non-food purposes across countries and regions. More importantly, the utilization of fish for direct human consumption increased significantly over the years from 67 percent in 1960 to 88 percent in 2016 (Onyeneke *et. al.,* 2020). Hence, the consumption patterns for fish have peculiar implications for the sub-sector in various economies. Disparities exist for fish consumption between and within countries, regions and areas due to location specific varieties, per capita consumption quantity, and geographic concentration of production and more importantly, the trade and international trade realities (Tveterås *et. al.,* 2012). Considering the upsurge in population growth, urbanization and demographic dynamics fish consumption (demand) raises enormous challenges for economies (Barange *et. al.,*2018). Currently, people are more enlightened with the growing awareness creation on the nutritional and health value of fish food supplies, contributing to the upsurge in disproportionate demand for fish. The study therefore considered the assessment of household consumption pattern and constraints on fresh and smoked *Clarias* and *Tilapia* species in Lokoja, Local Government area, Kogi State, Nigeria. Specific objectives are: (i) describe the types of fish consumed and preferred by the respondents (ii) examine the reasons for fish consumption (iii) identify the constraints faced by the respondents in the studied area.

METHODOLOGY

The study was carried out in Lokoja Local Government Area of Kogi State. Lokoja is a city in Nigeria. It lies at the confluence of the Niger and Benue Rivers and is the capital of Kogi State. Lokoja lies about Latitude 7.8'23° North of the Equator and Longitude 6.73'33° E of the Meridian. It is about 165 Km Southwest of Abuja as the crow flies, and 390 Km Northeast of Lagos by same measure. Residential districts are of varying densities, and the city has various suburbs such as Felele, Adankolo, Otokiti and Ganaja. A multi-staged random sampling technique was employed in selecting the respondents for this study. The first stage was selection of densely populated and less densely populated areas. Later, seventy-five respondents were randomly selected from each of the identified areas to give a total population of one hundred and fifty respondents (150). Data were collected using a structured questionnaire and scheduled interview administered to the fish consumers. Data obtained were analyzed using descriptive statistics and mean score.

RESULTS AND DISCUSSION

Types, sources, quantities and preferences for fresh and smoked fish consumed

Table 1 showed that only 44.00% consumed Clarias, 16.7% consumed Tilapia while 39.3% consumed both species of fish. However, 68.7% preferred Clarias spp while 31.3% preferred Tilapia spp this implied that most of the household consumed Clarias more than Tilapia. The reason for high consumption preference of Clarias spp (68.5%) was because of flavour but on a general reason for consuming fish of both species as fresh or dried was because of the nutrient it supplied (45.3%). On health related issue, 10.0% consumed fish based on recommendation. Only 31.3% of the respondents consumed fish on a daily basis while 16.7% consumed fish twice daily. Also, the results indicated that majority of respondents (66.00%) got the fish consumed from open market. An increase in income leads to a higher dietary diversity: individuals tend to consume more high-valued products such as fish. Can and Can (2015) reported that fish consumption preferences are affected by individuals' socioeconomic characteristics. Decisions on the type of fish and how much to purchase and consume are believed to be affected by various factors. Fish consumption levels, frequency and food budget allocation could be influenced by socio-economic and geographic characteristics of consumers and by fish attributes (Pieniak *et. al.,* 2011). For a balanced and healthy nutrition, it is beneficial to consume fish and seafood at least 2-3 times a week due to both its nutritional value and its therapeutic and preventive effects on major diseases (Kizilaslan, 2019).

Consumers' Perception on fish Consumption

Results on respondents' perception on fish consumption Table 2 indicated that consumers believed that fish prices are generally affordable with a high mean score of 2.52. This implied that majority of the consumer agreed that fish prices are generally affordable. This is because fish is often considered to be a 'rich food for poor people' Fish is the most accessible and affordable source of animal protein, providing many of the key nutrients and calories that are needed for physical and mental development (Christophe *et. al.,* 2015). The results also showed that respondents believed that fish is not likely to pose health challenge if not killed through poison with a mean score of 2.33. This implied that fish killed with poison is dangerous to health of consumers. Pieniak *et. al.,* (2011) Fish consumption, frequency, and preferences are affected by consumers' geographic, social, and cultural characteristics. It is known that food preferences are also affected by a number of sensory (taste, smell, texture) and non-sensory factors (behavior, beliefs, personal characteristics, risk perception).

Constraints to fish consumption

Constraints to fish consumption are those factors that limit the consumption of the product by households as presented in Table 3. Price instability with mean score of 3.20, perishability 2.94, and inadequate marketing information 2.86 were rated high as constraints to fish consumption by the respondents. Fish being a perishable food item, its freshness can be kept intact by increasing its local production which can be supplied to local consumers in shortest possible time frame. Debnath *et al,* (2014) reported in a similar study that price as a constraint for fish consumption is an important factor to be considered for improvement in fish consumption. Das and Kumar (2020) opined that major constraints to fish consumption are price (level and fluctuation) followed by availability.

CONCLUSION

Clarias spp are mostly preferred by the respondents and most of the fish consumed by the respondents were from open markets. Perception on fish consumption showed that consumers believed that the fish prices are generally affordable. Price instability was the most severe problem faced by fish consumers in the study area. It is recommended that efforts should be made by Government to increase capital investment in the fishery sector to create enabling environment for increasing fish production that will make it to be adequately supplied at an affordable price. Provision of jobs and entrepreneurship training by government, private sector and other cooperate bodies to the jobless are means of ensuring income generation which invariably can increase the purchasing power of consumers. This will contribute positively to the improvement of the nutritional status of the people. Government and relevant Institutions involved should make credit easily accessible to fish farmers, provision of inputs like feeds at subsidized rate and enabling environment to ensure increased production of fish to reduce price of fish. It is not only fish farmers that should engage in fish farming, households with backyard spaces can raise fish by constructing ponds, earthen or concrete for small scale fish farming, this will help in making fish to be available for consumption.

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Table 2: Consumers' Perception on fish Consumption

Statements	SA 5	A 4	UD 3	D 2	SD 1	Mean
I get fish supplied to me when I need it	83	49	7	10	1	1.65
I believe the fish prices are generally affordable	40	44	25	30	11	2.52
Good quality fish is available for me to purchase	50	68	14	17	1	2.01
I get the fish I want throughout the year	50	72	2	19	7	2.07
Fish is not likely to pose health challenge if not killed through poison	51	40	19	38	2	2.33

Source: Field survey 2021

Key: SA = Strongly agree, A = Agree, UD = Undecided, D = Disagree, SD = Strongly Disagree

Table 4: Constraints to fish consumption

Constraints	VS 4	S 3	NS 2	UD 1	Mean
Price instability	64	56	26	4	3.20
Seasonal in nature	23	54	72	1	2.66
Low product quality	25	68	48	9	2.73
Inadequate marketing information	34	59	49	7	2.86
Perish ability	40	68	35	7	2.94
High incidence of storage pest	41	34	64	11	2.70

Source: Field Survey, 2021

Very Sevier (VS), Sevier (S), Not Sevier (NS) Undecided (UD)

Table 1: Types, sources, quantities and preferences for fresh and smoked fish consumed

Items	Frequency	Percentage
Type of fish consumed		
Smoked fish	48	32.0
Fresh	23	15.3
Both	79	52.7
Total	150	100.0
Type of fish preferred		
Smoked fish	92	61.3
Fresh	58	38.7
Total	150	100.0
Species of fish consumed		
Clarias fish	66	44.0
Tilapia fish	25	16.7
Both	59	39.3
Total	150	100.0
Species of fish preferred		
Clarias fish	103	68.7
Tilapia fish	47	31.3
Total	150	100.0
Reasons		
Flavour	98	65.3
Bone	17	11.3
Recommended	15	10.0
Affordable	17	11.3
Scale	3	2.0
Total	150	100.0
Where you get the fish consumed		
Open market	99	66.0
River bank	26	17.3
Road side	4	2.7
Seller	15	10.0
Super market	6	4.0
Total	150	100.0
Frequency of consumption		
Once	33	22.0
Twice	25	16.7
Thrice	45	30.0
Daily	47	31.3
Total	150	100.0
Quantity of fish consumed		
less than 1kg	27	18.0
1kg	54	36.0
1.1-5kg	34	22.7
Above 5kg	35	23.3
Total	150	100.0
Reason for consuming fish		
Taste	44	29.3
Nutrient	68	45.3
Affordable	27	18.0
Availability	11	7.3
Total	150	100.0

Source: Field Survey, 2021

Assessment of Fish Post-Harvest Losses and Its Impact on the Livelihood of the Fisher Folks in Ibi Local Government Area, Taraba State

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ABSTRACT

The fish post-harvest losses and its impact on the livelihood of the fisher folks in Ibi Local Government Area, Taraba State was assessed. Random sampling was used to obtain data from two hundred and ten fisher folks using structured questionnaire and scheduled interview. The data obtained was analyzed using a descriptive statistics (frequency and percentages) and Pearson Product Moment Correlation (PPMC) to test the hypothesis at $p<0.005$ level of significance. The results indicated that the use of chemicals on the water body before fishing (97.1%), and fish marketing (87.6%) caused fish post-harvest losses which affected fisher folks children education ($\bar{x}$ =2.55), socio economic condition ($\bar{x}$ = 4.47) and investment ($\bar{x}$ =2.26). Major determinants of income losses among the respondents are use of chemical for fishing ($\bar{x}$ = 3.25), delay in fish hauling ($\bar{x}$ = 3.02) and price/quality of fish ($\bar{x}$ = 2.92). There was a significant relationship between income loss and the effects of fish post-harvest losses on the livelihood of fisher folks at $p < 0.005$). Fisher folks incurred fish post-harvest losses as a result of chemicals on the water body before fishing and during marketing of fish. These losses affected their children education and further investment in the business. The study therefore recommended that the Government at all levels and the entire fishing communities should endeavor to enforce fishing regulation law which bans the use of chemical for fishing and the use of ice blocks on fish caught before transportation to the market for sale.

Keywords: Assessment, fish, fisher folks, livelihood, post-harvest

INTRODUCTION

The call and encouragement for improvement of fish production and value chain in Nigeria can only be achieved through effective extension effort and services and fisher folk's knowledge for sustainable fisheries development. This relationship existed but little effect has the introduction of improved technology brought to reduce post-harvest loss and increased availability of fish that met consumer's preferences. The fishers still rely on their indigenous practices for development and ignored the improved technologies introduced (Adigun and Adigun, 2015). Fish is one of the most important foods on the planet. It is a source of top quality protein and for many, in a less developed parts of the world, it represents a significant proportion of animal protein in their diet. Fish is found abundantly in all natural waters. It is a valuable source of food, rich in high quality protein, minerals and vitamins. Oily fish are rich in omega-3 polyunsaturated fatty acids (Downs and Fanzo, 2015). Post-harvest fish losses are often caused by biochemical and microbiological spoilage changes that occur in fish after death. A live fish has natural defense mechanisms that help to prevent spoilage. However, once a fish dies, its defense mechanisms stop and enzymatic, oxidative and microbiological spoilage begins to cause quality deterioration (Yvette and Mgawe, 2011). Post-harvest fish losses are nutrient or economic losses that render the commodity unavailable or nutritionally deficient for human utilization (Cole *et al.,* 2020). Fisheries play an important contribution to the animal protein supplies of many communities in both the industrialized and developing world and provide the main source of animal protein for about one billion people globally (Adewolu and Adoti, 2015). Fisheries are an important part of food security and nutrition, particularly for many poor people in developing countries. In coastal areas and around major river systems, the dependence on fish is usually higher (FAO 2010).

Fish are perishable and hence susceptible to high losses if intervention measures are not put in place. Fish losses are among the highest in comparison with all other commodities in the entire food production system (FAO 2010). However fish is one of the most perishable of all staple commodities, and in tropical climates of most developing countries, it will become unfit for human consumption within about one day of capture unless it is subjected to some form of processing (Ayodeji Ahmed, 2020). Even after the fish has been processed, particularly if traditional method has been used the fish is still subjected to many form of loss and spoilage because of the chemical composition on keeping quality, a proximate composition like moisture, lipid, protein and ash/mineral content of fish from the time of harvest to different transportation and storage periods decreased with increase drip loss due to quality deterioration. Food and Agricultural Organization has estimated post-harvest losses in developing countries to be up to 50% of domestic fish production (Tesfay and Teferi 2017). Fish is highly perishable and spoils immediately after death as soon as rigor mortis sets in (Getu *et. al.,* 2015; Mohammed, 2015; Adeyeye, 2016).

Rigor mortis is the stiffening of fish muscle tissue which starts between 1 – 7 hours after death. The sum of duration is calculated to be between 30 – 120 hours while fish that are suffocated and not preserved with ice indicate shorter period of fish muscle toughening between 32 – 93 hours. A substantial amount of fish can be lost after harvest in tropical countries due to high temperature. In the tropics, fish can spoil while still in the boat, at landing, during storage or processing, on the way to the market and while waiting to be sold. Pragmatic classification of fish loss into four common categories: physical loss, quality loss, nutritional loss and market force loss (Tyrer. *et al.,* 2019). fish losses are of great concern because they equate to a loss of valuable animal protein for consumers and lost income for fishers, processors and traders. Assessing losses and understanding them is a key to addressing the fish loss problem and to plan for reductive in fish post- harvest losses. Reducing losses is therefore an important development goal in the fisheries sector. The study therefore aimed at determining the fish post-harvest losses and its impact on the livelihood of the fisher folks in Ibi Local Government Area of Taraba State. The specific objectives of this study are: (i) Identifying the causes of fish postharvest losses in the study area (ii) Determining the effects of losses on livelihood of fisher folks (iii Determinants of income losses among fisher folks in the study area.

METHODOLOGY

Ibi is a town and administrative headquarters in Ibi local Government Area Taraba State, Nigeria. The town is located on the South Bank of River Benue, Rivers Taraba and Donga flow into River Benue within the Local Government Area. Ibi Local Government is one of the 16 Local Government Areas in Taraba State. It covers the total land area of 2,672km^2 and extends between Latitude 8^0,19 North of the Equator and 9^0,51 East of the Greenwich meridian Ibi Local Government Area has two seasons; the rainy, from April to October, and the dry which last for 5months. The annual rainfall ranges between 1058mm and 1300mm with the temperature range of 28^{0}c-39^{0}c. It is dominated by the Jukuns, who are predominantly farmers and engaged in different types of activities such as fishing, hunting, local craft, and arable farming (Ogunremi *et. al.,* 2019). Structured questionnaire and scheduled interview were administered to the fisher folks in two fishing communities around lower River Benue in Ibi, and Nwonyo Lake (I and II). The registered fisher folks in the study area - Ibi and Nwonyo Lake (I and II) were five hundred and two hundred respectively. Thirty percent of the respondents were selected randomly from each of the two communities, which are sixty and one hundred and fifty respectively, to make up total sample size of two hundred and ten. A descriptive statistics (frequency and percentages) were used to analyze the data while Pearson Product Moment Correlation (PPMC) was used to test the hypothesis at $p < 0.005$.

RESULTS AND DISCUSSION

Table 1 showed that the use of chemicals on the water body before fishing among fisher folks (97.1%), long fishing duration on water (89.5%) and marketing (87.6%) were major causes of fish losses. losses occurred at different points from capture to marketing and in some fisheries the level of losses could be considerable. Gyan *et al.,* (2020) in a similar study indicated that the use of chemicals on the water body before fishing causes fish losses. The loss in fisheries due to poor handling practices is one of the most significant challenges for developing countries (Adigun and Adigun 2015). Marketing infrastructure is one of the greatest obstacles to value chain improvements. One way to reduce costs is to organize transportation to urban markets so that each trader does not bear the transportation costs alone (Phiri *et. al.,* 2013). Fish post harvest losses is caused by poor handling practices (e.g. washing fish in unclean water), processing methods that expose fish to contaminants and for long periods exposure to high temperatures, lack of storage facilities and poor transportation (Béné, 2011). These practices produce bacterial spoilage, which in turn creates toxins that can cause food poisoning (Getu *et al.,* 2015). Table 2: indicated the effects of fish losses on the respondents children education ($\bar{x}$ =2.55), socio-economic condition ($\bar{x}$ =2.47) and investment ($\bar{x}$ =2.26) respectively. The implication is that fisher folks would find it difficult to give qualitative education to their children if there is no intervention from the Government and also the standard of living would be low since fish post harvest losses reduces the income of the fisher folks. Table 3: showed the determinant of income loss of the fisher folks resulting from fish losses. Use of chemical when fishing ($\bar{x}$ =3.25) was ranked highest by the mean score as the main determinant of income loss, delay in hauling ($\bar{x}$ =3.02),

Price of good/bad quality fish ($\bar{x}$ =2.92) and fresh fish handling ($\bar{x}$ =2.90) respectively. The implication is that when fishes are caught through the use of chemical it exposes fish to serious decomposition and deterioration in terms of quality there by reducing the market value and eventually reduces the income of the fisher folks. Fishes caught with gill net are strangulated to death and if the hauling is not done on time rigor mortis sets in quickly resulting to bad quality of fish and poor pricing. Elin *et al,* (2020) reported that fish post harvest loss is caused by the time it takes to transport fresh fish from the time of catch to the landing sites and fresh and processed fish from the landing sites to urban markets. Delays reduce the quality and availability of fish products to consumers.

Table 4 showed that there was a significant relationship between income loss and the effects of fish losses on livelihood of fisher folks ($r = .427$, $n = 210$, (p .0001<.0.0005). Hence, loss of income influenced the effects of fish losses on the livelihood of the respondents. The implication is that the more the fisher folk's losses income due to fish post harvest losses the more it affects them on their children education, investment, purchasing capacity and clothing. If these continue without addressing it on time, some of the fisher folks who are full timer in fishing and fish processing may be forced to source for other means of livelihood to cushion the effect of fish post harvest losses. This is not good for the economy because there would be reduction in domestic fish production and for the fisher folks, poverty can set in. Yvette and Mgawe (2011) opined that fish losses are a major concern and occur in most fish distribution chains throughout the world. Not only do losses constitute lost income to fishers, processors and traders but they also contribute to food insecurity as loss of fish means less fish available for the consumer and invariably reduce protein intake of the populace. Adelaja and Binti (2017) reported that economic losses occur when fish which is meant for human consumption is downgraded due to spoilage which leads to decrease in value. This loss leads to physical and financial losses of product as a result of quality fish deterioration. This fish will be sold out at a lower price against the amount it ought to be sold.

CONCLUSION

Fisher folks incurred fish post harvest losses as a result of chemicals on the water body before fishing and during marketing of fish. These losses affected their children education, socio economic and further investment in the business. However, the use of chemical for fishing, delay in fish hauling, fish price, quality of fish and fresh fish handling were determinants of income losses among the fisher folks in the study area. The study therefore recommended that the Government at all levels and the entire fishing communities should endeavor to enforce fishing regulation law which bans the use of chemical for fishing. Fishing communities should be provided with ice block plants so that fisher folks can apply ice blocks on fish caught to slow down rigor mortis action on fish and inhibit bacterial activities on fish. Credit facilities can as well be provided for fisher folks and social amenities which will improve the livelihood of the fisher folks.

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Table 1: Causes of fish post-harvest losses among fisher folks

Causes of fish post-harvest losses	No Frq.	%	Yes Frq.	%
Does washing your fish after caught cause post-harvest losses	156	74.3	54	25.7
Does the use of chemicals on the water body before fishing cause post-harvest losses	6	2.9	204	97.1
When do you normally incur losses? Handling	102	48.5	108	51.4
Marketing	26	12.3	184	87.6
Storage	82	39.0	128	60.9

Source: Field survey 2021

Table 2: Effects of post-harvest losses on livelihood of fisher folks

Effect of post-harvest losses	Low	Moderate	High	$\bar{x}$	S.D.
Children education	19(9.0%)	57(27.1%)	134(63.8%)	2.55	0.65
Investment	23(11.0%)	110(52.4%)	77(36.7%)	2.26	0.64
Purchasing capacity	66(31.4%)	122(58.1%)	22(10.5%)	1.79	0.61
Clothing	81(38.6%)	116(55.2%)	13(6.2%)	1.68	0.58
Socio economic condition		104(49.5%)	102(48.6%)	2.47	0.54
Savings	4(1.97.6%)	115(54.8%)	78(37.1%)	2.29	0.61
Better food	17(8.1%) 51(24.3%)	109(51.9%)	50(23.8)	2.00	0.69

Source: Field survey 2021. *Weighted mean = 2.09*

Table 3: Determinants of income loss among fisher folks

Stages	SD	D	A	SA	X	SA
Use of chemical for fishing	9(4.3)	29(13.8)	73(34.8)	99(47.1)	3.25	0.85
Delay in fish hauling	2(1.0)	32(15.2)	136(64.8)	40(19.0)	3.02	0.62
Price of good/bad quality fish	9(4.3)	59(28.1)	81(38.6)	61(29.0)	2.92	0.86
Fresh fish handling	16(7.6)	76(33.8)	42(20.0)	81(38.6)	2.90	1.01
High fish consumption	8(3.8)	98(46.7)	92(43.8)	12(5.7)	2.51	0.67
Fish distribution	16(7.6)	99(47.1)	75(35.7)	20(9.5)	2.47	0.77
High cost of fishing gear	7(3.3)	110(52.4)	90(42.0)	3(1.4)	2.42	0.58
Processing cost	14(6.7)	124(59.0)	61(29.0)	11(5.2)	2.33	0.67
Cost of packaging	76(36.2)	76(36.2)	41(19.5)	17(8.1)	2.00	0.94

Source: Field survey 2021. *Weighted Mean = 2.65, Figures in parenthesis are in percentage*

Table 4: Pearson Product Moment Correlation (PPMC) showing the relationship between income loss and effects of post-harvest losses on livelihood

Variables	Mean	Std. Deviation	N	R	p-value	Remarks
Income loss	23.8190	4.06003	210	.427*	.0001	Sig.
Effects on livelihood	16.7429	3.34186				

** Correlation is significant at the 0.05 level (2-tailed)*

Production Cost and Resource Use Efficiency in Catfish Production in Ogun State

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ABSTRACT
This study was carried out to determine the production cost and resource use efficiency in fish farming in Ogun State, Nigeria. The study was based on primary data collected from 120 respondents in the study area. Multistage sampling technique was used to randomly select communities in the study area. In terms of age, evidence showed that majority (60.0 percent) of the sampled fish farmers have their age falling between 31 and 40 years, and 70.8 percent of the fish farmers were males: it also showed that majority (92.5%) of the fish farmers were married as expected. Meanwhile, results showed that all the fish farmers (100.0%) possessed formal education, which is predominantly at the tertiary level; Majority (58.3%) of the sampled fish farmers were also Muslim by religion with 5-10 years fish farming experience. The results also showed the distribution of the budgetary analysis of fish production which revealed that the mean of the total variable cost is positive (₦4,048,275.00), the mean of the gross margin is also positive (₦2,657,463.33), total cost is (₦4,187,853.89), total revenue is (₦1,390,811.66), the net income is also positively signed (₦2,797,042.22) while the mean of the total fixed cost is (₦139,578.89). This implies that the level of profitability of fish farming in the study area is impressive, since the above table shows the net income to be positively signed. The major constraint impeding expansion of fish production in the study area was financial problem. Based on the findings of this study, it is recommended that credit facilities should be made available and accessible to fish farmers at low interest rate by the government and private organizations. There should be an insurance policy that would protect the farmers against mass loss as a result of disease outbreak, pollution, predation and devastating effect of flooding.
Keywords: Catfish, Production, Marketing, Credit, Insurance

INTRODUCTION
The growth of a country's population is usually accompanied by increase in the demand for the basic necessities of life including water, food and shelter. This is the case with the unrestricted increase in the demand for protein rich food items of animal origin especially. The Food and Agriculture Organization (FAO, 1991), recommended that an individual takes 35 grams of animal protein per day for sustainable growth and development. However, the animal protein consumption in Nigeria is less than 8g per person per day, which is a far cry from the FAO minimum recommendation (Niang and Jubrin, 2001). The major animal protein sources in the country include cattle, goats, sheep, poultry and fish. Out of these sources, fish products provide more than 60% of the total protein intakes in adults especially in the rural areas (Adekoya, 2004). Therefore, the importance of the fishing industry to the sustainability of animal protein supply in the country cannot be over-emphasized. Regrettably, the supply of food fish has been on the decline. This is due to consistent decline from the country's major source of food fish, the artisanal fisheries, from 90% in 1990 (Tobor, 1990) down to 40% in

2006, resulting to about 300,000 metric tonnes (Global Agriculture Information Network GAIN, 2007). Currently, domestic fish production is put at 551,700 metric tonnes as against the present national demand of about 1.5 million metric tonnes estimated for 2007 (Osawe, 2007). The shortfall is said to be bridged by the importation of 680,000 metric tonnes annually consuming about N50 billion in foreign exchange (Odukwe, 2007). It has been asserted by Adediran (2002) and Ugwumba (2005) that the only way of boosting fish production and thereby move the country towards self-sufficiency in fish production is by embarking on fish farming especially catfish farming. This has prompted the Federal Government of Nigeria to package the Presidential Initiative on fisheries and aquaculture development in 2003 to provide financial and technical assistance to government programmes and projects encouraging fish production. Regardless these efforts of the government, fish production has remained low in the country as well as in Ogun State. This has been attributed to inadequate supplies from the local catfish farmers due to the use of poor quality catfish seeds, inadequate information, high cost of feeds, traditional techniques, small size of holdings, poor infrastructural facilities and low capital investment (Ugwumba *et al*., 2006; Adeogun, 2007; Ugwumba and Nnabuife, 2008). Greater improvement in catfish production can be achieved with a proper analysis that will lead to the knowledge of the level of profitability of catfish farming and constraints to production which constitute the basis for this study. According to Adinya and Ikpi (2008), fish production in Nigeria has been inadequate to bridge the demand-supply gap because of non–optimal use of resource and enormous post–harvest losses. Farrel (1957) revealed that there are three important production efficiencies namely; technical, allocative and economic efficiencies. Technical efficiency is the measure of the farms success in producing maximum output from a given set of resources or is the ability of producing a given level of output with a minimum quantity of inputs under a given technology. Allocative efficiency is the ability of the farmer to use the inputs in optimal proportions given their respective fish and the production technology.

Economic efficiency is the product of the technical and allocative efficiencies (Adinya *et al*, 2008). However, given the low rate of adoption of fish technologies by fish farmers, improvement in resource use efficiency remains the most cost effective way in enhancing productivity. From both theoretical and applied perspectives, measurement of efficiency is important because it might lead to resource saving, more profit from investment, effective loan repayment and also have important implication on both policy formulations and firm management (Adeogun, *et. al.,* 2007). Nigeria has a population of over one hundred and sixty million people and has her national fish demand at over 1.5 million metric tonnes. The current annual aquaculture production hovers around 500,000 metric tonnes. This combined with ever decreasing catch (due to over exploitation) from the capture, fisheries have not been able to meet the ever-increasing protein demand of the country. Thus, the challenge to increase protein consumption in Nigeria appears to be more urgent now than ever (Mbanasor, 2002). Poor people are facing new barriers in both their production and returns on fish. Even by the standards of developing countries, homestead fish farmers and fish workers are often among the poorest people and they generally operate on a small scale and use traditional fishing practices, yet, new technologies and environment requirements favour large scale capital intensive operation at the expense of traditional and small scale commercial fishing (Delgado *et al*, 2003). Whereas small scale fish farming supplies the greatest percentage of the Nigerian's annual fish production output (FDF, 1995). Regrettably, the supply of food fish has been on the decline. This is due to consistent decline in the country's major source of food fish, the homestead fisheries, from 90% in 1990 (Tobor, 1990) down to 40% in 2006 resulting to about 300,000 metric tonnes (Global Agriculture Information Network, GAIN, 2007). According to Osawe (2007), domestic fish production is put at 551,700 metric tonnes as against the present national demand of about 1.5 million metric tones estimated for 2007. The shortfall is said to be bridged by the importation of 680,000 metric tones annually consuming about ₦50 billion in foreign exchange (Odukwe, 2007). Thus, it is worthy of note to study the production cost and resource use efficiency in fish farming in the study area. The main objective of the study is to determine the production cost and resource use efficiency in fish farming in Ogun-Water Side Local Government Area of Ogun State, Nigeria. The specific objectives are to:

i. determine the cost and return structure of fish production in the study area.
ii. analyse the technical efficiency of the resource used in fish production.
iii. determine the factors responsible for inefficiency of the fish farmers.

METHODOLOGY

The study was carried out in Ogun State, Nigeria. Ogun State is divided into four divisions, viz: Ijebu, Egba, Yewa and Remo Divisions respectively. It lies $6^0 40'$ and 7^0 N and latitude 3^0 46' and 4^0 15' E. It has average annual rainfall of between 1250 and 1500mm. The rainy season is bimodal with peak in June and October while the dry season starts from the middle of November to the middle of March. The annual average temperature range is between 27^0 C and 32^0 C, while the relative humidity is between 80-90%. The study area has common boundaries with Oyo State on the Eastern side; Remo and Egba Divisions are on the Western side, while Lagos State is one the Southern side. It has a proximity to the Atlantic Ocean and complex network of streams and rivers and other water bodies. However, with growing migration of people, the area is now home to various ethnic groups and tribes from within and outside the country. One of the main occupation is farming, they produce food and cash crops which include; cassava, maize, melon, cashew, citrus and kola. Also some of the household members are civil servants. Also most of the residents engage in fish farming as there are several sources of water available to the respondents in the study area (NPC, 2006). The data for the study were drawn from primary source with the aid of well-structured questionnaires. The questionnaire was administered on 120 randomly sampled fish farmers in Yewa division of the state. The questionnaires were personally administered to obtain data on the socio-economic characteristics such as age, years of fishing experience, marital status e.t.c. yewa consists of five (5) LGAs out of which 2 LGAs Yewa North and Yewa South LGAs were purposively selected due to major fishing activities of the people. Multi-stage random sampling technique was adopted for the study. The first stage involved the random selection of 2 out of the 5 Local Government Areas (LGAs) in the study area. In stage two, however, ten communities were purposively selected from each of the two selected Local Governments Areas owing to their high level of involvement in small-scale fish farming. In stage three, ten (10) fish farmers were randomly selected from each of the selected communities for the study and 60 percent of the total populations were included in the sample for the study. Altogether, one hundred and twenty fish farmers were sampled from the two selected Local Government Areas in the Division. The socio-economic characteristics of the respondents were analysed using descriptive statistical analysis.

Cost and Return Structure of Small and Medium Scale Enterprise

Profitability of the fish production was estimated by Gross Margin equation which is specified as:

GM = $\sum_{i=1}^{n} P_i Q_i - \sum_{j=1}^{n} r_j x_j$

Where;

GM = Gross Margin,

P_i = Unit of fish output,

Q_i = Quantity of output in kg,

r_j = Unit of fish of input in naira,

x_j = Quantity of variable inputs used.

The Net Income (NI) was estimated;

NI = TR- TC

TC = TVC + TFC

TC=Total Cost in naira.

TVC = Total Variable Cost.

TFC = Total Fixed Cost.

TR = Total Revenue in naira.

The Profitability Index

The Profitability Index was calculated as:

1. Profitability Index (PI) = NFI / Revenue
2. Rate of Returns on Fixed Cost (%) = TR – TVC / TFC X 100 %
3. Rate of Returns on Investment (%) = NF1/ TC x 100%.

Total fixed cost is the depreciation cost on tools and implements used in production.

Determination of factors responsible for total output of fish farmers in the study area

Regression Model: - Multiple regression analysis was employed to ascertain the factors responsible for total output of fish farmers in the study area. The model employed is of the form:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12} \ldots\ldots\ldots e)$$

Where,

$Y =$ Total Output (kg)

$X_1 =$ Age (in years)

$X_2 =$ Gender (Female = 1, Male = 0)

$X_3 =$ Marital Status (Married = 1, Single, Divorced or Widowed = 0)

$X_4 =$ Household Size

$X_5 =$ Years of Formal Education

$X_6 =$ Income of respondents (Naira)

$X_7 =$ Primary Occupation (Farming = 1, Non-farming = 0)

$X_8 =$ Access to credit facility (No = 1, Yes = 0)

$X_9 =$ Seeds (kg)

$X_{10} =$ Fertilizer (kg)

$X_{11} =$ Labour (mandays)

$X_{12} =$ Land (ha)

b = Regression parameters or coefficient

e i = Error term.

RESULTS AND DISCUSSION

The age of the respondents is an important factor that affects their level of productivity and overall coping ability within the business. Age is believed to influence the level of physical work as shown in Table 1. In terms of age, evidence showed that majority (60.0 per cent) of the respondents in the study area have the age of their household heads falling between 31 and 40 years. As much as 3.3 per cent were aged, while youths (30 years or younger) featured prominently among the farmers. This confirms the commonly reported aging of rural farm population in Nigeria (DFID, 2004; Okali, *et al*. 2001). Sex determines the ability to perform some physical work. It is generally believed that men are more efficient in activities than woman. This perhaps is because they are more energetic and can handle more tedious work than their female counterparts. Majority of the respondents (70.8%) are male while 29.2% are females. This implies that fish farming activities in the study area is gender sensitive. The marital status of respondents helps to reduce labor cost especially when the respondents are married in which they can supply labour from their households. This in turn increases their income considerably. Furthermore, the result showed that 92.5 per cent of the respondents were married which will make them to be more hardworking in order to get more income to cater for their families. Formal education is a widely known avenue for improving knowledge and rate of skill acquisition Formal education is also important in business because it determine the degree of level of adoption of innovation and new technologies. It also determines the degree of competence in any activity. Majority of the respondents possess formal education, which is majorly at the tertiary level (53.30%). This may help their ability to take full advantage of extension services, thus positively affecting their income generation and reduce poverty. In terms of religion, majority (58.3 percent) of the respondents in the study area were Muslims and 40.8% were Christians. This is seen to be as a result of the Muslims being the largest dwellers in the study area. Also, the findings revealed that majority (57.3%) of the respondents were fish farmers, 32.7% are artisans, 2.0% are trader while 8.0% are transporters. The number of years in which the respondents have been involved in fish production could be used to measure their efficiency. Experience is expected to have a significant positive impact on the managerial ability of the respondents. Therefore, the more experienced they are, *ceteris paribus*, the more efficient they would be in management because the acquired experience over the years would be brought to bear on their activities. The results, revealed that majority of the respondents (55.8%) are with fish farming experience between 5 to 10 years. The total household size of the respondents comprises of their wives, children and dependants. As shown in Table 1, the household size of the respondents showed that majority of the respondents (56.7%) have household between 4 - 6 members. This implies that the household with many members will geared toward increasing their income through their involvement in business that will increase their standard of living. Table 2 shows that majority (90.8%) of the respondents percent were culturing *clarias* fish. The study further showed that 95.0% of the fish farmers did not raise their fingerlings but purchased from private hatcheries available within their locality. The table also showed that majority (52.5 per cent) of the fish farmers were using concrete pond, 40.8% of the fish farmers sourced water from river/stream available within their farm location.

Gross Margin Analysis

The Budgetary Analysis of combined fish farming enterprise

Table 3 present the budgetary analysis of combined fish farming enterprise in the study area. This was considered necessary in order to determine if the business would be profitable despite all problems encountered in the study area. The distribution of the budgetary analysis of fish production in the study areas shows that the mean of the total variable cost is positively signed (₦4,048,275.00), the mean of the gross margin is also positive (₦2,657,463.33), total cost is (₦4,187,853.89), total revenue is (₦1,390,811.66), the net income is also positively signed (₦2,797,042.22) while the mean of the total fixed cost is (₦139,578.89). This implies that the catfish production is profitable and the net income realized could be used to increase the well-being and standard of living of the sampled respondents and the entire community.

Production Efficiency Model Estimates for Fish Production

The production function and inefficiency model were estimated by Maximum Llikelihood Estimate and the result are presented in Table 4. There was presence of technical inefficiency using likelihood ratio test. The coefficient of fertilizer quantity was significant at 1%. This shows a significant positive relationship with the efficiency of the other farmers in the study area. The implication of this is that the farmers tend to be more productive if more of the fertilizers used are increased. The analysis of the inefficiency model showed that the coefficient of age was significant at 1%. The positivity of the coefficients of age simply implies that increase in the age of the farmers will increase the level of efficiency of the farmers. This a priori expectation is that age of farmers is expected to have a positive effect on technical inefficiency effects. This is because old people are less energetic and less receptive to agricultural innovations and hence develops inefficient production routines and practices. The analysis of the inefficiency model also showed that the coefficients of sex and education were significant at 1% level of probability but negative. The negativity of the coefficients of sex of the farmers and education simply implies that these variables contributed positively to the level of efficiency of the farmers. Sex is expected to have a negative effect on the technical inefficiency effects as an indication that male farmers are more effective in the utilization of farm resources than their female counterparts Educational level of farmers is expected to have a negative effect on technical inefficiency. This is because education improves understanding and receptiveness to agricultural innovations. The result of this would be effective utilization of inputs which in turn increases the technical efficiency of the farming operation. The mean level of efficiency as estimated for catfish farmers in the study areas is 51.70% which mean that the farmers are about 48.30 technically inefficient.

Regression Analysis Results of Technical Inefficient Determinants

The estimated parameters and the relevant statistical test results obtained from the analysis are presented in Table 5. It had an adjusted R^2 value of 0.621. This implies that about 62.1% of the variation in efficiency (Y) is accounted for by the variables (X_1-X_7) included in the model, while the remaining 37.9% is as a result of non-inclusion of other explanatory variables in the model. The F- value is positive and statistically significant at the 0.01, indicating that the variables included in the model adequately explain the efficiency level of the farmers in the survey area. Out of the 7 variables modelled, only age and education are statically significant in determining the level of efficiency of the respondents in the survey area.

Technical Efficiency Gap

The coefficient for age is positive and was found to be statistically significant at 0.05 levels. This implies that there is a positive relationship between age and the efficiency level of the respondents. This implies that the farmers level of efficiency increases with increase in their age. The coefficient for education is positive and was found to be statistically significant at 0.10 levels. This implies that there is a direct relationship between the education of the farmers and their efficiency level. This implies that the farmers level of efficiency increases with increase in their education.

Constraints to fish farming in the study area

Table 7 showed the distribution of the fish farmers by their constraints to fish farming. Majority of the respondents (28.8%) are faced with the problem of lack of fund, 12.5% are being confronted with pilfering of their fish, 7.5% are faced with the problem of heavy rainfall and lack of fund/animal destruction, 6.3% are faced with the challenge of shortage of water and pilferage/lack of capital. The study revealed that majority of the respondents (30%) suggested grants of loans from the government, as a solution to the problem of lack of fund, opening of in-let and out-let pipes was suggested by 7.5% of the respondents as a solution to the problem of heavy rainfall. Application of multi-vitamins and anti-biotics was suggested by 2.5% of the respondents

CONCLUSION

The study looked at the production cost and efficiency of the resource-use in catfish production. With the increase income of catfish farmers and improved standard of living in the study area. It is concluded that catfish production is profitable; the farming households could increase their income through production and marketing of catfish, and invariably increase the standard of living of the rural dwellers in the community. It is therefore recommended that efforts should be made to reduce the production input cost, increase the rate of supply of factors of production at lowest cost possible and timely to the catfish farmers.

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Table 1: Socioeconomic Characteristics of the Respondents

Variables	Frequency	Percentage
Age		
Below 30 years	14	11.7
31 - 40 years	72	60.0
41 - 50 years	16	13.3
51 - 60 years	14	11.7
Above 60 years	4	3.3
Sex		70.8
Male	85	29.2
Female	35	
Marital Status		
Single	2	1.7
Married	111	92.5
Divorced	7	5.8
Educational Level		
Primary	15	12.5
Secondary	41	34.2
Tertiary (HND/BSc)	64	53.3
Religion		
Muslim	70	58.3
Christian	49	40.8
Traditional	1	0.8
Main Occupation		
Fish farming	86	57.3
Artisan	49	32.7
Trading	3	2.0
Transportation	12	8.0
Fishing Experience		
Below 5 years	33	27.5
5 - 10 years	67	55.8
11 - 15 years	6	5.0
16 - 20 years	3	2.5
Above 20 years	11	9.2
Household Size (persons)		
1 – 3	41	34.2
4 – 6	68	56.7
7 – 9	11	9.2
TOTAL	120	100

Source: Field Survey, 2019

Table 2: Distribution of sampled households by their farm characteristics, n=120

Culture System Practised By The Farmers	Frequency	Percentage
Monoculture	120	100.0
Species of Fish Cultured		
Clarias	109	90.8
Heteroclarias	6	5.0
Tilapia	5	4.2
Do You Raise Fingerlings Yourself		
Yes	6	5.0
No	114	95.0
sources of fingerlings		
State government hatchery	44	36.7
Private hatchery	76	63.3
Type of Ponds		
Concrete pond	63	52.5
Earthen pond	57	47.3
Main Sources		
Borehole	11	9.2
Well	45	37.5
River/stream water	49	40.8
Spring water	15	12.5
Total	**120**	**100.0**

Table 3: Budgetary Analysis of Combined Fish Farming Enterprise.

Inputs	Mean	% total cost
Feed	3975720.00	94.9
Veterinary and Medical	5172.50	0.1
Energy (Fuel For Water Pumping)	4090.83	0.09
Labour wage	5462.50	0.1
Fingerlings	56808.33	1.35
Total Expenditure On Water	1020.83	0.02
TVC	**4048275.00**	**0.84**
Input Land Price	35325.83	0.78
Net	32943.33	1.01
Pumping	42706.66	0.13
Wheelbarrow	5487.50	0.004
Knives	168.33	0.05
Generator	22275.83	0.01
Borehole	671.39	
TFC	**139578.89**	
TC	**4187853.89**	
Total Revenue	**1390811.66**	
GM	**2657463.33**	
NI	**2797042.22**	

Source: Field Survey, 2019

Table 4: Results showing the Production Efficiency of Catfish Production

Variables	**Parameters**	**OLS Coefficient**	**MLE Coefficient**
Constant	β_0	8.25	14.90***
		(3.10)	(9.37)
Farm size	β_1	0.76	0.15
		(6.67)	(1.03)
Seed quantity	β_2	0.36	0.06
		(2.46)	(0.46)
Family labour	β_3	-0.41	0.58
		-(0.98)	(0.23)
Fertilizer	β_4	0.02	0.05***
		(0.83)	(2.60)
Pesticides	β_5	0.19	0.04
		(3.54)	(1.02)
Hired labour	B_6	-0.50	-0.12
		(-1.75)	(-0.94)
Age	X_1		0.19***
			(3.53)
Sex	X_2		-0.61***
			(-3.23)
Education	X_3		-2.95**
			-(3.95)
Years of Experience	X_4		-0.29
			(-0.40)
Sigma Squared	δ^2		8.67
			(5.71)
Gamma	Γ		0.95
			(44.29)

Source: Field Survey, 2014. *Figures in parenthesis are T-value. * = Significance at 10%, ** = Significant at 5% and *** = at 1%*

Table 5: Regression Analysis Result of Technical Inefficient Determinants

Variable Code	Variables Name	Coefficient	T-value
β_0	(Constant)		-0.689
X_1	Farm size	0.112	1.150
X_2	Age of respondents	0.274**	2.351
X_3	Sex of respondents	-0.122	-1.345
X_4	Extension agent visit	-0.054	-.0574
X_5	Educational status	0.162*	1.659
X_6	Cooperative society	0.099	1.045
X_7	Farming experience	-0.019	-0.193

Source: Field Survey 2019. *** = 10% Significance level, ** = 5% Significance level, and * = 1% Significance level

Table 6: Technical Efficiency Range Distribution

Technical Efficiency Range	Frequency	Percentage
Below 0.64	2	1.7
0.75-0.79	5	4.2
0.8-0.84	4	3.3
0.85-0.89	17	14.2
0.9-0.94	32	26.7
0.95-0.99	60	50.0
Total	**120**	**100.0**

Source: Field Survey 2019

Table 7: Distribution of Respondents by Constraints to Catfish Farming in the Study Area

What are the problem you are facing in the fish farming	Frequency	Percentage
None	18	22.5
Heavy rainfall	6	7.5
Lack of fund	23	28.8
Theft	10	12.5
Presence of predators like lizard, snake and bird	6	7.5
Hanging problem	2	2.5
Shortage of water	5	6.3
Poor performance of the fish	4	5.0
Thief and lack of capital	5	6.3
Casualty	1	1.3
Total	120	100.0

Source: Field Survey, 2019

Factors Influencing Fresh Fish Marketing in Ibi Local Government Area, Taraba State, Nigeria

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ABSTRACT
The study examines the factors influencing fresh fish marketing in Ibi Local Government Area, Taraba State, Nigeria. Multistage sampling technique was used. Eighty (80) fresh fish marketers in the study area were purposively and randomly selected. Primary and secondary data were collected. Descriptive statistics and regression analysis were used. The result showed that 87.5% of the respondents were between the age of 21-40, female respondents were 71.25%, and 55% married. The regression analysis results revealed that cost of storage, cost of transportation and cost of cooling system were inversely related to the revenue generation and their influence was significant at <p 0.001, while cost of labour and cost of rent were also inversely related to revenue at <p 0.01. The R value was 0.832, R^2 value was 0.693 and F-value was 27.798. It was concluded that all the factors that were considered were significant in influencing fresh fish marketing in the study area with the exception of building and it had been recommended that fresh fish marketers should form association in other to seek funds and other empowerments from government and nongovernmental organization
Keywords: Factors, Influencing, Fresh, Fish, Marketing

INTRODUCTION
Fish being a perishable product has been facing lots of marketing challenges in the developing countries. Hunger and malnutrition remain amongst the most devastating problems facing the world poor and needy (Umoinyang, 2014). Fish is an important source of protein in developing countries. However, it is highly perishable especially in the hot climate where unsanitary environment and poor handling practices worsen the situation (Ikeme, 2006). Demand for agricultural products is expected to reach unprecedented levels in the near future as the world population is increasing considerably with rapid population growth in the developing countries. Potentials therefore, exist for demand-supply imbalance. Stake-holders in many developing countries are making efforts to overcome poverty, food insecurity and malnutrition. United Nations Population Fund (UNPF,1993). Marketing of fresh fish passes through several market participants and exchange points before they reach the final consumers. The marketing system and structure is one of the main circumstances of socio economic condition of the local people and production system of any area (Alam *et al.*, 2010). It is a chain of different systems involved in the marketing from production to consumption with intra-linkages and inter-linkages. At various stages in the marketing chain, fish has to be packed and un-packed, loaded and un-loaded to meet consumer demand. Each handling cost will not amount so much but the sum total of all loading can be significant, depending on the length of chain (Ali *et al.,* 2008). Before the increase in urbanization, fish were consumed locally where they were produced. Increasing urbanization and development has further increased the

distance between fish producers and consumers, result to importance of fish marketing. Fish marketing involves all activities undertaken in conveying fish from producer to consumers. It includes processing, storage, preservation, transportation, wholesaling, and retailing. The process of fish marketing is a very delicate one, if the quality and nutrition of fish is to be maintained to the highest possible value. (Umoniyang, 2014). This study was aimed to prove the relevant data required for improving fresh fish marketing in the study area. Meanwhile, socio-economic characteristics of the fresh fish marketers such as age, gender, marital status and others would be considered. Government intervention policies, cost of storage facilities, transportation costs, cost of labour, cost of rent and cost of building construction were also to be considered.

MATERIALS AND METHODS

This study was conducted in Ibi Local Government Area of Taraba State. It is one of the 16 local government areas of the state. The Ibi town is the Local Government Headquarters of Ibi LGA of the state. The town is located on the south bank of the Benue River. Both the Taraba and Donga Rivers flow into the Benue River within the LGA (Afigbo, 1997). It covers an area of approximately 2,672 km^2 and lies between longitude $9^0 51'$ E and 9.850° E and latitude $8^0 19'$ N and 8.317°N and the economic activities of the people is mostly fishing and farming. Purposive and random sampling techniques were used for the study. A sample size of 80 respondents was drawn out of the fish marketers in the study area. The unit of study was fish wholesalers engaged in fresh fish marketing in Ibbi Local Government Area, Taraba State, Nigeria. Data collected were primary data. The data that were collected from fresh fish marketers include age, gender and marital status. Structured questionnaires were used in the study area. Descriptive statistics and regression analysis were used to analyse the data collected in the study area. Descriptive statistics was used to analyse the socio-economic characteristics of fish marketers and regression analysis to analyze the factors influencing fresh fish marketing in Ibi Local Government Area.

Model Specification

The model used in the study was the Ordinary Least Square (OLS) regression model. This regression analysis was estimated to determine the factors that influence fresh fish marketers. The explicit form of the linear equation is given as:

$$Y = b1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 \tag{1}$$

The implicit form of the equation is given by:

$$Y = f\,(X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + U) \tag{2}$$

Where,

Y = Revenue (₦)

X_1 = cost of storage

X_2 = cost of building

X_3 = cost of rent

X_4 = cost of transportation

X_5 = cost of Labour

X_6= cost of cooling system

U = Error term

RESULTS AND DISCUSSION

Table 1 showed that 87.5% of the respondents were between the age of 21-40 years. This indicated that fresh fish marketers in the study area were relatively young. This finding is in line with the findings of Madugu and Edward (2011), which showed that 46.25% of fish marketers are between the ages of 31-40 years. Another study in Ondo State revealed that marketers between the age of 31- 40 years had the highest frequency of 37.6% in fish marketing activities (Lawrence and Sylvester, 2014). The result also revealed that 57 of the respondents representing 71.25% of the total respondents were female; while only 28.75% were male. This implied that women dominated the marketing of fresh fish in the study area. This is in line with Lawal and Ideg (2004) who reported that about 90% women participate in fresh fish marketing. It is also in line with Lawrence and Sylvester (2014) who also reported that 78% of fresh fish marketers were women while men formed the 22% remaining. While Madugu and Edward (2011) had contrary opinion that 50% of women participate in fish marketing in Adamawa State. Furthermore, the results revealed that 44 of the marketers were married representing 55.0% of the respondents, 42.5% were divorced and 1.3% were widow(er) and single. The implication was that married people dominated the fresh fish marketing in the study area. This might be due to their family responsibilities, to meet up with; responsibilities like feeding, payment of children school fees, health bills and others. This is in line with Abah, et' al. (2013) who viewed that 80.6% of fish marketers were married.

The results in Table 2 revealed that cost of storage, cost of transportation and cost of cooling system had negatively influenced the revenue generation at $p < 0.001$ significant level. This implied that an increase in the cost of variables considered had decreased the revenue generation. Meanwhile, if there was low cost of the factors considered the revenue generation would have increased. It also showed that cost of rent and cost of labour had significantly influenced negatively on the revenue generation at 5% level of significance. Cost of building had no significant influence on the revenue generation. The R^2 was 0.693 which implied that the independent variables explained the variability in the dependent variable at 69%. The R value was 0.832 which implied that there was a strong relationship between the dependent and independent variables considered in the model.

Hypothesis Testing

Decision rule: From the ANOVA Table 3, the Fcal was 27.798 which were greater than Ftab which was 2.29. Therefore, the null hypothesis "The Factors influencing fresh fish marketing significantly influenced the Revenue" was accepted and the alternative hypothesis" was rejected. This was because cost of storage, cost of transportation and cost of cooling system had negatively influenced the revenue generation at $p < 0.001$ significant level. Cost of rent and cost of labour had significantly influenced negatively on the revenue generation at 5% level of significance.

CONCLUSION

From the findings research of this study, it was concluded that majority of fish marketers in the study area were at their youthful age (21-40 years) and women dominate the fish marketing business with 71.5%. Majority (57%) of the respondents had family size of 6-10 persons and most (45.0%) of the respondents put attention only on fish marketing with few participating in other activities to supplement income. There is no cooperative society of marketers in the study area and source of capital is majorly (82.5%) base on personal savings; marketers do not access formal credit from government or financial institutions. It is therefore recommended that fish marketers should organise themselves inot thrift or cooperative societies to be able to pull their resources together to access cheap loans to expand their trades. Government should also institute policies that would make fish marketers to obtain loan with little or no rigidities and at low interest rates.

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Table 1: Socioeconomic characteristics of fresh fish marketers

Socio-economic characteristics	Frequency	Percentage
Age		
1-20	2	2.5
21-40	70	87.5
40 above	8	10
Total	**80**	**100**
Gender		
Male	23	28.75
Female	57	71.25
Total	**80**	**100**
Marital status		
Single	36	45
Married	44	55
Total	**80**	**100**
Major occupation		
Farming	31	38.8
Civil service	13	16.3
Fish marketing	36	45
Total	**80**	**100**
Marketing experience		
1-5	41	51.2
6-10	33	41.2
11 above	6	7.5
Total	**80**	**100**

Source: Field survey, 2019

Table 2: Factors influencing fresh fish marketing in Ibi

Variables	Regression Coefficients	Standard Errors	Level of significance
X_1	-0.960	4608.702	0.007***
X_2	0.786	73235.496	0.001^{ns}
X_3	-0.914	41707.730	0.098**
X_4	-0.856	10265.580	0.780***
X_5	-0.604	6743.939	0.311**
X_6	-0.220	6108.895	0.004***
R = 0.832	Adjusted R = 0.668	R Square 0.693	

Source: Field survey 2019. ***Note:*** *Y = Revenue, X1= cost of storage, X2= cost of building, X3= cost of rent, X4= cost of transportation, X5= cost of labour, X6= cost of cooling system.*
**** = significant at 1% level. ** = significant at 5% level NS = not significant*

Table 3: ANOVA table for Hypothesis Testing

Source of Variation	Sum of Squares	Df	Mean Square	F*cal	F*tab	Sig
Regression	11571829158233.393	6	1928638193038.899	27.798	2.29	.000^c
Residual	5134182907366.608	74	69380850099.549			
Total	16706012065600.000^d	80				

Source: Field survey, 2019

Effects of Nicosulfuron Herbicide on the Haematological Profile and Behaviour of Juvenile *Clarias Gariepinus* (Burchell, 1822)

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ABSTRACT

The hematological changes of Clarias gariepinus juvenile exposed to varying concentration of Nicosulfuron herbicide for 96hr using static bioassay was determined. Healthy180 pieces active fish of mean weight 13.6-46.1 g and11.00-20.00 cm length were randomly distributed into five treatments and control (0.0ml, 1.5ml, 1.625ml, 1.75ml, 1.875ml and 2.0ml) in triplicates of ten fish per tank. Data obtained were at P< 0.05 using Minitab. There was an increase in WBC, PCV, Hb MCV and decrease in MCHC with increase in concentration. The result shows no significant difference in RBC and MCH. The toxicity could be of low impact when compared to other toxicant but the bioaccumulation effect can be hazardous. The result of this work can serve as baseline information to develop models on effects of Nicosulfuron herbicides on ecological characteristics of aquatic environment. It can also be as an index of toxicity in water to determine the health of an aquatic organism.

Keywords: *Clarias gariepinus, Nicosulfuron, Haematology, Behaviour*

INTRODUCTION

Clarias gariepinus is an important fish in Nigerian Aquaculture. Offem *et al.* (2010) said it is the second most culture fish in Nigeria in the 2000s. Presently, *C. gariepinus* is famous in Aquaculture because of its taste, high price command in the market, and availability of seeds since it can reproduce or at least initiate reproduction in captivity. This places it in Nigerian Aquaculture higher than its relative, *Heterobranchus* species that cannot reproduce in captivity (Freund *et al.*, 1995; Anetekhai, 2013). This fish is remarkable fish species in Nigeria where it is a leading aquatic crop. It has credentials of fast growth, resistance to disease and handling stress. It has air-breathing structure and therefore tolerates very low oxygen levels in any aquatic environment as well as on land (FAO, 2012). Pesticides are known to be toxic by design-Biocides, designed to kill, repel and reduce pests, unwanted herbs etc; which impart threat to crop plants. Lack of knowledge and injudicious use of the pesticides leads to lethal effects on organisms. Nicosulfuron is used for control of weeds such as pigweed and crops such as field corn and popcorn (OHS Database. 1994). Fish blood gives the possibility of knowing physiological conditions within the fish long before there is an outward manifestation of diseases. This is because under stressful conditions as well as environmental imbalances, some parameters in the blood change in response to the changes (Shah and Atindag *et al,* 2004). The potential utility of biomarker for monitoring both environmental quality and health of organisms inhabiting polluted aquatic ecosystems has received increasing attention in recent times (Lopes *et al*., 2001, Gautheir *et al.,* 2004), Despite the rangy use of Nicosulfuron herbicide, literature on its effects on hematological parameters of *C. gariepinus* are scanty, hence this research aimed at studying the acute toxicity(LC50) of Nicosulfuron herbicide to juvenile *C. gariepinus*, its effect on hematological parameters and behavior of the fish exposed to the toxicant.

MATERIALS AND METHODS

The experiment was carried out in the fisheries laboratory of Adekunle Ajasin University Akungba -Akoko using Plastic tanks of 75 cm x 40 cm x 40 cm; 50L capacity. Apparently 250 healthy juvenile catfish *C. gariepinus* (11.00-20.00 cm length and 13.6-46.1g weight) were collected at a private fish farm Etioro Akoko Ondo state. The fish were acclimated to the laboratory condition for three weeks and fed with commercial (Skretting) at 5% body weight. The herbicide, Nicosulfuron was introduced with 5ml syringe.

Toxicity Test

***Range finding test**:* Preliminary 24h range finding test was conducted using varying concentration of 1.0, 1.5, 2.0, 2.5, 3.0, 3.5 to make Six treatments for determination of the toxic range of Nicosulforon to juveniles of *C. gariepinus,* following static bioassay procedure.

***Definitive test**:* Based on the results from the range finding test, 96h definitive tests was carried out, following static bioassay procedures described by Parish (1985) . Batches of Ten juveniles *C. gariepinus* were batch weighed and distributed into a set of 18 rectangular plastic tanks filled with 30L of Unchlorinated water. Five test solutions of Nicoulfuron of 1,5, 1.625, 1.75, 1.875, 2.0ml as earlier determined from the range finding test was introduced in a single dose directly into the plastic tanks. The test fish were not fed throughout the 96 h test. The behavioral pattern and mortality of the fish in each tank was monitored and recorded every 15min for the first one hour, every hour for the next four hour, once every four hours for the next 24h and once every 24h for the rest 96h. Dead fish was removed immediately with scoop net to avoid contamination due to rotting.

***Hematological analysis**:* Blood (1-3ml fish-1) was collected from the fish after 96h of exposure through the vertebral caudal blood vessel with the help of disposable hypodermic syringe and needle. Blood sample was emptied into 10ml sample bottle treated with anticoagulant, Ethylene Diamine Tetracetic Acid (EDTA). Hematological analysis of fish followed the method described by Svobodova *et al*. (1991).

***Statistical analysis**:* All results were collated and analyzed using computerized probit and logit analysis (Lichtfield and Wilcoxon, 1949). The median lethal concentration, at selected period of exposure and an associated 95% confidence using MINITAB (version 14.) and hematological by statistical analysis using SAS.

RESULTS AND DISCUSSION

Lethal concentration: The acute toxicity of Nicosulfuron to *C. gariepinus* juvenile is 1.496ml -14.962ml. This was derived by multiplying the 96-h LC_{50} by a constant of 0.01-0.1. This is represented in fig 2.

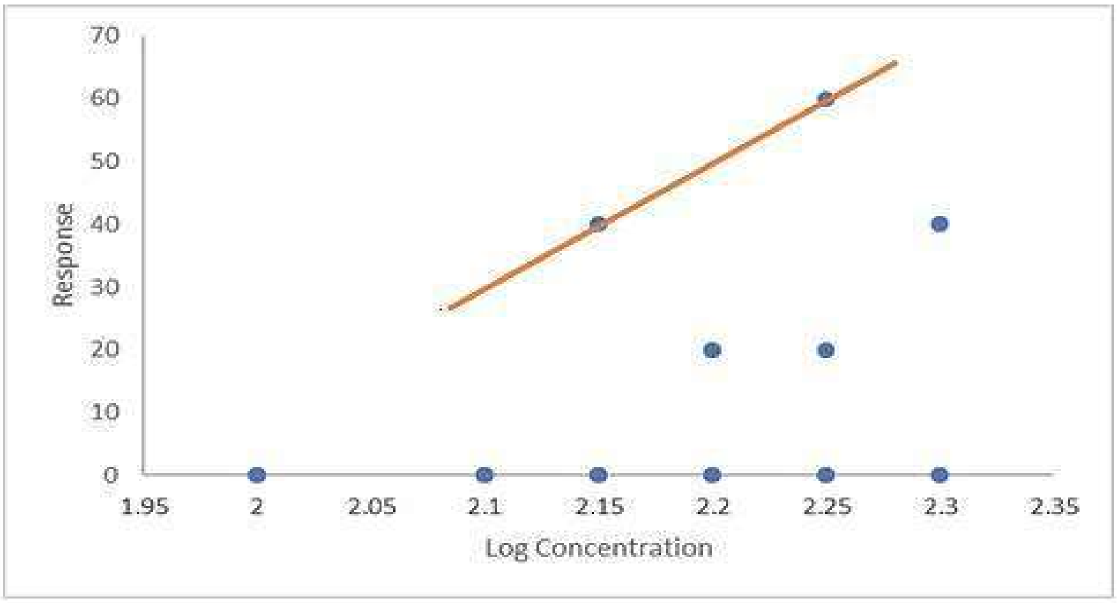

Fig 2: Log of concentration of Nicosulfuron herbicide and its probit value for juvenile *C. gariepinus*

Behavioural changes: Table 1 shows the behavioural response of juvenile *C. gariepinus* exposed to Nicosulfuron herbicide. (Maikai *et al*., 2008). The fish finally settled at the bottom motionless with slow opercula movement.

Table1: Behavioural changes observed in the juvenile *C. gariepinus* exposed to Nicosulfuron herbicide

Behaviour	24hrs					48hrs					72hrs					96hrs				
Concentration	1.50	1.625	1.75	1.875	2.0	1.50	1.625	1.75	1.875	2.0	1.50	1.625	1.75	1.875	2.0	1.50	1.625	1.75	1.875	2.0
Loss of reflex	-	+	+	+	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-
Air gulping	+	-	+	+	+	+	+	-	-	-	-	+	-	-	-	-	+	-	-	-
Erratic swimming	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barbel deformation	-	+	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Excessive mucus	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molting	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-

Keys : + reaction; - No reaction

Haematological studies: The result of the haematological studies shows a significant increase ($p<0.05$) in some values of *C. garipinus* blood parameters (Pcv, Hb, Rbc, Wbc, Mcv and Mch) after exposure to Nicosulfuron herbicide for 96hrs (Table 2). and decrease in Mean cell haemoglobin concentration.

The mortality rates observed in the present study suggests a clear relationship that is proportional to the mortality rate. The Lc_{50} of Nicosulfuron herbicide to *C. gariepinus* juveniles is 1.496ml which is similar to the result observed by Ayotunde *et al* (2011) who reported 2.42mg/l, for *O. niloticus* juveniles exposed to aqueous extract of *Moringa oleifera* seed powder. The observed increase in some hematological parameters is contrary to what was observed by Altreza *et al* (2012) when *Mesopotamichthys sharpeyi* was exposed to Paraquat herbicide but the decrease in MCHC is in agreement with his work. The increase also correlates with the work of Adene *et al* (2017) who investigated the acute toxicity and blood profile of adult *C. gariepinus*. The observation was contrary to what obtained by Adene *et al* (2019) on hematological assessment and piscicidal effect of sodium hypochlorite on juvenile *Heterobranchus bidorsalis*. The increase in WBC could be as a means of fighting against the presence of the toxicant in the blood since WBC function as an Antigen that fight any unwanted microorganisms or infections in the body.

Table2: Haematology Parameters of *C. gariepinus* exposed to Nicosulfuron herbicide

Treatment/ Parameters	T1(0.00ml)	T2(1.50ml)	T3(1.625ml)	T4(1.75ml)	T5(1.875ml)	T6(2.0ml)
RBC (10^2/L)	2.13±0.25^b	3.00±0.26^a	3.00±0.10^a	2.77±0.32^a	2.87±0.15^a	2.67±0.06^a
WBC(10^3/mm^3)	60.00±10.28^b	98.07±11.89^a	99.1±0.62^a	88.5±11.64^a	100.83±8.37^a	85.73±2.50^a
HB(g/dl)	9.03±0.75^b	13.63±1.24^a	13.50±0.10^a	12.50±1.47^a	13.00±0.44^a	12.23±0.60^a
MCV(FL)	108.57±3.39^b	126.30±0.92^a	126.20±0.26^a	124.93±0.65^a	127.77±4.74^a	128.47±6.00^a
MCH(pg)	42.53±1.11^b	45.47±0.60^{ab}	44.93±0.85^{ab}	44.70±0.36^{ab}	45.57±2.47^{ab}	48.83±4.91^a
MCHC (g/dl)	39.17±0.35^a	35.97±0.55^b	35.60±0.61^b	35.77±0.12^b	35.67±0.72^b	35.67±0.72^b
PCV (%)	27.00±2.00^b	41.00±3.46^a	40.67±0.58^a	37.33±4.62^a	39.33±1.16^a	36.67±1.53^a
N (%)	1.33±0.58^a	1.33±0.58^a	1.00±0.00^a	1.00±0.00^a	1.00±0.00^a	1.00±0.00^a
L (%)	95.33±0.58^a	95.67±0.58^a	94.00±0.00^a	94.33±0.58^a	94.67±02.08^a	94.33±0.58^a
M (%)	2.00±0.00^a	1.67±0.58^a	3.00±0.00^a	2.67±0.58^a	2.67±01.53^a	2.67±0.58^a
E (%)	1.00±0.00^a	1.33±0.58^{bc}	2.00±0.00^a	2.00±0.00^a	1.67±0.58^{ab}	2.00±0.00^a

Note: Means with the same column followed by the same letter are not significantly different from each other.

CONCLUSION

It can be concluded from the present study that Nicosulfuron herbicide is moderately toxic to catfish *C. gariepinus* and even low doses of it could modify the haematological profile of fish. The toxicity could be of low impact but the bioaccumulation effect can be hazardous.

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Fish Species Composition of Artisanal Fisheries of Ilaje, Coastal Area of Ondo State, South-West Nigeria

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ABSTRACT
This study was carried out to investigate the fishery composition of Ilaje Local Government Area of Ondo State, Nigeria. The area was divided into three zones and three fishing communities with one landing site were randomly selected from each zone. Data were collected from all the zones once in a week for twelve months. The first three vessels to land from the lagoon were assessed for their catches. The catches were identified, sorted, counted and classified into species. The data collected were analyzed based on zone and pooled together for the entire study area. A total fish catch of 920,418 were assessed in all the zones. Thirty-four (34) fish species from twenty-two (22) family were assessed and quantified with basket. Twenty-nine (29) were finfishes and five (5) were shellfishes. Ethmalosa fimbriata was the most abundant fish species followed by Arinus lasticulatus, Ilisha africana, Polydactylus quadrifilis and Caranx hyppos they contributed 8.83%, 7.95%, 7.93%, 7.08 and 21 6.72% of the total catch respectively. The least fish species assessed were Pragelus graveli, Coryphaena equiselis and Echiophis creutzbergi with total of 0.005, 0.008 and 0.001% respectively. The shellfish assessed were Pink shrimp (Penaeus notalis) and Guinea shrimp (Parapenaeopsis atlanticus).
Keywords: Caranx hyppos, finfishes, Pink shrimp, shellfish

INTRODUCTION
The coastal area of Ondo State, Nigeria, is richly endowed with natural resources and is among the Niger Delta States of Nigeria which contribute more than 50% of the entire domestic Nigerian fish supply (Akankali and Jamabo, 2011). The fishing activity in the Region is aided by the presence of Lagoons, Rivers and the Atlantic at the coast which provide avenues for a number of economically viable small and medium scale fishing enterprises. Both freshwater and maritime fishing are done in the area. Ilaje community area is the most recognized coastal area of Ondo State. The people of the community engaged in sea fishing using simple fishing gears and trawlers but during high tides of the sea, some professional fishermen would resort to Inland fishing, however, industrious fishermen would access both sea and Inland fishing for economic security and subsistence (Ehinmore, 2007). Inland water fisheries are mostly exploited by the artisanal fisherfolks. Artisanal fisheries cover the operation of small-scale canoe fisheries, operating in the coastal and inland water. The folks in this sector operate within a limited fishing range with small canoes of about 3 to 6m, mostly powered with paddles (FAO, 1996). The limited fishing range and lack of other tangible employment opportunities in the coastal communities confine the inhabitants to fishing (Mathew, 2000). The artisanal fisherfolks have no alternative but to continue exploiting the available fish resources. The aim of this study is to assess the fisheries exploit by the artisanal fisheries of the Ilaje community.

MATERIAL AND METHODS

The study area is Ilaje Local Government Area (LGA), Ondo State. Ilaje Local Government Area lies between 4° 50" and 5° 15" E and 6° 00" and 6° 25" N (Figure 1). The area comprises of several fishing communities located along the coastline. The area is situated in the rainforest belt of Nigeria with an annual rainfall of 200 – 250mm. It is characterized by two distinct seasons, the rainy season which is between March and September while the dry season is between October and February. The relative humidity is high throughout the year generally above 60% (Abdus-Salam *et al.,* 2010). The major occupation of the residents are fishing, canoe making and fishing net making. Apart from fishing activities, the dwellers also engage in other agricultural practices such as cultivation of cassava, maize, rice, vegetables and palm oil. Mineral resources available in the area include glass sand, tar sand, salt and quartz.

Data Collection

The study area was divided into three zones for easy fish assessment and data collection. Three fishing villages were randomly selected from each zone totaling nine villages. In zone 1, the villages were Ayetoro, Alagbon and Eruna, zone 2 comprised of Ijo Odo, Ashisha and Idogun and in zone 3, the villages were Omifun, Etikan and Oroyo. Data on fish caught were collected for twelve months, from the month of May 2014 to April 2015. Each landing site from the zones was visited once in a week for data collection (Plate 1).

Fish Catch Assessment

The first three canoes from the sea were assessed for their catches or harvest. The catches were identified, counted, weighed and classified into species. The fish were identified to species level with the aid of Field Guide of the Commercial Marine Resource of Gulf of Guinea (FAO, 1997).

RESULTS AND DISCUSSION

The various fish species assessed in the study area were shown in Table 1. A total fish catch of 920,418 individuals was assessed in the study area. *Ethmalosa fimbriata* was assessed most followed by *Arinus lasticulatus* and *Ilisha Africana*. The least fish species assessed were *Pragelus graveli,* with total abundance of 5, *Coryphaena equiselis* and *Echiophis creutzbergi* with total abundance of 8 and 16 respectively. The shellfish assessed were Pink shrimp (*Penaeus notalis)* and Guinea shrimp (*Parapenaeopsis atlanticus).* They were quantified with basket.

Family abundance and percentage (%) composition

Fish species from the family Clupeidae had the highest number of catch of 211,646 and percentage composition of 22.10% followed by Cynoglossidae, Scaenidae, Ophichthidae, Sphyraenidae, Haemilidae, Lutjanidae, Ariidae, Carangidae, Elopdae, Mugilidae, Trichuridae, Polnemidae, Ephippidae, Magalopedae, Corphaenidae, Rajidae, Palinuridae, Paneidae, Portunidae, Dasytidae and Seranidae. The family abundance and percentage composition is presented in Figure 1.

The fish sampled in this study comprised of thirty-four (34) species from twenty-two (22) families and thirty-two (32) genera. This result differs from the findings of Bolarinwa *et al.* (2015) who reported 67 species belonging to 36 families from the coastal waters of Ondo State. However, similar to the findings of Akegbejo-Samsons (1995) who reported 32 species from the coastal waters of Ondo State. Odulate (2004) reported 38 species and 25 families from the marine coastal water of Ogun State. Ayoola and Kuton (2009) recorded 39 species belonging to 23 families from the Lagos Lagoon. The difference between the species diversity in this study and the previous works might be due to the locations and icthyofauna of the study areas. The number of species caught in this study, might be due to the richness and the distribution of fish species in the coastal area. This study shows that *Ethmalosa fimbriata* from the family Clupeidea was the most predominant species in the coastal area, this could be attributed to the high reproductive capacity and the salt tolerance of the fish. Lévêque *et al.* (1990) and

Guyonnet *et al.* (2003) stated that *E. fimbriata* is abundant along the West Africa coast, highly adapt to environmental change and profoundly exploited by the artisanal fishermen. The high exploitation of *Ilisha africana* in this study could be attributed to the economic importance of this species. *I. africana* abundance in Nigerian waters and the demand for the species is high (Moses, 2000).

CONCLUSION

Conclusively, from this study, the coastal water of Ondo State is endowed with variety of fish species. A total of 920,418 fish from 34 fish species were identified across the study location. *Ethmalosa fimbriata* and *Illisha africana* from the family Clupidae were most represented in the study area. The fisheries resources of coastal waters of Ondo State could be painstakingly said to be high in biodiversity resources however, like other fisheries resources worldwide, it is vulnerable to extinction through overexploitation, pollution, climate change and anthropogenic activities that destroyed the natural ecosystem. It is very important to protect, conserve and manage these resources sustainably.

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Table 1: Major Marine Fish Species Composition Assessed in all the Zones

Family	Scientific name	English name	Local name
Clupeidae	*Ethmalosa fimbriata*	Bonga shad	Folo
	Ilisha Africana	West African shad	Faranfaran
	Sardinella maderensis	Madeiran Sardinella	Sawa
Cynoglossidae	*Cynoglossus senegalensis*	Sole	Abo
	Cynoglossus browni	Sole	Abo
Polymedae	*Polydactylus quadrifilis*	Shiny nose	Ofon
Scaenidae	*Pseudotolithus elongatus*	Croaker	Upokun
	Pteroscion peli	Croaker	Ojune
Ophichthidae	*Ophichthus ophis*	Eel	Ejomalokun
	Echiophis creutzbergi	Spoon nose eel	Ejo okun
Sphyraenidae	*Sphyraena afra*	Barracuda	Kuta
Dasytidae	*Raja miraletus*	Sting ray	Nate
Seranidae	*Epinephelus aeneus*	Gouper	Lowutu
Haemulidae	*Brachydeuturus auritus*	Bigeye grunt	Majugha
	Pomadasys peroteti	Parrot grunt	Ikekere
Lutjanidae	*Lutjanus dentatus*	Red snapper	Obira
Ariidae	*Arinus lasticulatus*	Marine catfish	Arighon
Carangidae	*Caranx hippos*	Graville jack	Agasa
	Ariomma bondi	Red bigeye	Olojugudugbu
	Chloroscombrus chrysurus	African moon fish	Kokote
Elopidae	*Elops lacerta*	African lady fish	Sogbon
Mugilidae	*Mugil cephalus*	Mullet	Itoko
Coryphaenidae	*Coryphaena equiselis*	Dolphin fish	Obeje
Rajidae	*Rhinobatus rhinobatus*	Skate	Olupan
	Pragelus graveli	Shark	Yanyan
Trichuridae	*Trichirus lepturus*	Cutlass fish	Doje
Polynemidae	*Pentanemus quinquarius*	Threadfin	Luroro
Ephippidae	*Chaetodipterrus gerensis*	Spade fish	Akaraba
Megalopidae	*Megalops atlanticus*	Megalop	Agha
Palinuridae	*Penulinus species*	Lobster	Ipa
Penaeidae	*Penaeus notalis*	Pink shrimp	Ede
	Parapenaeopsis atlanticus	Guinea shrimp	Ede
	Penaeus monodon	Giant tiger prawn	Ede
Portunidae	*Portunus validus*	Marine crab	Akan

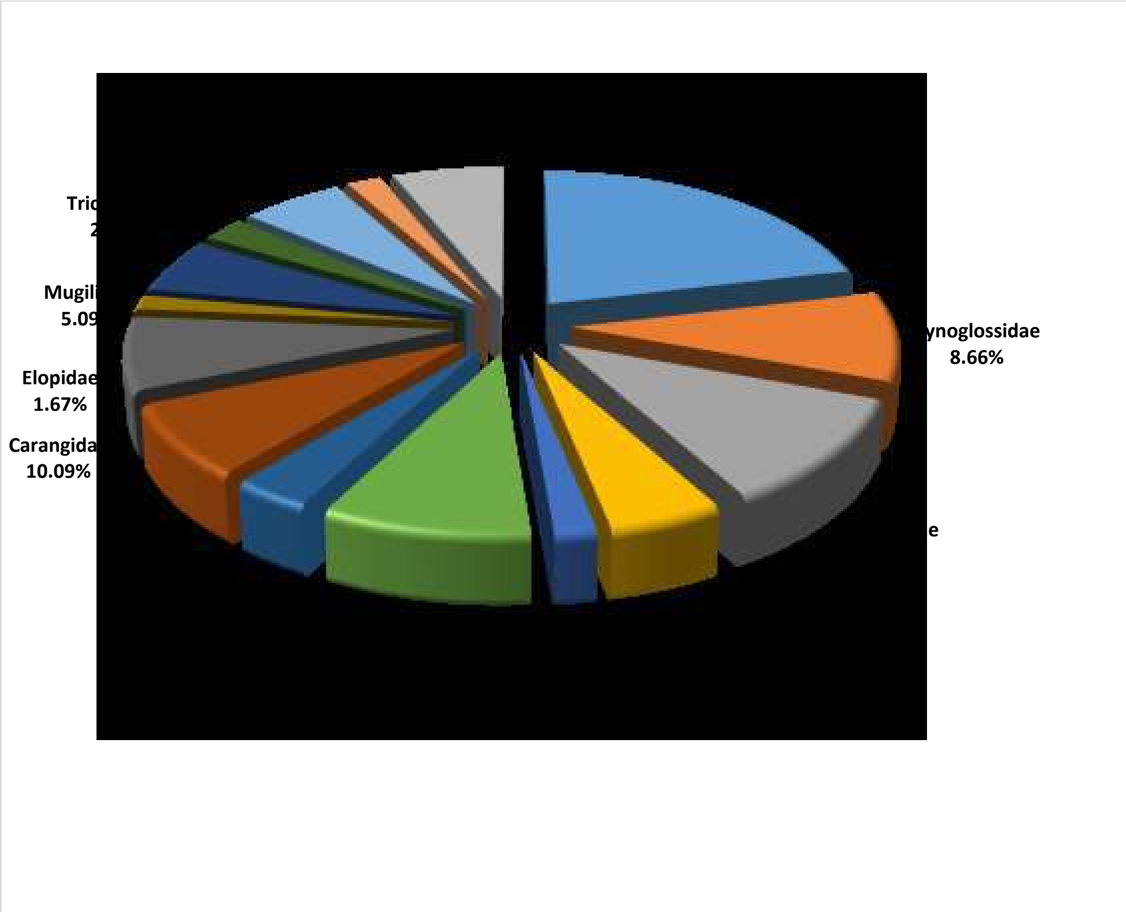

Figure 1: Percentage composition and abundance of fish species (Shell fish and fish species that are less than 1% were not represented)

Heavy Metal Assessment in Bonga Fish *(Ilisha africana)* and West Africa Shad (*Ethmalosa Fimbriata*) From Ondo State Coastal Waters

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ABSTRACT

This study was conducted to assess the heavy metal concentration on two predominant fish species (Illisha africana and Ethmalosa fimbriata) from Ondo state coastal waters with respect to four fishing communities (Jirinwo, Ikorigho, Odofado and Ojumole). The study revealed the highest concentration of Zn of 0.445 and 0.472 in gills and tissue respectively in I. africana. Also, the highest concentration of zinc of 0.440 and 0.430 was observed in E. fimbriata gills and tissue respectively. The highest metals concentration observed in the gills and tissue of the fish species assessed was Zn followed by Fe, Cu, Pb and Cd respectively. The concentration of Cu and Zn are significantly different in both species which may be due to their natural occurrence in the Nigerian soil. The levels of concentration are still within the World Health Organization (WHO) and Food and Agricultural Organization (FAO) permissible limit of 5mg/l and 2mg/l which makes the fish safe for consumption.

Keywords: Ethmalosa fimbriata, fishing communities, fish species, Illisha Africana, permissible limit

INTRODUCTION

Pollution of heavy metals in aquatic ecosystem is growing at an alarming rate and has become an important worldwide problem (Malik *et al.*, 2010). Increase in population, urbanization, industrialization, and agriculture practices have further aggravated the situation (Gupta *et al.*, 2009). Polat *et al* (2015) reported that fish have the ability to uptake and concentrate metals directly from the surrounding water or indirectly from other organisms such as small fish, invertebrates, and aquatic vegetation and they offer several specific advantages in describing the natural characteristics of aquatic systems and in assessing changes to habitats (Lamas *et al.,* 2007). Also, Benaduce *et al.,* (2008) reported that accumulation of heavy metals in a tissue is mainly dependent on water concentrations of metals and exposure period; although some other environmental factors such as water temperature, oxygen concentration, pH, hardness, salinity, alkalinity and dissolved organic carbon may affect and play significant roles in metal's accumulation and toxicity to fish. Bayode *et al.,* (2011) documented on the exploration of oil in 1977 from Ondo State coastal water with particular reference to Awoye, Ojumole and Odofado which are part of the research area under study. Fishing is an integral part of the coastal community, of which fishing and fish consumption also plays a major component in their daily diet and livelihood. For this reason, detailed information gathered on the level of concentration of heavy metals in some of the abundant fish species in the four coastal communities (Ojumole, Ikorigho, Jirinwo and Odofado) in Ilaje Local Government Area of Ondo State. The aim of this study is to determine the heavy metal concentrations in the gills and tissues of *Ethmalosa fimbriata and Illisha africana* species from four coastal waters in Ilaje L.G.A of Ondo State.

MATERIALS AND METHODS

The study area covers four coastal communities (Ojumole, Ikorigho, Jirinwo and Odofado) in Ilaje Local Government Area of Ondo State that lies between Latitude 6º12'N and 6º 30'N of the Greenwish Meridian and between Longitudes 4º 45'E and 5º of the Equator. It is bounded to the West by Ogun state, in the East by Ese Odo Local Government Area and Delta State, in the North by Ikale Local Government Area and in the south by Bight of Benin and Atlantic Ocean (Olaniyi, 2013).

Sample Collection

Fish samples were collected monthly for five months from Ojumole, Ikorigho, Jirinwo and Odofado form August to December, 2018 with the aid of gill net of mesh sizes 1.0cm, 2.0cm, 3.0cm and 4.0cm. the fish species were identified with the aid of FAO identification guide (VI) 2005.

Determination of Heavy Metal

This was done according to the AOAC, (1994) procedure. Ten (10) fish sample were digested and heavy metals analysed using their gills and tissue. Fish samples were dissected using a clean dissecting knife, separating the gills and the tissues from the bones. The gills and tissues was then oven dried at 105º C until a constant weight is gotten. The dried samples were grinded and homogenized into a powdery form. 10g of the dried sample was weighed into a $100cm^3$ pyrex beaker and $5cm^3$ of concentrated nitric acid was added to the content in the beaker and placed over an electric burner with temperature of 40º C. after heating for 15 minutes, another 5 cm^3 of concentrated nitric acid and $10cm^3$ of concentrated tetraoxosulphate (IV) H_2SO_4 acid was added and the temperature raised gradually to 100ºC. the heated solution was set aside for 20minutes to cool and digested samples were diluted with $10cm^3$ of distilled water. The solution was boiled until the suspended solids dissolves and is allowed to cool again. The digests were then transferred into a $100cm^3$ volumetric flask and marked up with distilled water. The heavy metal concentration was determined using the Atomic Absorption Spectrophotometer (Buck Scientific 210 VGP).

Statistical Analysis

Data obtained were subjected to descriptive analysis and analysis of variance (ANOVA) was used to find out the significance difference between the metals in the tissue and gills of the fish. Mean values was separated using the Duncan Multiple Range Test (DMRT) $p< 0.05$.

RESULTS AND DISCUSSION

From the result of the study, *I, africana* caught from Ikorigho had the highest Zinc(Zn) value in its gills (0.455 ± 0.242^b) than *E. fimbriata* (0.422 ± 0.175^b). The high Zn value recorded in the gills of *I. africana* agrees with the work of Olusola and Festus (2015) that recorded a higher Zn abundance in the tissue of *Auritus latisculata* (5.11mg/kg) from the coastal waters of Ondo state. This was attributed to the presence of Metallothionein protein synthesis in the liver and gills of fishes when exposed to heavy metals to detoxify them. The mean concentration of Lead (Pb) and Copper (Cu) in both fish samples are still below the FAO/WHO and permissible limit of 0.30mg/kg and 1.5μg/g Cu/l (FAO 2011; FEPA, 1991). The lower Pb and Cu values recorded does not agree with the work of Obot *et al., (2016)* that had a higher Pb (0.46 ± 0.24^a) and Cu value for *E. fimbriata* caught from Makoko river in Lagos state. Copper (Cu), an essential trace metal and micronutrient for cellular metabolism in living organism can have adverse health consequences at high concentrations (Demirezen and Uruc, 2006). Toxicity of copper relies on the hardness and pH of water. *I.africana* had the highest Fe recorded in the tissue (0.405 ± 0.168) which does not tally with the work of Obot *et al., (2016)* who recorded a higher Fe value (305.72mg/kg) in *E. fimbriata* from lower Cross river estuary. Olowu *et al.,* (2010) associated the high concentrations of Fe and Cu in the Nigerian waters to the natural occurrence of these metals in the soil. The Cadmium (Cd) values recorded are still within the World Health Organization (WHO) permissible limit of for portable drinking water of 0.005 μg/g (WHO, 2011).

CONCLUSION

From the finding of this study, the four coastal waters are not significantly contaminated, with lower values of heavy metal recorded in the tissue and gills of *I. africana* and *E. fimbriata*. The concentrations of Zn, Fe, Cu, Pb and Cd were generally lower than the Food and Agriculture Organization (FAO) and World Health Organization (WHO) permissible limits. The levels found in the tissue and gills may be due to the anthropogenic and agricultural activities in the study area. Also, the lower concentrations recorded showed that the fishes are contaminated but not to the level that poses a health risk or challenge to the consuming population.

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Table 1: Heavy Metal Concentration in the tissue of *Ethmalosa fimbriata* across locations

Metals	Jirinwo	Ikorigho	Ojumole	Odofado
Zn	0.341 ± 0.107^{a}	0.411 ± 0.187^{bc}	0.361 ± 0.147^{ab}	0.430 ± 0.163^{c}
Pb	0.046 ± 0.033^{a}	0.037 ± 0.027^{a}	0.044 ± 0.027^{a}	0.041 ± 0.034^{a}
Cu	0.201 ± 0.089^{a}	0.229 ± 0.111^{a}	0.214 ± 0.092^{a}	0.207 ± 0.078^{a}
Fe	0.365 ± 0.129^{a}	0.390 ± 0.164^{a}	0.372 ± 0.126^{a}	0.397 ± 0.162^{a}
Cd	0.002 ± 0.002^{a}	0.003 ± 0.004^{a}	0.003 ± 0.004^{a}	0.004 ± 0.006^{a}

Table 2: Heavy Metal Concentration in the gills of *Ethmalosa fimbriata* across locations

Metals	Jirinwo	Ikorigho	Ojumole	Odofado
Zn	0.341 ± 0.114^{a}	0.440 ± 0.230^{b}	0.399 ± 0.191^{ab}	0.422 ± 0.175^{b}
Pb	0.037 ± 0.023^{a}	0.040 ± 0.025^{a}	0.076 ± 0.200^{a}	0.034 ± 0.023^{a}
Cu	0.234 ± 0.091^{a}	0.297 ± 0.100^{b}	0.263 ± 0.133^{ab}	0.273 ± 0.103^{ab}
Fe	0.336 ± 0.142^{a}	0.381 ± 0.132^{a}	0.352 ± 0.121^{a}	0.393 ± 0.145^{a}
Cd	0.005 ± 0.004^{a}	0.009 ± 0.008^{bc}	0.010 ± 0.006^{a}	0.008 ± 0.007^{b}

Table 3: Heavy Metal Concentration in the tissue of *Illisha africana* across locations

Metals	Jirinwo	Ikorigho	Ojumole	Odofado
Zn	0.472 ± 0.181^{a}	0.441 ± 0.170^{a}	0.422 ± 0.148^{a}	0.418 ± 0.133^{a}
Pb	0.059 ± 0.028^{a}	0.066 ± 0.034^{a}	0.063 ± 0.317^{a}	0.062 ± 0.032^{a}
Cu	0.298 ± 0.839^{a}	0.305 ± 0.115^{a}	0.306 ± 0.110^{a}	0.296 ± 0.103^{a}
Fe	0.405 ± 0.168^{a}	0.377 ± 0.146^{a}	0.391 ± 0.167^{a}	0.352 ± 0.158^{a}
Cd	0.119 ± 0.008^{a}	0.011 ± 0.008^{a}	0.011 ± 0.007^{a}	0.010 ± 0.008^{a}

Table 4: Heavy Metal Concentration in the gills of *Illisha africana* across locations

Metals	Jirinwo	Ikorigho	Ojumole	Odofado
Zn	0.429 ± 0.127^{ab}	0.455 ± 0.242^{b}	0.423 ± 0.169^{ab}	0.382 ± 0.098^{a}
Pb	0.051 ± 0.020^{a}	0.050 ± 0.029^{a}	0.053 ± 0.027^{a}	0.050 ± 0.032^{a}
Cu	0.297 ± 0.098^{a}	0.335 ± 0.110^{ab}	0.353 ± 0.144^{b}	0.314 ± 0.114^{ab}
Fe	0.387 ± 0.143^{a}	0.348 ± 0.136^{a}	0.388 ± 0.154^{a}	0.391 ± 0.124^{a}
Cd	0.009 ± 0.007^{a}	0.011 ± 0.008^{ac}	0.012 ± 0.007^{a}	0.009 ± 0.007^{a}

Means for groups in homogenous superscript are not significantly different at ($p<0.05$)

Assessment of Some Heavy Metals Contamination in Muscle Tissue of *Peneaus notialis* and *Peneaus monodon* from Makoko, Lagos Lagoon, Southwestern, Nigeria

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ABSTRACT
This study assesses the concentrations of heavy metals, copper (Cu), iron (Fe), nickel (Ni), lead (Pb) and cadmium (Cd) in muscle tissue of Peneaus notialis and Peneaus monodon obtained from Makoko, Lagos lagoon South Western Nigeria. Cu, Fe, Ni, Pb and Cd concentrations were determined using flame atomic absorption spectrophotometer. The mean concentration of Cu, Fe and Ni in P. notialis were (4.91, 10.6 and 1.49) mg/Kg respectively while they were (0.12, 4.19 and 2.01) mg/Kg respectively in P. monodon. Pb and Cd were below detection limit in both species studied. The result showed increase in the concentrations of Cu, Fe and Ni in P. notialis when compared with WHO/FAO guidelines. The above result showed the presence of these metals in the lagoon and constant monitoring is required.
Keywords: Heavy metals, Peneaus notialis, Peneaus monodon, Lagos lagoon

INTRODUCTION
Many marine lives are becoming endangered as a result of the impact of human activities. Waste such as heavy metals are discharged into the marine ecosystems. The increasing use of heavy metals in industry has led to an increase in the release of harmful heavy metals into the aquatic environment (Oguguah and Ikegwu, 2017). Over 85% of all industries in Nigeria are situated in the Lagos metropolitan area and their effluents enter the Lagos lagoon complex directly or indirectly via drains or streams. (Oyewo and Don-Pedro, 2003). Lagos lagoon is the largest lagoon system in the Gulf of Guinea coast in West Africa and has an estimated 10,000 m^3 industrial effluents discharged into it per day (Hill and Webb, 1958). These pollutants on getting to the environment accumulate in aquatic organisms such as plankton, fish and shell fishes Matuouke and Abdullahu, 2020). Fish is a basic and important food for human nutrition. Fatty acid in fish can reduce the risk of heart disease and stroke. This is because they have the ability in lowering the cholesterols levels in blood and also provide minerals and vitamins (Azaman *et al*., 2015). Fish is a very suitable bioindicator of heavy metals contaminations. The presence of toxic heavy metals in fish can invalidate their beneficial effects. Several unfavorable effects of heavy metals to human health have been known for long time (Castro-Gonzalez and Mendez- Armenta, 2008). This includes serious threats like renal failure, liver damage, cardiovascular diseases, and even death (Rahman, *et al*; 2012). Essential metals such as copper (Cu), cobalt (Co), zinc (Zn), iron (Fe), calcium (Ca), magnesium (Mg), nickel (Ni), selenium (se), and manganese (Mn) are required in very minute quantity. They are necessary for the proper functioning of enzyme systems, hemoglobin formation and vitamin synthesis in human body. But at a very high concentration they might have neurotoxin and carcinogenic effect (Tuzen, 2009). Chromium and nickel are known to cause various pulmonary disorders while high consumption of copper are responsible for liver and kidney damage (Forti *et al*.,

2011). In this present study, Cu, Fe, Ni Pb and Cd concentrations in muscle tissues of some economic important fish species collected from Makoko, Lagos lagoon were determined. Heavy metals are most often non-biodegradable and have the ability to accumulate and biomagnify in some internal compartment such as muscles tissues. Therefore, in this study, muscles were selected as the main compartment of uptake and accumulation. In addition, prolong consumption of heavy metal-laden fish may lead to harmful health risks. Therefore, it is necessary to conduct an assessment on non-carcinogenic human health risks due to consumption of contaminated fishes.

MATERIALS AND METHODS

***Study Site*:** The study site, Lagos state is located on Latitude: 6°27′14″N and Longitude: 3°23′40″E.

***Reagent/apparatus*:** All reagents used were of analytical grade. Distilled water was used for solutions preparation and dilutions. All glass wares were soaked in 10% nitric acid for 24 hours and later rinsed with distilled water prior to use for metal analysis.

***Sample collection and preparation*:** The sample of *Peneaus notialis, Dentex dentex, Penaeus monodon and Callinectes amnicola* were purchased from professional fishermen fishing in the Makoko, Lagos lagoon. The samples were immediately preserved in air sealed plastic bags for further analysis. The samples were taken to the Marine Biology Department of Nigerian Institute for Oceanography and Marine Research, Victoria Island Lagos for proper identification. In the laboratory, the fishes were allowed to thaw to room temperature.

***Heavy metal analysis*:** using scientific flame atomic absorption spectrophotometer Varian Spectrophotometer AA 600 model. (EPA, 3050B)

RESULTS AND DISCUSSION

Cu is an essential element in human. It acts as metalloproteinase and function as enzymes. However, lond term exposure to high level of copper through contaminated ffood can result into Cu toxicity. Diarrhea, headache and dizziness are symptoms of Cu toxicity and may lead to liver and kidney failure in severe cases (Eske, 2020) The mean concentration of Cu in this present study showed Cu higher than the WHO/FAO (2012) guidelines in *P. notialis* (4.91mg/Kg) and lower than the permissible limit in *P. monodon* (0.1mg/Kg). Iron plays an important role in diet, it helps the red blood cells transport oxygen to all parts of the body. However, higher concentration of iron can increase level of hemoglobin in blood but also the risk of liver cancer and diabetes is plausible (Matuouke and abdullahu, 2020). The mean concentration of iron in both spesies exceeded that of WHO/FAO (2012) guidelines. Nickel is a micronutrient essential for proper functioning of the human body as it increases hormonal activity and is involved in lipid metabolism (Zygmunt, *et al*., 2016). High doses of nickel may result into nausea, vomiting abdominal disorder, visual disturbance, headache, gidding and cough (Dudu-Chodak and Blaszczyk, 2008). In this study Ni mean concentration was higher when compared with the WHO/FAO (2012) guideline. Cadmium is a heavy metal with high toxicity and it is a non-essential element in foods and natural waters and it accumulates principally in the kidneys and liver (Adesuyi *et al*., 2015). The concentration of Cd in this study was below detection limit.

CONCLUSION

The present study showed that Cu, Fe and Ni were present in the muscle tissue of the fish species studied at different concentration. Pb and Cd were below detection limit. These levels equally indicate presence of these metals in the sampling location. Therefore, constant monitoring of Makoko, Lagos lagoon and greater enforcement of sewage disposal management should be adopted

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Table I: Mean concentrations of some in the m heavy metals in muscle tissue of some fish species in mg/Kg from Makoko Lagos lagoon

Species	Cu	Fe	Ni	Pb	Cd
Penaeus notialiss	4.91	10.6	1.49	BDL	BDL
Penaeus monodon	0.1	4.19	2.01	BDL	BDL
WHO/FAO (2012) guidelines	0.4	4.0	0.6	0.3	0.03

Ecosystem Dynamics, Economics, Microalgal Diversity and Trophic Status of Ijora Creek, Lagos

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ABSTRACT
The nutrient concentrations available to phytoplankton communities in Ijora creek are influenced by anthropogenic enrichment as well as the buffering effect of tidal seawater and floodwaters. Nutrient levels were high due to excessive amounts of bio-degradable waste discharges; however, trace elements were low. The phytoplankton diversity present was mainly of four Algal groups with 691 individuals comprising 46 species.
Keywords: Anthropogenic, Ijora creek, phytoplankton, seawater

INTRODUCTION
One interesting way to describe Phytoplankton algae is as the grass of the sea as they are the "powerhouse" of aquatic food webs and the base of energy transfer through trophic levels. Like land plants, they are barely distributed completely at random due to variations in reproductive pattern, microhabitat preference or grazing. Therefore, most phytoplankton have an uneven distribution despite the fact that they are continuously mixed by water movement. (Effiong and Inyang, 2016). The creeks and lagoons of south-western Nigeria, in addition to their more ecological and economic significance, serve as a sink disposal for an increasing array of waste types - sewage, wood waste, refine oil, waste heat, municipal and industrial effluents among others - finding their way unabated into immediate coastal waters through conduits such as storm water channels, rivers, creeks and lagoons. Environmental disturbances from such wastes have been reported to induce changes in the structure and function of biological systems which can then be used to determine the degree and severity of pollution (Nwankwo, 2004). For instance, algal blooms which results from elevated levels of primary production in nutrient laden waters, would worsen an already worrying situation as they produce toxins which could poison domestic animals, wildlife, fish, benthic organisms and humans as well as community and economic loss of aesthetic values that greatly affect tourism and its associated benefits including loss to artisanal fisheries and aquaculture and effects on seafood quality (Asplund *et al*., 2013). This study aims to provide information on the effect of anthropogenic influence on the phytoplankton population and productivity, showing the status of pollution stress on the coastal marine environment in the Ijora creek by providing empirical information on how seasonal variations affect environment factors and in turn, affect microalgae diversity, trophic status and eventually economy.

MATERIALS AND METHODS
Study site: the Ijora creek is one of the major creeks in Lagos adjoining the Lagos harbour end of the Lagos lagoon and is open all year to the sea. It is a shallow and sheltered creek that experiences semi-diurnal tidal oscillations.
***Water sample collection*:** water samples were collected monthly for a period of six months specifically between 08.00 and 10.00hrs by manually dipping 75cl plastic bottles to obtain

surface water. Water samples and were taken to the laboratory for physical and chemical analysis for nutrients, trace elements and all other water quality parameters.
Plankton collection: A plankton net (53 μm) was towed horizontally and slowly (<4 knots) by a motorboat for 5 minutes. Water samples collected were fixed in situ with 4% formalin and taken to the lab for analysis.

Determination of physico-chemical parameters
Air Temperature (°C): the thermometer was held up in air for two minutes while shielding its bulb from direct sunrays to avoid error in the reading.
Water Temperature (°C): surface water temperature was determined in-situ by collecting 200ml of surface water and dipping the thermometer into it for two minutes for acclimatization before taking the reading.
Rainfall Data (mm): rainfall data were obtained from the University of Lagos Climate Station, Lagos.
Total Suspended Solids (TSS) (mg/L): was estimated by using the gravimetric method (APHA, 2005).
Total Dissolved Solids (TDS) (mg/L): was determined using gravimetric method (APHA, 2005).
Hydrogen Ion Concentration (pH): were determined by the electrometric method using the Cole Parmer Test.
Salinity (‰): was determined using saline test salinity meter (Hanna Instrument HI 98203).
Conductivity (µS/cm): was determined by using Philips PW9505 conductivity meter (Range 3-100,000µ S/cm).
Dissolved Oxygen (DO) (mg/L): was estimated by titrimetric method using the Azide Modification procedure 4500°C (APHA, 2005).
Biochemical Oxygen Demand (BOD_5) (mg/L): This is usually done after dissolved oxygen has been measured. The Winkler method was used to determine the amount of dissolved oxygen present and repeated after the sample was kept in the dark at 20°C for five days. The difference in concentration between day 0 and day 5 is the Biochemical Oxygen Demand expressed in micrograms of oxygen per litre.
Chemical Oxygen Demand (COD) (mg/L): was determined by using the closed reflux method with higher concentration of potassium dichromate solution.

Determination of nutrients
Nitrate – Nitrogen (NO_3^-) (mg/L): was determined using the colorimetric method using an APHA/HACH DR 2010 Colorimeter with internal standard (APHA, 2005).
Phosphate – Phosphorus (PO_4^-) (mg/L): was determined using the colorimetric method (APHA, 2005).
Sulphate (mg/L): was determined using the Turbidimetric method (APHA, 2005).
Silica (S_iO_2) (mg/L): was measured using colorimetric method (APHA, 2005).

Determination of trace elements
Magnesium (Mg^{2+}) (mg/L): was estimated using the titrimetric method in a water sample diluting 1:000 (APHA, 2005).
Copper (mg/L): was determined using the Atomic Absorption Spectrometer (AAS) (APHA, 2005).
Iron (mg/L): was determined using the Atomic Absorption Spectrometer (AAS) (APHA, 2005).
Zinc (mg/L): was determined using the Atomic Absorption Spectrometer (AAS) (APHA, 2005).
Lead (mg/L): was determined using the Atomic Absorption Spectrometer (AAS) (APHA, 2005).
Manganese (mg/L): was determined using the Atomic Absorption Spectrometer (AAS) (APHA, 2005).
Chromium (mg/L): was estimated using the Atomic Absorption Spectrometer (AAS) (APHA, 2005).
Nickel (mg/L): was determined using the Atomic Absorption Spectrometer (AAS) (APHA, 2005).

***Determination of biomass* (per ml):** in terms of numbers using counting methods, Plankton sample were decanted to 20ml. 2 drops of the sample was thoroughly investigated using the Drop Count Method. Five transect were investigated by moving the stage at different

positions under an Olympus CH binocular microscope. This was repeated 5 times per sample. The content of each cell within the counting chamber were identified, counted and recorded.
Determination of community structure analysis: Species diversity index (d), Shannon and Wiener Diversity Index (Hs), Menhenicks (D), Evenness or equitability indices (j) and Simpson's Dominance index (C) were used to estimate the phytoplankton biodiversity.

***Determination of statistical analysis*:** Standard Deviation and other statistical tests were employed; such as Principal Components Analysis (PCA) to determine major controlling water quality indices; Canonical Correspondence Analysis (CCA) to describe the effects of physic-chemical and biological parameters, Nutrient stoichiometry for determination of the limiting nutrient in the system and Pearson's correlation coefficient for determination of the water quality indices that influenced the phytoplankton occurrences.. All statistical analyses were done using Excel, Paleontological Statistics (PAST) and Statistical Package for Social Sciences (SPSS).

Determination of trophic state index: trophic state index (TSI) of Carlson was calculated using the formulae below
a. TSI for Chlorophyll *a* (CA) TSI = 9.81In Chlorophyll *a* (μg/L) +30.6
b. TSI for Secchi depth (SD) TSI = 60-14.41In Secchi depth (cm)
c. TSI for Total phosphorus (TP) TSI = 14.42 In Total phosphorous (μg/L) + 4.15

RESULTS AND DISCUSSION

The monthly variations in the physicochemical parameters at Ijora Creek from November to April are represented in table 1 below. High air and water temperature values recorded during this study are typical of the region, however, the range of water temperature values are in contrast to earlier observations by Sandison and Hill (1966) reporting that water temperature in the Lagos lagoon never varied more than 4°C. This may be due to increased insolation arising from greater solar radiation, plausibly a reflection of global warming trends. The rainfall values showed great fluctuation, ranging from 0 - 222.9mm. Transparency was relatively high due to the effect of rainfall. The salinity regime was seasonal with high salinities from December to April and low salinities between May and November. The salinity during sampling ranged from 6-29‰ which confirms that the study site is a brackish ecosystem. pH values are consistent with tidal creeks which are usually slightly alkaline. Nutrient levels were high due to the high amount of bio-degradable waste discharges in the region and reduced dilution effects from floodwaters. Conductivity values increased with increase in salinity and total dissolved solids, which may be the reason for the increase in total hardness.

The trace elements were low throughout the study period except magnesium which had higher values. Studies have shown that the levels of algal pigments in water are influence by environmental variables and as such, Chlorophyll *a* is an index of total phytoplankton abundance. Chlorophyll *a* values were positively strongly correlated with salinity, conductivity, DO, TDS, total hardness and sulphate, and however, negatively correlated with pH, BOD, COD, TSS, nitrate, silica, iron, copper and zinc. The composition and abundance of phytoplankton in Ijora creek, Lagos are shown in the figures 1 and 2. The total number of phytoplankton species identified was 691 individuals comprising 46 species. This high plankton diversity is an indication of increased nutrient from organic and industrial waste around the study area. The qualitative and quantitative dominance of diatoms and dinoflagellates in the study area is also an indicator of water quality and environmental conditions. *Oscillatoria* spp. is by far the most significant blue-green algae genera in determining water quality, furthermore, it is highly important as a diagnostic indicator (Onyema and Popoola, 2013). Higher species diversity encountered in February was due to the dislodgement of attached forms as a result of increase in rainfall. There was also an increase in sulphate, magnesium, nitrate and total dissolved solids which indicates that the water was diluted with a high level of dissolved oxygen. The Carlson's trophic status index shows that the creek is oligotrophic. The absolute supplies of nitrogen (N) and phosphorus (P) in the environment have a major influence on the diversity of species and it is fundamental in understanding microbial diversity.

CONCLUSION

Greater species diversity in ecosystems can influence ecosystem functions thereby leading to adaptation to a wide variety of conditions and greater stability of natural processes in the face of external stress such as to be able to weather disturbances, disease, and climate change.

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Table 1: Monthly variations in water quality parameters at Ijora Creek, Lagos (November - April)

Parameters	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Average	Std
Air temperature (°C)	29	30.5	34	31	30	32	31.08	1.59
Water temp. (°C)	28.5	29.5	31	30	29	30	29.67	0.80
Transparency (cm)	37.4	142.5	70.5	98.5	78	106	88.82	32.58
Rainfall (mm)	16.5	0	112.16	222.9	100.5	83.3	89.23	79.76
Salinity (‰)	6	17.9	24	29	23.2	21.1	20.20	7.17
pH	7.85	7.89	7.8	7.9	7.76	7.6	7.80	0.10
Conductivity (μS/cm)	11210	27530	38600	42300	39700	35000	32390.00	10561.19
TSS (mg/L)	3.6	0.9	0.8	0.7	0.6	1	1.27	1.05
TDS (mg/L)	6929	19800	25000	31240	25609	23421	21999.83	7543.17
Total Hardness (mg/L)	1200	3530	4210	5505	4470	3300	3702.50	1326.01
DO (mg/L)	5	5.9	6.1	6.3	6.7	6.8	6.13	0.60
BOD (mg/L)	2	2	1	1	1	1	1.33	0.47
COD (mg/L)	10	8	5	7	7	6	7.17	1.57
Nitrate (mg/L)	5.9	5	5.2	7.7	7.6	2.4	5.63	1.79
Silica (mg/L)	2.66	2.89	1.33	1.3	2.11	2.15	2.07	0.60
Phosphate (mg/L)	0.5	0.64	0.98	0.45	0.48	1.36	0.74	0.33
Sulphate (mg/L)	402	1200	1765	2100	1980	1601	1508.00	572.43
Magnesium (mg/L)	240	596	900	1208	886	790.6	770.10	298.27
Zinc (mg/L)	0.05	0.07	0.04	0.04	0.05	0.05	0.05	0.01
Iron (mg/L)	0.05	0.1	0.06	0.06	0.08	0.09	0.07	0.02
Copper (mg/L)	0.003	0.003	0.002	0.002	0.003	0.004	0.00	0.00
Lead (mg/L)	0.0006	0.0007	0.0007	0.0009	0.0009	0.0008	0.00	0.00
Chromium (mg/L)	0.0006	0.0007	0.0009	0.0009	0.0007	0.0003	0.00	0.00
Manganese (mg/L)	0.01	0.03	0.03	0.03	0.05	0.09	0.04	0.03
Nickel (mg/L)	0.0005	0.0006	0.0007	0.0009	0.0008	0.0008	0.00	0.00
Chlorophyll a (μg/L)	10.2	10	15.6	13.3	12.5	14.5	12.68	2.07

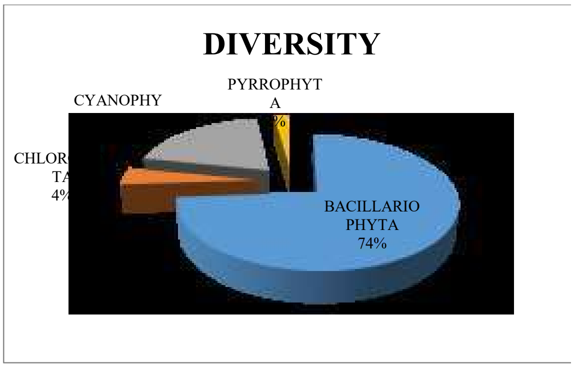

Figure 1: Percentage composition of phytoplankton in terms of diversity at Ijora creek, Lagos, Nigeria (November - April)

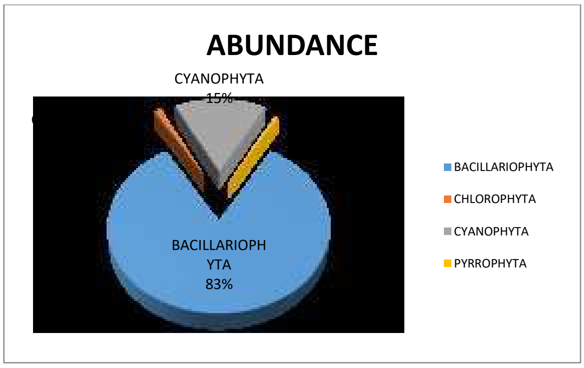

Figure 2: Percentage composition of phytoplankton in terms of abundance at Ijora creek, Lagos, Nigeria (November – April)

Table 2: Community structure indices at Ijora Creek, Lagos (November- April)

PARAMETERS	N	D	J	F	M	A	Min	Max
Total species diversity(S)	5	8	8	27	6	2	2	27
Total abundance (N)	36	52	52	463	72	8	8	463
Log of species diversity (log S)	0.70	0.90	0.90	1.43	0.78	0.30	0.30	1.43
Log of abundance (log N)	1.56	1.72	1.72	2.67	1.86	0.90	0.90	2.67
Shannon-Weiner index (Hs)	0.62	0.85	0.80	1.03	0.77	0.30	0.62	1.03
Menhinick index (D)	0.83	1.11	1.11	1.25	0.71	0.71	0.71	1.25
Margalef index (d)	1.12	1.77	1.77	4.24	1.17	0.48	0.48	4.24
Equitability index (j)	0.89	0.94	0.89	0.72	0.99	1.00	0.72	1.00
Simpson's dominance index (c)	0.28	0.17	0.23	0.19	0.36	0.5	0.17	0.36

Table 3: Carlson's trophic status index of Ijora Creek, Lagos, Nigeria (November – April)

Parameter	NOV	DEC	JAN	FEB	MAR	APR
TSI OF T	7.81	-11.46	-1.32	-6.14	-2.78	-7.2
TSI OF P	-5.85	-2.29	3.86	-7.37	-6.43	8.58
TSI OF Chl-*a*	53.38	53.19	57.55	55.99	55.38	56.83
CTSI	18.45	13.15	20.03	14.16	15.39	19.4

Where TSI= Trophic State Index, T= transparency, P= phosphorus, Chl-*a*= chlorophyll *a*, CTSI= Carlson's Trophic State Index.

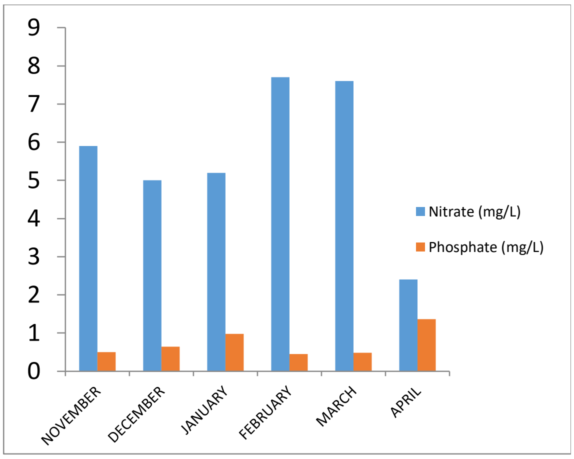

Figure 3: Relationship between Nitrate and Phosphate in Ijora Creek

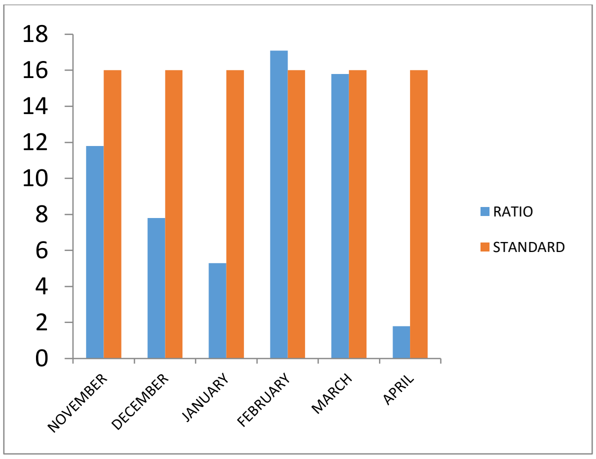

Figure 4: Nutrient stoichiometry in Ijora creek, Lagos, Nigeria

Phenotypic and Biochemical Characterisation of Lactic Acid Bacteria Isolates from the Gut of *Clarias gariepinus* juveniles Fed Mushroom (*Pleurotus pulmonarius*) Stalk Meal Supplemented Diets

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ABSTRACT
The stalks of mushrooms are by-products from mushroom processing which are rich in dietary fibre and polysaccharides. They could act as substrate to enhance the growth of endogenous probiotics in the gut of fish. The phenotypic and biochemical characteristic of the endogenous probiotic organism in the gut of Clarias gariepinus fed diet supplemented with Pleurotus pulmonarius stalk meal was examined using standard methods. The lactic acid bacteria isolate was identified to be a gram positive homofermentative Lactobacillus specie.
Keywords: Lactic acid bacteria, mushroom stalk meal, Clarias gariepinus, Pleurotus pulmonarius, gastrointestinal tract

INTRODUCTION
The gastrointestinal (GI) tract of fish has a complex and dynamic community of microorganism which can be modulated by diet. Probiotic supplementation has been extensively utilised in animal and human nutrition. However, their application in aquaculture is still limited to a greater extent. The production and utilisation of probiotics as a supplement is limited by cumbersome statutory/regulatory approvals and technical requirements for its safety and efficacy (Sanders *et al*., 2014). Consequently, prebiotics has attracted attention as it serves as substrates to boost systemic growth of probiotics in the gut of cultured fish. Prebiotics are indigestible food constituents that stimulate the growth of beneficial organisms such as probiotics and improve the gastrointestinal balance thereby beneficially affecting the host (Davani-Davari *et al*., 2019). They result in increased growth of beneficial bacteria population, such as *bifidobacteria* and *lactobacillus* species in the gastrointestinal tract of fish. These beneficial bacteria have the abilities to stimulating host gastrointestinal development, digestive function, mucosal tolerance, stimulating immune response, and improved disease resistance (Ringo *et al*., 2018). The stalks of mushrooms are by-products from mushroom processing which are rich in dietary fibre and polysaccharides (Chou *et al*., 2013; Adejonwo *et al*., 2021). They could act as a low-economic value source of prebiotics that boosts the activity of probiotics in the gut of cultured fish. There are a few studies on the application of the mushroom stalk meal as a potential prebiotic supplement in fish (Jabir *et al.,* 2012, Ahmed *et al*., 2017, Adejonwo *et al*., 2020). Dietary application of mushroom stalk meal has been reported to boost the endogenous growth of Lactic acid bacteria in the gut of *C. gariepinus* (Adejonwo *et al*., 2020). However, there is paucity of information on the phenotypic and biochemical characterisation of the endogenous probiotic organisms in the gut microbiota of cultured fish as a result of supplementing the diet with mushroom stalk meal. Hence, this study was done

to characterise the endogenous probiotic microorganism isolated from the gut of *Clarias gariepinus* juveniles fed *Pleurotus pulmonarius* stalk meal supplemented diets.

MATERIALS AND METHODS

Processing of mushroom stalks: The stalks of matured cultivated mushrooms (*P. pulmonarius*) were air-dried at room temperature (25 ^{0}C) for two weeks, milled in a blender, bagged and stored in the refrigerator at 4 ^{0}C until time for feeding experiment.

Experimental diet formulation and preparation: Graded levels of *P. pulmonarius* stalks meal were used in the diet formulation of purified diets containing about 40% crude protein. The control diet (0.0g/100g $PPSM_1$) was prepared without the stalk meal while the other four diets: $PPSM_2$, $PPSM_3$, $PPSM_4$ and $PPSM_5$ were supplemented with graded inclusion levels of *P. pulmonarius* stalk meal at 2.5 g/100g, 5.0 g/100g, 7.5 g/100g and 10.0 g/100g respectively as shown in table 1. The dry ingredients were weighed appropriately, mixed thoroughly with about 40% of water and pelleted using a fabricated pelleting machine through a 2 mm-sized dice. The pellets were oven-dried at 60 ^{0}C and cooled at ambient room temperature (25 ^{0}C). They were packaged in labelled transparent nylon bags for the feeding trial.

Feeding trial: Juveniles of *C. gariepinus*, with initial weight of 10.84±0.04 g, were fed commercial diet and acclimatised to experimental conditions for two weeks. The feeding trial was conducted for 8 weeks using a completely randomised design. A total of 375 healthy juveniles were stocked at 25 fish/60 litres of water. Feeding trial was done in a static renewal condition with total water change every two days. Treatment diets were fed to *C. gariepinus* juveniles in triplicate, twice daily at 3% body weight daily.

Collection of gut for microbiological analysis: The gut of *C. gariepinus* juveniles were obtained by dissecting the fish using sterile scalpels. Forceps were used to handle the guts which were homogenised with ceramic mortar and pestle under aseptic conditions per diet treatment.

Isolation of Lactic acid bacteria: Homogenised gut (5g) was weighed into 45 mL of peptone water (pH 8.5) for enrichment. The enriched medium (5ml) was measured into 45 ml of deMan Rogosa Sharpe (MRS) broth (pH of 5.5). The broth culture was incubated at 35 ^{0}C for 12 hours. Serial dilution to 10^{-3} and 10^{-5} dilution factor was done using distilled water. Aliquots of 1 mL of each incubated broth culture was dispensed into Petri dishes and MRS agar was poured over it. They were incubated in an anaerobic jar containing gaspak for 24 hours at 35 ^{0}C, as described by Ogunshe and Olabode (2009). Circular glistening low convex colonies which were cream to whitish in colour were sub cultured by streaking to get pure cultures.

Characterisation of Lactic acid bacteria isolates: Pure isolates of Lactic acid bacteria were characterised using microscopic, biochemical and physiological assessment. Grams` reaction, catalase and sugar fermentation test of the Lactic acid bacteria were evaluated using 24 hours old pure culture.

Gram staining technique: The gram staining techniques was determined as described by Harrigan, 1998. A thin streak of pure isolate was smeared on a glass slide and flamed to heat-fix the isolate. Two drops of crystal violet were placed on the flamed smear for 60 seconds. The glass slides were rinsed with water and stained with Gram's iodine solution for 1 minute. The stain was decolourized by washing with alcohol. Then 2 drops of safranin reagent was dropped on the decolourized isolate for 10 seconds, washed with tap water and dried with a filter paper. The colour, shape and arrangement of treated isolate were examined using a microscope with an oil immersion objective.

Catalase test: The catalase test was determined as described by Harrigan, 1998. Petri dishes containing the MRS agar with the streaked isolates were each incubated for 18 hours. A smear from the isolates was made on a slide. One drop of newly prepared 3% hydrogen peroxide was dropped on each slide.

Sugar fermentation test: The sugar fermentation test was determined as described by Harrigan, 1998. About 1g of glucose, xylose and mannose is dissolved in 100mL peptone water respectively. Cultured cells grown for 18 hours in MRS agar were inoculated into tubes of the basal media (10mL) containing test carbohydrates at 30 ^{0}C for 4 days. Durham tubes were placed in test tubes containing 5 ml solution. Sterilisation by tyndallisation was done three times for 30 minutes each. Samples were inoculated in triplicate and two drops of phenol red indicator was added. Un-inoculated tubes served as controls.

Statistical Analysis: All values were expressed as mean ± standard deviation. Data obtained was subjected to one-way analysis of variance (ANOVA) using SPSS 17.0.

RESULTS AND DISCUSSION

Initial and final weight of Clarias gariepinus juveniles fed P. pulmonarius stalk meal supplemented diet

The initial and final weight of *C. gariepinus* juveniles fed P. pulmonarius stalk meal meal supplemented diet are as shown in Table 2. There was no significant difference in the initial and final weight in all the diet treatment groups. This finding was in consonance with the finding of Jabir *et al.* (2012) who reported no significant difference ($P>0.05$) in growth indices of Tilapia fingerlings (*Oreochromis* species) fed diet supplemented with *P. sajor caju* stalk meal as a prebiotic.

Phenotypic and biochemical identification of Lactic acid bacteria isolates from the gut of Clarias gariepinus fed P. pulmonarius stalk meal supplemented diets

The phenotypic and biochemical identification of the Lactic acid bacteria are presented in Table 2. It was observed that the isolates from the MRS agar for $PPSM_1$-$PPSM_5$ were gram-positive. The isolates were short rods shaped in clusters arrangements. They were purple in colour which indicates gram positive bacteria. The catalase activity was negative for all diet groups as there was no evolution of gas/bubbles during the analysis. In the sugar fermentation, accumulation of gas in the Durham tubes signifies production of gas (fermentation), and change of colour to yellow indicates production of acid while no colour change indicates no acid production. The sugar fermentation test for glucose indicated a positive and negative result for acid production, however no gas was produced in all the treatment groups. The xylose sugar test indicated that there was acid production but no gas was produced. The mannose sugar had no acid production except $PPSM_3$, which was both positive and negative for acid production; however, there was no gas production in all the treatment groups. Lactic acid bacteria are non-pathogenic, non-putrefactive, non-toxigenic, saccharolytic organisms that prevent deleterious activity in the intestinal tract. The phenotypic and biochemical analyses of this study on the LAB isolates from the gut of *C. gariepinus* fed *P. pulmonarius* stalk meal supplemented diet revealed that they are gram-positive organisms, obligate homofermentative *lactobacilli* which could ferment hexose sugars (glucose) by glycolysis and produces lactic acid without carbon IV oxide (CO_2) gas production as described by Wood and Holzaphel, 1995. These characteristics is in consonance with the report of Ringo *et al*., 2018 on lactic acid bacteria in fin fish which are revealed be the most promising bacterial genera as probiotic in aquaculture.

CONCLUSION

Dietary supplementation of *Pleurotus pulmonarius* stalk meal enhanced the growth of obligate homofermentative *Lactobacillus* specie in the gut of *C. gariepinus*.

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Table 1: Formulation of experimental diets

Ingredients	$PPSM_1$(Control)	$PPSM_2$	$PPSM_3$	$PPSM_4$	PSM_5
Casein	36.58	36.58	36.58	36.58	36.58
Gelatin	7.32	7.32	7.32	7.32	7.32
Corn starch	35.35	35.35	35.35	35.35	35.35
Fish oil	2.00	2.00	2.00	2.00	2.00
Soya bean oil	3.00	3.00	3.00	3.00	3.00
Fish premix	3.00	3.00	3.00	3.00	3.00
DCP	1.00	1.00	1.00	1.00	1.00
Calcium carbonate	0.25	0.25	0.25	0.25	0.25
CMC	1.50	1.50	1.50	1.50	1.50
Non nutritive cellulose	10.00	7.50	5.00	2.50	0.00
P. pulmonarius stalk meal (PPSM)	0.0	2.50	5.00	7.50	10.00

Note: $PPSM_1$, $PPSM_2$, $PPSM_3$, $PPSM_4$, $PPSM_5$ = P. pulmonarius stalk meal at 0, 2.5, 5.0, 7.5, and 10 g/100g inclusion level; DCP = Dicalcium phosphate; CMC = Carboxyl methyl cellulose

Table 2: Initial and final weight of *Clarias gariepinus* juveniles fed *P. pulmonarius* stalk meal supplemented diet

Parameters	**$PPSM_1$(control)**	**$PPSM_2$**	**$PPSM_3$**	**$PPSM_4$**	**$PPSM_5$**
Initial weight	10.82±0.05	10.83±0.03	10.86±0.03	10.85±0.04	10.84±0.04
Final weight (g)	48.81±3.37	50.28±3.63	53.81±2.17	51.91±1.50	51.63±4.98

Table 3: Phenotypic and biochemical identification of Lactic acid bacteria isolates from the gut of *Clarias gariepinus* juveniles fed *P. pulmonarius* stalk meal supplemented diets

Diet group	**Gram's reaction**	**Colony appearance/cell morphology**	**Colour**	**Catalase test**
$PPSM_1$	+	Clusters/short rod	Purple	-
$PPSM_2$	+	Clusters/short rod	Purple	-
$PPSM_3$	+	Clusters/short rod	Purple	-
$PPSM_4$	+	Clusters/short rod	Purple	-
$PPSM_5$	+	Clusters/short rod	Purple	-

Keys: (–): Negative result; (+): positive result; $PPSM_1$, $PPSM_2$, $PPSM_3$, $PPSM_4$, $PPSM_5$ = P. pulmonarius stalk meal at 0, 2.5, 5.0, 7.5, and 10g/100g inclusion level

Table 4: Carbohydrate fermentation test of Lactic acid bacteria isolates from the gut of *Clarias gariepinus* juveniles fed *P. pulmonarius* stalk meal supplemented diets

Diet group	Carbohydrate fermentation test					
	Glucose		Xylose		Mannose	
	AP	GP	AP	GP	AP	GP
$PPSM_1$	+/-	-	+	-	-	-
$PPSM_2$	+/-	-	+	-	-	-
$PPSM_3$	+/-	-	+	-	-/+	-
$PPSM_4$	+/-	-	+	-	-	-
$PPSM_5$	+/-	-	+	-	-	-

Keys: (–): No acid production/ no gas production (+): there is acid production/ gas production; AP: acid production, GP: gas production. $PPSM_1$, $PPSM_2$, $PPSM_3$, $PPSM_4$, $PPSM_5$ = P. pulmonarius stalk meal at 0, 2.5, 5.0, 7.5, and 10g/100g inclusion level

Hydroclimate of West-Africa: Evidence from Deep-Sea Core

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ABSTRACT

Sediment core DY26III-Nig-S60-GC2 from eastern Equatorial Atlantic (EEA) was studied to unravel the sediment transport dynamics and to reveal the history of West African climate of the last 120 kyr. This was done based on the combination of grain-size analysis with lithological studies and oxygen isotope stratigraphy. The grain size investigations of the sedimentary sequence show the dominance of very fine sand and clay. The core sediment is poorly sorted with symmetrical skewness and a leptokurtic-mesokurtic distribution. The lithology of the sediment shows four unit sub-divisions: unit I, 0-10.7 ka (0-65 cm), has a grain–size distribution that shows a unimodal distribution with a mean modal grain size of 7.8 µm; unit II, 10.7-49 ka (65-255 cm), has a mean modal grain size of 6.5 µm with a large spread at the coarse side of the distribution, also with peaks of coarse grains of size 700 µm. Unit III, 49-111.8 ka (225-325 cm) has a normal distribution with a mean modal grain size of 6.5 µm. It has few peaks at the coarse side; unit IV, 111.8-120 ka (325-350 cm), has a normal distribution with a mean modal grain size of 5µm. End-member modeling of a data set of grain size distributions results into three end-members: the fine end-member, EM2, interpreted as hemipelagic mud; the EM1 interpreted as fine-grained distal aeolian; and the coarse end-member, EM3, interpreted as a gravity-driven mass deposit. The shift toward more arid conditions correspond with increase in grain size and sedimentation rate. We interpret the grain size increase in EEA during 10.7 – 49 ka to be a response of the Nigerian continental margin to the lowering of sea level or deposition of terrigenous sediment due to slope failure associated with the destabilization of gas hydrates deposits as a result of reduced hydrostatic pressure.

Keywords: Eastern Equatorial Atlantic; grain size; sedimentary sequence; sediment core; climate; sea level

INTRODUCTION

Paleo-environmental interpretation of deep sea sediments is a function of the transport and depositional processes associated with each sediment horizon (Joseph *et al.,* 1998). Distinction can be obvious but at times two or more sedimentary processes may alternate through time (Joseph *et al.,* 1998). Grain size is one of the well adopted proxies in use for paleo-depositional interpretation based on the following factors: wide usage by sedimentologists for the classification of sediments; unraveling of transport dynamics; and provision of ability to discriminate between sources/transport pathways in a depositional environment (Joseph *et al.,* 1998). Terrigenous sediments deposited in the subtropical deep-sea are a combination of eolian component brought in by the wind and a hemipelagic component transported by rivers and brought from the shelf (Stuut *et al.,* 2002). The analysis of eolian input allows the estimation of aridity in the source regions through flux determination (Rea, 1994). The flux of terrigenous hemipelagic sediments is associated with continental runoff, which can serve as a proxy for continental humidity (Prins and Weltje, 1999). Variations in Quaternary terrigenous grain-size distributions of North-West African continental margin sediments have been linked to changes in fluvial and aeolian inputs, which are in turn associated with fluctuations of continental humidity (Zabel *et al.,* 2001). Previous studies have used eolian dust in the Equatorial North Atlantic deep marine sediments to reconstruct palaeo-environmental changes in North -West Africa (Sarnthein et al., 1981; Ratmeyer et al., 1999; Stuut et al., 2005 and Tjallingii et al., 2008). Previous works on grain size distribution and its statistical parameters within the study area have mostly been concentrated on river sediments (Friedman, 1961 and Deptuck *et al.,* 2007). Therefore, there is paucity of information on the deep sea counterparts within the EEA. However, in our recent study (Akinnigbagbe et al., 2018) in the study area, we established the importance of the terrigenous input as a prerequisite for the interpretation of ITCZ position in the EEA and arrived at a conclusion that there is a close coupling between the terrigenous input and climatic changes in the terrigenous source area. In this present study, we aim to use grain size analysis, stable oxygen isotopes and ^{14}C AMS measurements to determine the late Quaternary grain size record of fine grained terrigenous sediments from our core, with a further application of the end members to the transport mechanisms of the land derived sediments and finally use the results for the reconstruction of the paleoclimatic evolution of the West-Africa which has been done before on the NW Africa. In this study, we applied an inversion algorithm for end–member modeling of compositional data (Weltje, 1997) to the grain size distributions from core DY26III-Nig-S60-GC2. The study area is located on the western flank of the Niger Fan and south of the Niger Delta, under the influence of West African monsoon. In 2012, a sediment core DY26III-Nig-S60-GC2 was taken from the slope of the EEA offshore Nigeria (4°.358″E, 3°.764″N; water depth: 2946 m) during Chinese DY26 cruise. The terrigenous materials reaching the study site are river-suspended matter via the Niger River and as eolian dust carried by the northeasterly trade winds (Zabel et al., 2001). Therefore, this study location will serve as a good site for the reconstruction of past changes with respect to grain size variations.

MATERIAL AND METHODS

DY26III-Nig-S60-GC2 is a 350 cm long sediment core collected from the slope of the EEA offshore Nigeria, (4°28'56″.388′E, 3°33'10″.764′N; water depth 2946 m) during RV *'Da Yang Yi Hao'* cruise DY26III in August 2012. DY26III-Nig-S60-GC2 continuously covers the last 120,000 years before present (yr B.P.) Akinnigbagbe et al. (2018). Prior to the transport of the sediment core to the laboratory of Second Institute of Oceanography, State Oceanic Administration (SIOSOA), the sediment core was split into halves: Working half was sampled in the spacing of 1cm for various analyses such as stable isotopes measurements, radiocarbon dating and grain size analysis.

RESULTS AND DISCUSSION

To differentiate the end-members of the measured grain-size distributions of sediment core DY26III-Nig-S60-GC2, end-member modeling algorithm method was used. The model generates grain size distributions (GSDs) from the grain size data from which end-members (EMs) required for a satisfactory approximation of the data was estimated. Our results, using inversion algorithm for end-member modeling of composition data, display a three end-member model that explained more than 95% of the variance. The measured grain-size distributions of the core can now be expressed as relative proportion of the constant-sum of the three end-members, i.e. (EM1+EM2+EM3 = 1). The first end-member, EM1 consists of high concentration of grains within the range of 3.4- 31.25 μm (8.2 to 5 Φ) and modal grain size of 7.8 μm (7 Φ), representing fine silt which makes up 90% loading volume of EM1. The second end member EM2 has a polymodal distribution with the highest contribution from clay which constitutes 60% of the loading volume of EM2. The peak at the fine side of EM2 has a concentration of grains that covers a size range of 0.24 to 17.9 μm (12 to 5.8 Φ), with a modal grain size of 1.95 μm (9 Φ). Other contributions to EM2 are from the small peaks from coarse side 62.5 and 500 μm (4 Φ and 1 Φ) of the main peak. The third end member EM3 has 76% contribution from coarse and very fine-sand. The coarse peak of EM3 consists of concentration of grains within the range of 307.8 to 2000 μm (1.7 to -1 Φ), and its modal grain size is 594.6 μm (0.75 Φ), representing coarse sand. Furthermore, the fine peak of EM3 consists of grain fractions of particle sizes 3.9 to 250 μm (8 to 2 Φ), with a modal grain size of 62.5 um (4 Φ). The contributions from the coarse fraction and fine fraction of EM3 are 45 and 31% loading volume respectively. The mean grain-size is strongly influenced by the proportions of the very coarse sand fraction of EM3.

Based on the lithological characteristics, four different units are identified in DY26III-Nig-S60-GC2 core sediments. The percentage of coarse grains (2-5 ϕ) result depicts that unit II has the largest fraction of the coarse grains (15%), followed by unit III (~ 5%) and then, units 1 and IV with less than 5% coarse-grains. A shift in climatic system toward arid conditions relates a significant increase in the percentage distribution of grains size with significant change in sedimentation rate as already discussed in Akinnigbagbe et al. (2018). Thus, we interpret the grain size increase in unit II of the DY26III-Nig-S60-GC2 sedimentary sequence during the period of 10.7 to 49 ka to be a response of the sedimentary system to the aridification resulting from regional climate change. This interpretation is in agreement with the study of Sharon et al. (2010) on sedimentation in the Eastern Cordillera of northwest Argentina. The genetic significance of end members can be deduced in three ways: (1) From their spatio-temporal distribution patterns; (2) end-members estimated to sediments compared with that of known origin; and (3) by geochemical analysis of specific size fraction. The EMs had been compared to sediments of known origin to infer their genetic significance in time past (Weltje and Prins, 2003). Moreno *et al.* (2002) and Prins *et al.* (2001) compared their EMs of presumably aeolian origin to aeolian dust samples collected with sediment traps in their study areas. In this study, our EMs result was compared with the result of EMs of core DS97-2P from Reykjanes Ridge, North Atlantic (58°56.327′N, 30°24.590′W) Prins et al. (2001), and sediment core of Tjallingii et al. (2008) GeoB 7902-2 (20°45.09'N-18°34.90'W, 2278 m water depth). We further did comparison with EMs result in core NIOP472 from Makran Margin Arabian Sea, (Weltje and Prins, 2003), and with grain size analysis results of the sediments from Osun and Ogun Rivers, South Western Nigeria (Joshua and Oyebanjo, 2010; Okeyode and Jibiri, 2013), that have been suggested to transport large quantities of sediments to canyon heads for onward transfer to the deep-sea (Burke, 1972; Olabode and Adekoya, 2008).

The first end-member EM1 of the GSD result varies within the size range of 3.4 to 31.25 μm (8.2 to 5 Φ) with modal grain size of 7 Φ, which is 7.8μm representing fine-silt that makes up 90% loading volume of EM1. The EM1 of this study matches the EM2 of Tjallingii et al. (2008) that was interpreted as fine-grained distal aeolian. The second end-member EM2 has a polymodal distribution with the highest contribution from clay which constitutes 60% of the loading volume of EM2. The clay fraction exists within the size range of 0.24 to 17.9 μm (12 to 5.8 Φ), with a modal grain size of 2 μm (9 Φ). The EM2 of this study matches the EM3 of Tjallingii et al. (2008). Based on this comparison, the EM2 of our study is interpreted as non-aeolian hemipelagic mud. The third end member EM3 has 76% contribution from coarse and very fine-sand. The coarse-sand fraction varies in size range 307.7 to 2000 μm (1.7 to -1 Φ), and its modal grain-size is 0.75 Φ (595 μm). Furthermore, the very fine sand fraction varies in size range 3.9 to 250 μm (8 to 2 Φ), and its modal grain-size is 4 Φ (62.5 μm). The coarse-sand fraction is within the range of fluvial deposit reported by previous authors on river sediments from South-West Nigeria (Joshua and Oyebanjo, 2010; Okeyode and Jibiri, 2013 and Deptuck et al., 2007). Lowering of sea level is considered by several authors to have favoured downslope mass movement (Sarnthein, 1978; Embley, 1980; Maslin et al., 1998, 2004). Allen (1965) and Damuth (1994) also suggested that the occurrence of tectonic and compactional subsidence during Late Pleistocene-early Holocene might have assisted the sediments transport to the deep water beyond the Nigerian continental shelf. Wei et al. (2015) highlighted that the continental margin offshore Nigeria is undergoing slow deformation due to gravity-driven tectonics that leads to rapid seaward progradation and loading of large sediments. Based on the above points, the EM3 is suggested to be a product of landslide associated with gravity-driven movement.

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Study of the Distribution of *Vibrio* Species in Lagos Lagoon Using TCBS Agar

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ABSTRACT
Vibrio species are widely distributed in estuarine and coastal environments; a number of them are agents of water and seafood borne diseases. In this study, we aimed to isolate and observe the distribution of Vibrio species from the Lagos Lagoon. Surface water samples were collected from 12 sites for four sampling periods and it was observed that the Lagoon surface water was contaminated with the bacteria. The highest mean variation of culturable Vibrio species was observed at station 5 with 1863.75 ± 700.46cfu/ml and a range of 810 to 3915, while the lowest was observed at station 12 with 146.25 ± 55.35cfu/ml and a range of 10 to 270. Due to the abundance of these bacteria, there is need for proper environmental monitoring for the presence of Vibrio species, as it can identify sources of infections.
Keywords: Vibrio species, TCBS agar, Lagos Lagoon and Pollution

INTRODUCTION
Vibrio species are autochthonous bacteria found in aquatic environments such as rivers, ponds, wells, estuarine and coastal environments (Shinoda 1992). The classical enteric disease cholera is the best known *Vibrio* infection but *Vibrio* spp. may infect a number of human body sites including wounds, lesions, ears and eyes as well as the gastrointestinal tract. Some species are invasive through the gastric mucosa and septicemia is a risk for vulnerable subjects. (Austin and Austin, 2007). In the marine environment, heterotrophic bacteria, such as members of *Vibrio* spp., are of great importance for the remineralization of organic matter in the sea (Fukami *et al*., 1985). However, the foremost attention brought to this genus is related to its many pathogenic strains. Over 75% of *Vibrio* infections currently occur between the months of May and October, suggesting that Warmer temperatures are responsible for the increased rates of infection (CDC 2009, 2012). Lagos Lagoon is a typical estuary which had undergone pollution in the last decade resulting from the development of industries and fishing villages all across the Lagoon. Scarce infrastructure to properly treat and dispose of the sewage has resulted in the discharge of significant amounts of untreated wastes from costal population into the lagoon. Direct release of domestic waste, leaching from poorly maintained septic tanks and inadequate management of farm waste are suspected as the major sources of waterborne disease (Huttly, 1990). Increasing abundances and distribution of *Vibrio* species in the aquatic environment subsequently pose a real threat to local fisheries and seafood industries, not only that, but also to the people living in coastal areas, hence the need for proper monitoring of environmental conditions to ensure public health and safety.

MATERIALS AND METHODS

Study Area

Lagos Lagoon is located in the western part of Nigeria; it is about 6354.788sq km in area and has a perimeter of 285km. Its central body is located between Longitude 3^0 23' and 3^040 E and latitude 6^0 22' and 6^0 28'N.In the present study, twelve study sites with high anthropogenic activities were selected.

Sampling

Surface water samples were taken from twelve stations of the Lagos Lagoon for four sampling periods i.e. May 2019, July 2019, October 2019 and January 2020.Surface water samples for bacteriological analysis were aseptically collected using 500ml sterile bottles and were kept in an ice chest box, they were then transported to the laboratory and analyses were carried out within 5 hours

Bacterial isolation, enumeration and identification

Enumeration and isolation of *Vibrio* species were performed by the membrane filtration technique through 0.45 μm membrane filters (American PHA, 1985; Haas and Heller, 1986). Sterile Quantities of 1ml of water were filtered onto membrane filter using a filtration unit. After filtration, forceps were used to place the membrane filters on TCBS (Thiosulfate-Citrate-bile salts-sucrose) agar. The petri-dish was incubated for 37^0C for 18 to 24 hours. Colonial characteristics were observed, and identified according to Bergey's manual of systemic bacteriology (Pallerony, 1984).

Statistical Analysis

For statistical analysis, bacteria counts were subjected to analysis of variance (ANOVA), correlation coefficient was analyzed using SPSS v.20 computer software program. Tests were carried out at 5% significance level.

RESULTS AND DISCUSSION

The highest mean variation of *Vibrio* specie was observed at station 5 with 1863.75 ± 700.46 and a range of 810 to 3915, while the lowest was observed at station 12 with 146.25 ± 55.35 and a range of 10 to 270. Statistically, the analysis of variance (ANOVA) showed that there were significant differences ($p<0.05$) in the *Vibrio* species across the stations of the Lagos Lagoon. *Vibrio* species were isolated from twelve (12) stations in four sampling periods (May, July, October (2019) and January 2020) on TCBS medium. Small yellow colonies, large yellow mucoidal colonies and green colonies were observed and these colonies were identified as *Vibrio cholera*, *Vibrio alginolyticus* and *Vibrio parahaemolyticus* respectively. These species of *Vibrio* were identified according to Bergey's manual of systemic bacteriology (Pallerony, 1984). The bacteriological analysis revealed that the water samples collected from the Lagos lagoon was contaminated with the bacteria. The high load *Vibrio* species isolated from all the stations indicated that the water body is undergoing severe sewage pollution. This is due to human interference through settlements along the coastal stretch and mixing of untreated municipality sewage. In tropical areas, the water temperatures can remain stable over different seasons and hence be of minor importance for variations in *Vibrio* loads (Parvathi et al. 2004). This suggests that any seasonal patterns in Vibrio abundances in such tropical areas must be controlled by other factors *Vibrios* display broad metabolic ranges and enzyme activities that enable them to use a wide variety of carbon sources (Thompson and Polz 2006). Other organisms, serving as sources for energy could therefore be important determinants for Vibrio outbreaks when large-scale hydrographical parameters fail to explain variability in Vibrio abundances. In subtropical areas, such as in Mozambique, the numbers of culturable *Vibrio* coincide with the warmer season which in turn overlaps with heavy rains bringing a high load of land run-off into the coastal areas (Collin *et al*., 2013). It can therefore not be excluded that energy sources supporting *vibrio* species may be of terrestrial origin.

CONCLUSION

The results of the present study are indicative of considerable bacteria pollution of the Lagos lagoon, which is a potential danger to the valuable fish resources of the lagoon as well as those who use it for recreation. The Lagos lagoon is severely contaminated during the rainy season.

This period could therefore be more favorable to outbreaks of infections caused by pathogenic bacteria responsible for waterborne diseases; hence, environmental monitoring for the presence of *Vibrio* species is important, as it can identify sources of infections.

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Table 1: Mean Viable Count of *Vibrio* species from the Lagos Lagoon in colony forming unit (cfu/ml)

Stations	May	July	October	January
1	165	120	0	450
2	100	50	1200	640
3	230	745	280	405
4	780	1220	225	665
5	1175	1555	3915	810
6	115	90	460	330
7	585	2600	320	400
8	1110	925	1485	390
9	310	355	595	95
10	345	665	0	155
11	80	2030	0	70
12	115	270	10	190

Table 2: Mean variations of *Vibrio sp*. of the Lagos Lagoon

	Mean	Std. Error	Minimum	Maximum
ST 1	183.75	95.34	0	450
ST 2	497.50	269.58	50	1200
ST 3	415.00	115.99	230	745
ST 4	722.50	204.46	225	1220
ST 5	1863.75	700.46	810	3915
ST 6	248.75	88.66	90	460
ST 7	976.25	544.09	320	2600
ST 8	977.50	227.86	390	1485
ST 9	338.75	102.54	95	595
ST 10	291.25	143.17	0	665
ST 11	545.00	495.32	0	2030
ST 12	146.25	55.35	10	270

Muscle Proteomics of *Chrysichthys nigrodigitatus* as Indicator of Environmental Stressors in Ologe and Badagry Lagoons, South-Western Nigeria

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ABSTRACT

Proteomics is an approach used to comprehensively catalogue the entire protein complements which represents an ideal analytical tool for the high throughput discovery of protein alterations in health and disease. The study was aimed to provide protein expression of Chrysichthys nigrodigitatus as an indicator of environmental stressors in Ologe and Badagry Lagoons. The quantification and the quality of the protein extracts was performed using Bradford method and SDS-PAGE gels was according to Laemmli's protocol. The gel spots for MALDI-TOF/TOF were destained, digested overnight with trypsin and peptides were extracted following standard techniques. A total of 8 protein spots were identified with 2 proteins spots (spots 1 and 4) represented by cytoskeletal proteins; Alpha Actin and Actin cytoplasmic 1 showed significant differences (p <0.05) indicating over-expression in the muscle protein. On the other hand, Fructose-bisphosphate aldolase A (spot 3), spot 2 and 8: Metallothionein, spot 5: Parvalbumin beta 1, spot 6: Hemoglobin subunit beta-1, and spot 7: Prolactin-1 all showed no significant differences (p >0.05) in muscle of C. nigrodigitatus indicating down-regulated proteins. The study identified intact protein markers expressed in the muscle of C. nigrodigitatus which serves as prognostic tool to assess the pollution and health status of the Lagoons.

Keywords: Biomarker, Proteomics, Fish, Pollution, Lagoons

INTRODUCTION

Most aquatic ecosystems in southwestern Nigeria are usually faced with several environmental threats from complex mixture of contaminants from industries, anthropogenic perturbations and other stressors. And for several decades, the presence of these environmental contaminants in aquatic biotic and abiotic samples has been measured using chemical analytical techniques (Bassey *et al.,* 2019). Proteomics are expressed as an unbiased, technology driven approach for the comprehensive cataloguing of entire protein complements and represent an ideal analytical tool for the high throughput discovery of protein alterations in health and disease (Vijaya *et al*., 2014). Muscle plays a central role in whole-body protein metabolism by serving as the principal reservoir for amino acids to maintain protein synthesis in vital tissues and organs (Mohanty *et al.,* 2013). Skeletal muscle fibers represent one of the most abundant cell types in vertebrates (Ohlendieck, 2011). It is increasingly important to profile proteins in order to understand biological processes in a post genomic era as the dynamics of proteins between cells at different times and under different environmental conditions provide an actual biological phenotype (Bassey *et al*., 2019). Hence, this study was aimed to provide protein expression profiles of the African catfish (*Chrysichthys nigrodigitatus*) which could serve as an indicator of environmental stressors in coastal environment.

MATERIALS AND METHODS

Study Area

The coastal ecosystems (Ologe and Badagry Lagoons) are part of the Lagos Lagoon complex within the southwestern region of Nigeria. Ologe Lagoon lies between longitudes 3°0' and 3°06' E and between latitudes 6°20' and 6°30' N, while Badagry Lagoon lies between Longitudes 3°0′ and 3°45′ E and Latitudes 6°25′ and 6°30′ N which borders the Republic of Benin via Port-Novo. It is approximately 60 km long and 3 km wide and. These Lagoons serve several socio-economic needs (aquaculture, fishing, sand dredging and drainage) to the towns and villages around their borders (Clark *et al.,* 2004).

Collection of Fish samples

Fish samples (*Chrysichthys nigrodigitatus*) were caught using trap basket slightly above the bottom at depth of 3.5 m from eight stations (October 2013- April 2015). Twenty-four (24) of *C. nigrodigitatus* were collected at average weight of 253 – 368 g.

Preparation of protein extracts and quantification

One hundred (100) mg of muscle tissue were collected from *C. nigrodigitatus* and minced using a clean scalpel. The tissue was homogenized with 1 mL of PBS and spinned at 3,000 rpm for 10 min at 4^0C. The supernatants were removed, and then 1 ml of whole cell lysis buffer was added to the 100 mg of homogenized tissue. The quantification and the quality of the protein extracts was performed by the modified Bradford method, measuring the samples extracts in duplicates and using Bovine Serum Albumin (BSA) as protein standard. The results of the quantification were checked by running 25 µg of each protein extract on 12.5% vertical SDS-PAGE gels according to Laemmli's protocol (Laemmli, 1970).

Gel electrophoresis

1-D SDS-PAGE gels were used to examine the range of protein MW and to assess the presence of interfering substances in the muscle protein extracts. The standard of protein determined from absorbance at 595nm wavelength plotted against Bovine Serum Album (BSA) concentrations. The Second Dimension (SDS-PAGE) run was performed using 12.5% resolving gels with 6% (w/v) stacking gel on a PROTEAN XI cell (Bio-Rad). The gels were stained with Coomassie Brilliant blue stained and the 2-D gel images were acquired by Image Scanner III LabScan 6.0 (GE Healthcare Biosciences) Proteomic Lab, IITB, India.

Matrix Laser Desorption Ionization Time of Flight/Time of Flight Mass Spectrometry (MALDI-TOF/TOF-MS)

A total of 8 gel spots were excised from the 2D gels, for MALDITOF/TOF-MS analysis; gel spots were picked up from one freshly run gel. The gel spots were destained and digested overnight with trypsin. The resulting peptides were extracted following standard techniques (Bringans *et al.,* 2008).

Sequence Database Search

The MS/MS data were subjected to Mascot protein database search engine (*www.matrixscience.com*) (Perkins *et al.,* 1999). Protein mass score is -10*Log (P), where P is the probability that the observed match is a random event. Protein scores greater than 46 are significant ($p < 0.05$).

RESULTS AND DISCUSSION

Gel electrophoresis

The results of the SDS-PAGE and 2D gel electrophoresis of all individual samples carried out to assess the protein quality in muscle proteome of *Chrysichthys nigrodigitatus* are presented in Plate 1. All extraction methods revealed proteins with a wide range of MW from over 110 kDa to as low as 15 kDa.

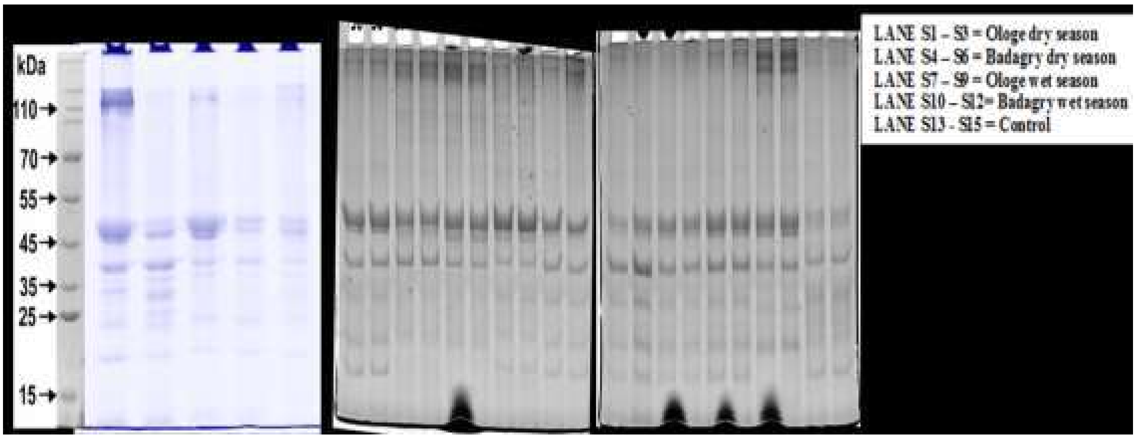

Plate 1: Protein Quantification and SDS PAGE Profile of C. nigrodigitatus

Protein Identification by Matrix-Assisted Laser Desorption/ Ionization Time of Flight/ Time of Flight Mass Spectrometry (MALDI-TOF/TOF-MS)

From the 2D gel run for spot picking for MALDI-TOF/TOF-MS, about 8 spots were visualized on the CBB-stained gels of the muscle protein extract of *C. nigrodigitatus*. The identified 8 protein spots (Plate 2) were matched from the Mascot search engine database for fish species. The output revealed 2 proteins spots represented by cytoskeletal proteins, Alpha Actin and Actin cytoplasmic 1 (spots 1 and 4) which showed significant differences ($p < 0.05$) indicating over-expression in the muscle protein. On the other hand, Fructose-bisphosphate aldolase A (spot 3), spot 2 and 8: Metallothionein, spot 5: Parvalbumin beta 1, spot 6: Hemoglobin subunit beta-1, and spot 7: Prolactin-1 all showed no significant differences ($p > 0.05$) in muscle of *C. nigrodigitatus* indicating that the proteins were down-regulated.

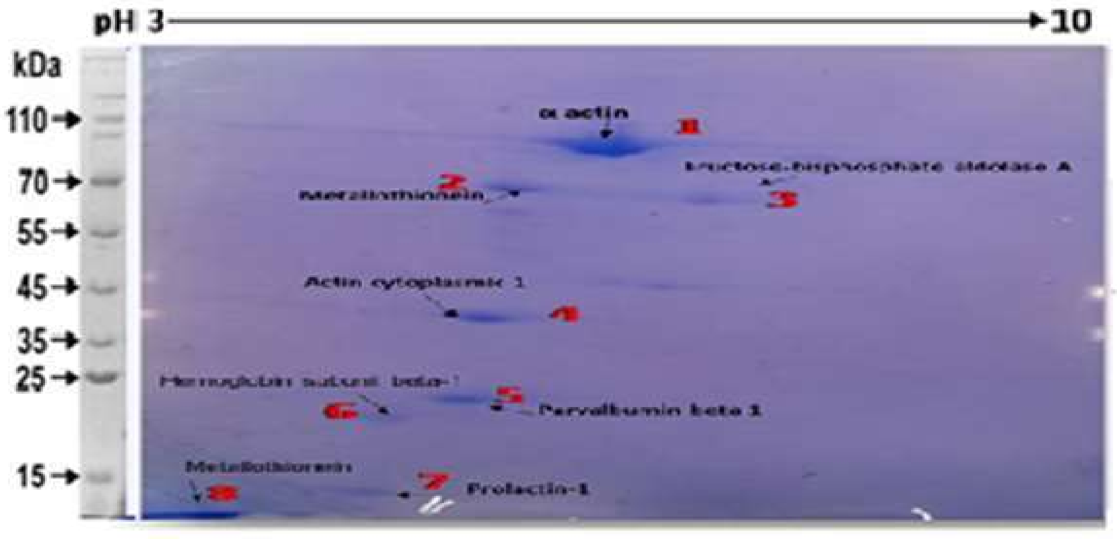

Plate 2: 2-D gel of C. nigrodigitatus muscle protein (MALDI TOF/ TOF Analysis)

Proteomics, the global analysis of protein synthesis, studies the protein expression patterns in response to environmental changes. Two-dimensional protein gels, combined with peptide mass mapping by MALDI TOF MS identified protein markers subject to up- and down-regulations in the protein expressed in *C. nigrodigitatus* influenced by environmental changes in Ologe and Badagry Lagoons. The results of the 2-D gel electrophoresis and MALDI-TOF/TOF MS revealed a total of 8 individual spots on the basis of their peptide mass fingerprints (PMF). This represented 2 proteins peptide identified as α-Actin and Actin cytoplasmic 1. These protein markers were also observed to be over-expressed, indicating the attempt of maintaining cell shape and functionality in cases of hypoxic and heat shock stress.

Actins are highly conserved proteins that are involved in various important cellular processes including cell motility, cell signaling, and the establishment and maintenance of cell junctions and cell shape. The change of actin isoforms (α- and β-Actin) in abundance might have been related to induced oxidative stress in Ologe and Badagry lagoons, since actins can be a direct target for oxidative modification (Lassing *et al.,* 2007). Actin is a cytoskeletal protein that is ubiquitously expressed in many eukaryotic cells and functions as maintenance of the cytoskeleton, cell motility and muscle contraction. The changes in the level of cytoskeletal and structural proteins expression can be very often attributed to the attempt of maintaining cell shape and functionality in cases of hypoxic (Tomanek and Zuzov, 2010; Letendre *et al.,* 2011) associated with low dissolved oxygen and slightly acidic pH level of the water quality.

CONCLUSION

The study identified intact protein markers expressed in the muscle of *C. nigrodigitatus* which serves as prognostic tools (MALDI-TOF/TOF approach) to assess the pollution status of Ologe and Badagry lagoons, which could also be useful for biotechnological interventions in fish health and disease management; besides adding to the existing knowledge base on comparative muscle proteomics on *C. nigrodigitatus* of a tropical ecosystem.

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Impact of Radiation Doses on Common Species of Frozen Fishes Imported in Ibadan, Nigeria

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ABSTRACT
Natural occurring radionuclide contents were investigated in different species of imported frozen fish in Ibadan, Nigeria. Seven samples of common imported frozen fish species, were purchased from a different cold room at Bodija and Oke-Ado market in Ibadan, Nigeria. The species include Trachurus trachurus (horse mackerel), Scomber scombrus (mackerel), Clupea harengus (herring fish), Sardinella aurita (panla kika), Dallia pectorals (alaska), Merluccius merluccius (hake panla), and Micropogonias undulatus (croaker). Five samples of each species were randomly collected for the study. The samples were identified at the fishery section, Department of Zoology, University of Ibadan, and were grouped based on their species. The radioactivity measurements of natural radionuclides, 40K, 238U, and 232Th in seven species were determined using gamma-ray spectroscopy. The mean activity concentrations varied from value 584.5076.76 (T. trachurus) to 1105.89109.67 (C. harengus), 18.2014.15 (M. undulatus) to136.82121.93 (M. merluccius), 5.541.24 (M. merluccius) to 30.389.95 (T. trachurus) for 40K, 238U, and 232Th, respectively. The means of annual effective ingestion dose ranged from 27.183.57 Svy-1 (T. trachurus) to 51.425.10 Svy-1 (C. harengus), 5.464.24 Svy-1 (M. undulatus) to 41.1935.68 Svy-1 (M. merluccius), and 2.454.46 Svy-1 (S. aurita) to 50.1316.42 Svy-1(T. trachurus) for 40K, 238U and 232Th, respectively. The highest mean annual effective dose 51.425.10 Svy-1 from C. harengus obtained in this study were less than ICRP recommended 50mSvy-1 for the population. Therefore, it suffices to say that the consumption of these species of frozen fish will not pose any significant radiological hazard to the population.

***Keywords:* Activity concentration, Frozen fish, Natural Radionuclide, Ingestion effective dose**

INTRODUCTION
The world is naturally radioactive and this natural radiation in the environment is augmented by artificial sources, emanating from human activities such as nuclear power generation, the fallout from a nuclear explosion, disposal of waste, deforestation, and those used for medical practices (Ademola and Ehiedu, 2010). Most of these radionuclides can find their way into the environment through routine releases, accidents, and improper disposal. Man-made sources are usually localized and affect a small population at any time, unlike the natural sources which are widely distributed around the world (Methler *et al*., 1990). There are both artificially and naturally occurring radionuclides in the environment in general and in the oceans in particular (Eisenbud and Gesell, 1997; Livingston and Povinec, 2000). Radionuclides that occur naturally are 238U, 232Th, and their decay series and 40K. Artificial radionuclides are 137Cs, actinium, lawrencium, nobelium from fallout, and effluent. Radionuclides of both

origins can be concentrated in the tissues of marine organisms and transferred along the food chains, exposing the organisms to ionizing radiation that may cause harmful biological effects on individuals, population, and ecosystems (UNSCEAR, 1982; Eisenbud and Gesell, 1997; Real *et al.*, 2004). Thus, monitoring the level of radionuclides in foodstuffs is an important parameter from which assessment of the dose to the population can be estimated. Deposition of radioactive and liquid waste into the ocean, where some of the aquatic animals live. This could lead to an increase in the activity concentrations of radionuclides around their habitat. The major foodstuffs contributing to the radiation ingestion dose will be those in which the radionuclides have a large transfer rate or those consumed in large quantities; such products include water, milk, meat, fish, beans, and some other vegetables (Ababneh *et al*., 2009). Global populations, especially in developing countries such as Nigeria eat fish as a source of protein. Fish are often at the top of the aquatic food chain and may contain some radionuclides, which often endanger public health as a result of the consumption of contaminated seafood. Hence the accumulations of radionuclide in fish tissues are finally transferred to other animals through the food chain. Fish contribute about 55% of the protein intake in Nigeria, which is one of the largest importers of fish with per capita consumption of 7.52 kg per annum and total consumption of 1.2 million metric tons with import making up about 2/3 of the total consumption (Adewuyi *et al.*, 2010). A tariff reduction made by the Nigerian Government in the year 2001 on all fishery products from 25% to 5% has led to Nigeria becoming a major destination for imported seafood. A recent study reported that the level of Cu in imported frozen fish was higher than the recommended maximum limit by World Health Organization (WHO), while Cd and Fe had values lower than the set limit (Udo *et al.*, 2011). However, there is no information on the radioactivity of imported frozen fish in Nigeria. Therefore, determination of the activity concentration of natural radionuclides in different species of imported frozen fish is necessary for both humans and their environment.

MATERIALS AND METHODS

Samples of seven popular species of imported frozen fish: *T. trachurus* (horse mackerel), *Scomber scombrus* (mackerel), *C. harengus* (herring fish), *S. aurita* (hake, panla kika), *Dallia pectorals* (alaska), *M. merluccius* (hake panla) and *M. undulatus* (croaker), were purchased from a different cold room at Bodija market and Oke-Ado market in Ibadan, Oyo State, Nigeria. These are the commonly available imported frozen fish in Nigeria. They are highly cherished as a source of animal protein, especially by the average population in Nigeria. Five samples of fish were randomly collected from each species with exception of croaker, where four samples were collected. This was due to the cost at the time of collection. In all, a total number of thirty-four (34) fish samples were collected. The Fish samples collected, were transported in an ice-packed cooler to the laboratory. The samples were identified at the fishery section, Department of the Zoology, University of Ibadan. They were grouped based on their species. The fish muscles and gills were carefully removed with a plastics knife and oven-dried at a temperature of 3000C until a constant weight was obtained. The dried fish samples were pulverized using clean mortar and pestle and then weighed and placed in plastic containers. The containers were sealed and kept for one month to ensure that the samples attained radioactive equilibrium between 226Ra, with its decay products in the uranium series (Ramasamy, 2004**).**

RESULTS AND DISCUSSION

Activity Concentration

The activity concentration of 40K 238U and 232Th in different species of imported frozen fish into Nigeria was determined. The activity concentration of the radionuclides, in each sample, is presented in Table 1. The annual effective ingestion dose due to intake of radionuclides, through food ingestion, was calculated. The calculated values of their corresponding mean values of each radionuclide for each species of fish are shown in Table 2. The activity concentration of 40K, 238U, and 232Th in different species of frozen fish in Nigeria were determined and the result as presented in Table 1, showed that the mean activity concentration of 40K, 238U, and 232Th, respectively. The mean activity concentration of 40K, 238U, and 232Th of each species of fish samples analyzed varied from 584.5076.76 to 1105.89 ± 109.67, 18.20±14.15 to 136.04±121.93, and 5.54±1.24 to 30.389.95 Bq/kg, respectively. From the results obtained, there are variations in the activity concentrations of the three radionuclides within the same species of fish. This could be due to the activity concentration of the habitat. The bar chart in figure 1 shows that *C. harengus* had the highest mean activity concentration of 1105.89 ± 109.67 Bq/kg for 40K while the least 584.5076.76 Bq/kg was obtained for *T. trachurus*. For 238U, *M. merluccius* recorded the highest mean activity concentration of 136.82±121.93 Bq/kg while *M. undulatus* have the least mean activity concentration of 18.20± 14.15 Bqkg-1. For 232Th, *T. trachurus* was also observed to have the highest mean activity concentration of 30.85±9.95 Bq/kg, while the least activity concentration of 5.54±1.24 Bq/kg, were obtained from *M. merluccius*. The observed variation could be due to different factors such as the feeding habit, radioactive waste from factories and industries (Fernando *et al,* 2011), geological formations of the bedrock beneath the water body, and uneven distribution of radionuclides in the habitat. The annual effective dose to be received from the consumption of the fish was calculated as presented in Table 2. The mean annual effective dose rate due to 40K ranged between 27.18Svy-1 (*T. trachurus*) and 51.425.10Svy-1 (*Clupea harengus*). For 238U, it ranged between 5.464.24 Svy-1 (*M. undulatus*) and 41.19Svy-1 *(M. merluccius)*. For 232Th, the mean value varied from 9.142.04Svy-1 (*M. merluccius*) to 49.25 Svy-1 (*T. trachurus*). The mean total annual effective dose due to the content of the three radionuclides in the frozen fish samples varied from 53.489.21Svy-1 (*M. undulatus*) to 104.42 41.95 Svy-1 (*C. harengus*). The Results of the mean annual effective dose calculated for all the samples were lower than the worldwide average annual effective dose of 70 Svy-1(UNSCEAR, 2000).

CONCLUSION

The measurement of natural radionclides in common frozen fish imported into Nigeria was carried out. The activity concentration of 40K, 238U, and 232Th was determined using gamma spectrometric method. The study reveals that no artificial radionuclides were detected in all the samples analyzed. The mean annual effective dose determined due to the ingestion of 40K, 238U, and 232Th in the fish samples, were below the worldwide average annual effective dose of 50mSvy-1 as recommended by the International Commission of Radiological Protection. This result revealed that the mean annual effective dose to the population from consumption of imported frozen fish is negligible and shows no significant radiological health effect to the population.

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Table 1: Activity concentration of imported frozen fish samples

Speciecs	**Sample**	**^{40}K (Bq/kg)**	**^{238}U (Bq/kg)**	**^{232}Th(Bq/kg)**
Trachurus trachurus	1	679.37	14.70	39.21
	2	609.02	9.06	32.97
	3	572.85	52.31	33.24
	4	593.96	19.83	16.09
	5	584.50	31.78	BDL
Mean ±std. dev.		584.50 ± 76.76	25.54 ± 15.35	30.38 ± 9.95
Scomber scombrus	1	736.69	40.33	28.15
	2	874.78	21.98	16.00
	3	380.20	29.42	19.16
	4	802.42	35.55	20.56
	5	611.51	11.19	39.44
Mean ±std. dev.		681.12 ± 194.11	28.09 ± 10.80	24.66 ± 9.39
Clupea harengus	1	1002.73	38.61	23.94
	2	1033.35	DBL	53.85
	3	1057.39	12.81	9.59
	4	1169.38	16.23	54.48
	5	1266.59	31.50	7.39
Mean ± Std. dev.		1105.89 ±109.67	23.29 ± 11.54	29.85 ± **23**.08
Sardinella aurita	1	1136.46	86.23	BDL
	2	1283.46	95.30	15.58
	3	1122.72	44.23	10.73
	4	695.38	44.84	11.90
	5	1214.60	38.35	16.22
Mean ± Std. dev.		1090.53 ±230.16	61.79 ± 26.76	13.61 ± 2.70
Merluccius merluccis	1	1086.14	BDL	4.75
	2	999.07	2.40	7.32
	3	1069.26	BDL	5.75
	4	978.94	182.41	BDL
	5	738.53	227.10	5.82
Mean ± std. dev.		974.39 ± 139.42	136.82 ± 121.93	5.54 ± 1.24
Dallia pectorals	1	780.96	14.42	9.63
	2	864.53	9.49	11.28
	3	970.64	BDL	9.63
	4	1422.71	15.01	11.27
	5	1058.05	40.58	13.09
Mean ± std. dev		1019.38 ± 248.68	19.88± 14.02	10.98± 1.44
Micropogonias undulates	1	858.43	7.58	7.93
	2	824.65	36.88	5.01
	3	935.91	21.44	6.67
	3	935.91	21.44	6.67
Mean ± std. dev.		824.65± 106.23	18.20 ± 14.15	5.87 ± 1.80

Table 2 Annual Effective Ingestion Dose of different species of frozen fish imported into Nigeria

Species	Sample	E_K (μSvy^{-1})	E_U (μSvy^{-1})	E_{Th} (μSvy^{-1})	E_T (μSvy^{-1})
Trachurus trachurus	1	31.59	4.41	64.70	100.71
	2	28.32	2.72	54.40	85.43
	3	26.64	15.69	54.85	97.19
	4	27.62	5.95	26.55	60.11
	5	21.18	9.54	BDL	28.27
MEAN±std. dev.		**27.18±3.57**	**7.66±5.15**	**50.13±16.42**	**70.34 ±32.19**
Scomber scombrus	1	34.26	12.10	46.44	92.80
	2	40.68	6.59	26.41	73.68
	3	17.68	8.83	31.61	58.13
	4	37.32	10.66	33.93	81.91
	5	28.44	3.96	65.07	97.46
MEAN±std. dev		**31.67±9. 03**	**8.43±3.24**	**40.69±15.49**	**80.79±15. 71**
Clupea harengus	1	46.63	11.58	39.57	97.72
	2	48.05	BDL	88.86	136.91
	3	49.17	3.84	15.83	68.84
	4	54.38	487	89.89	149.13
	5	58.90	9.45	2.19	60.05
MEAN±std. dev		**51.42 ±5.10**	**7.44±3.69**	**49.25±38.10**	**102.53±41.95**
Sardinella aurita	1	52.85	25.87	BDL	58.95
	2	59.68	28.59	25.27	113.98
	3	52.21	13.27	17.71	83.18
	4	32.34	13.45	19.63	65.42
	5	56.48	11.51	26.76	105.48
MEAN±std. dev		**50.71±10.70**	**18.54±8.03**	**2.45±4.46**	**85.40±24.10**
Merluccius merluccius	1	50.51	BDL	7.84	113.07
	2	46.46	0.72	12.07	126.66
	3	49.72	BDL	9.49	59.93
	4	45.5	54.72	6.69	25.99
	5	34.34	68.13	9.61	39.80
MEAN±std. dev		**45.31±6.48**	**41.19± 35.68**	**9.14±2.04**	**73.09±44.63**
Dallia pectorals	1	36.31	4.33	15.88	59.26
	2	40.20	2.85	18.62	58.94
	3	45.13	BDL	15.89	75.90
	4	66.16	4.50	18.59	92.25
	5	49.20	12.18	21.59	66.70
MEAN±std. dev		**47.40 ±11.56**	**5.96±4.21**	**18.11±2.37**	**70.61±13.94**
Micropognias undulates	1	39.92	2.28	13.09	55.28
	2	38.23	11.06	8.27	57.57
	3	43.52	6.43	11.01	60.96
	4	31.72	2.06	6.34	40.12
	5	NA	NA	NA	NA
MEAN±std. dev		**38.34±4.94**	**5.46±4.24**	**9.68±2.97**	**53.48±9.21**

Factors Affecting the Profitability of Cat-Fish Production in Kaduna Metropolis

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ABSTRACT
This paper analyzed the factors affecting the profitability of catfish production in Kaduna Metropolis. First, the study described the socio-economic characteristics of catfish farmers. Data was analyzed using descriptive statistics, multiple regression and gross margin. The result show results showed males (63.3%) are actively involved in fish farming than the females (36.7%). The result further indicated that the majority (80%) of the respondents are educated as most of them had attended tertiary education. The results of the multiple regression model show that five (5) out of the seven (7) independent variables were positively related to the dependent variable (viability and profitability of catfish farmers). And four (4) variables; variable inputs, the amount invested, source of credit, nearness to the market were statistically significant at 5%. In estimating the cost and returns of catfish farmers, the results show that catfish farming is profitable and therefore a viable enterprise. The majority of the farmers make on average a gross margin of ₦719,232. Also, 70% of the farmers made a profit; only 30% of the farmer did not make profit because of the high total fixed cost. Therefore, it is recommended that the government should provide infrastructural facilities, such as electricity, dams, good roads, and an enabling environment for fish farmers and commercials banks should lower their interest's rates to fish farmers or would be fish farmers in order to boost fish farming.
Keywords: Factors, Profitability, Metropolis, Viability, Gross margin

INTRODUCTION
Fish farming, also known as aquaculture, involves the planned growth and cultivation of fish harvesting as food, as opposed to catching fish in the wild. It provides lucrative returns to the farmers, employment in rural areas, besides supplying good quality protein diet for the people (Onoja, 2015; Oluwatayo and Adedeji, 2019). Among the common species of food fish in Nigeria are carp, tilapia, and catfish. However, catfish is the most sought after. The major reasons fish farmers in Nigeria focus on catfish are: they adapt well to culture environment; they can be retailed live; and they attract premium price (Asa and Solomon, 2015). Catfish are suitable for stocking in ponds and they tolerate low dissolved oxygen better than other common species in the country. Oguntola (2001); Asa and Solomon (2015) reported that catfish has a fast growth rate; are able to survive both natural and artificial food environments; and can be cross-bred to enhance certain favorable traits.

Again, Catfish production, also, serves as a source of income in Nigeria; reduces the rate of unemployment in the country; and increases the country's Gross Domestic Product. However, the current fish production in Nigeria has not met up with demand for fish and fish products (FAO, 2006). Out of the 35 grams of animal protein per day per person recommended by FAO, less than 7 grams is averagely consumed per person in Nigeria. These features have placed catfish farming in good position to serve as the only way of boosting fish production and thereby move the country towards self-sufficiency in fish supply. Global fish production is peaked at about 171 million tonnes in 2016, with aquaculture representing 47 percent of the total and 53 percent if non-food uses (including reduction to fishmeal and fish oil) are excluded. (FAO, 2018). Aquaculture in Nigeria focuses mainly on freshwater fish, with catfish species accounting for 64 percent of aquaculture production in 2015. According to The total fish demand for Nigeria based on the 2014 population estimate of 180m was 3.32m Mt. The domestic fish production from Aquaculture, Artisanal and Industrial fisheries for 2014 was 1.123m Mt.

Over the past 35 years, aquaculture production in Nigeria has grown 12 percent a year (compared to the world average of 8 percent), from a little over 6,000 metric tons in 1980 to nearly 307,000 metric tons in 2016. The country is the largest aquaculture fish producer in sub-Saharan Africa, accounting for 52 percent of the total. (Worldfish, 2018). Fisheries is estimated to employ over 8.6 million people directly and a further 19.6 million indirectly, 70 percent of whom are women. Currently, Nigeria produces just over 1 million metric tons of fish, leaving a deficit of over 800,000 metric tons, which is imported annually. (Worldfish, 2018). Also in 2014, fisheries in Nigeria contributed 0.48% to the Agriculture GDP and contribution of Agriculture to GDP (2014) was 20.24%. Nigeria has been ranked 68th within the group of 160 countries in terms of fish consumption per capita, 19 places above the position seen 10 years before 2014.

Fish consumption per capita reached 13.3 kg in 2017 in Nigeria, according to FAOSTAT, below to the world's average of 20.5 kg in 2017. The increase in population in Kaduna State is adjudged to provide market for production of catfish as this will in turn increase the demand for fish. Fish is produced and consumed mainly in the state and other states like Maiduguri supplied fishes to meet the teeming demand. Despite the huge fish potentials with an increasing interests in the sector in Nigeria (Shimang, 2005;), there is still a gap between the demand for fish in Nigeria (1.3 million metric tonnes annually) and its supply from domestic production (about 0.45 metric tonnes annually) has continued to widen (Oluwasola and Ajayi, 2013).

Fish farmers are bedeviled with inadequate knowledge and technology for fish production resulting into low production efficiencies and profitability, high cost of quality inputs like feeds, seeds and equipment's. Inadequate technical & business management support systems; Ineffective data collection and management systems and Poor organization and trust amongst aquaculture value chain players. Therefore, this paper seeks to examine the determinants influencing the production of catfish in Kaduna state metropolis with a view to determining its effects on employment generation, poverty alleviation and enhanced nutrition among the urban population. More specifically, the paper described the socioeconomic characteristics of fish farmers in Kaduna state Metropolis, analyzed costs and returns to catfish farming and determined the factors affecting the profitability of catfish production.

METHODOLOGY

The study was carried in three (3) local governments of the State namely, Chikun, Kaduna North and Kaduna South respectively. The State lies between Latitude: 10°31' 35.08" N and Longitude: 7°26' 19.64" E. The State had an estimated population of 6,066, 562 million based on 2006 provisional census figures (NPC 2006) and based on annual growth rate of 3.0 the projected population of the state in 2021 was 8,978,511million. Primary data was used for the study. A multistage sampling procedure was used to select respondents for the study. In the first stage, Kaduna state was selected purposively because of growing population and the ready market for a fish farming business. In the second stage the three (3) local governments (Chikun, Kaduna South, and Kaduna North) were selected because of it is the center of economic activities in the state and the average per capita income in these local governments is high. Thirdly, a list of names of fish farmers was obtained from the Agricultural Zonal office (Birnin Gwari) of the State and finally, simple random sampling was employed in the selection of cat fish farmers and sixty catfish farmers were sampled.

Analytical techniques

Analytical methods employed include descriptive statistics, Gross Margin model, and multiple regression model. Descriptive statistics such as, frequency table, percentages, and averages were used to analyze the socioeconomic variables. Profitability of catfish production was estimated using the gross margin. Gross margin is the difference between total revenue and total variable cost. Factors affecting the profitability of cat-fish were determined using multiple regression model given as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta X_4 + \beta X_4 + \beta_5 X_5 + \beta_6 X_4 + \ldots.\beta_7 X_7 + e$$

Where,
Y = the profit level of fish farmers (Naira)
X_1= Amount invested (Naira).
X_2 = Stocking density ($m^{2)}$
X_3 = Cost of inputs (Naira)
X_4 = Labour employed (man-days/hour)
X_5 = source of credit (yes or no)
X_6 = nearness to market (km)
X_7 = Feed (kg)
e = error term
$\beta_1 - \beta_6$ =Unknown scalar parameters to be estimated as elasticity
β_0 = constant

To estimate the cost and returns/profitability, the gross margin model was employed, the following formula was used:
NPM= GM/TR X 100
TVC = TVC+TFC
Where:
GM= Gross Margin,
TVC= Total Variable Cost,
NPM= Net Profit Margin,
TR= Total Revenue;
TFC=Total Fixed Cost;
TC=Total Cost

RESULTS AND DISCUSSION

Table I shows the results of the socio-economic characteristics of fish farmers in the study area. The results revealed that males (63.3%) are actively involved in fish farming than females (36.7%). This is in line with artisanal fishing, where fishing is male-dominated (Ele, 2008). It also shows that the farmers that are actively involved in fish farming fall within 45 and 54 years and this means that the farmers still have the strength to run the business. The result further indicated that the majority (80%) of the respondents are learned and highly educated as most of them had attended tertiary education. This means that education influences the adoption of practices in modern agriculture (Jatto *et al.*, 2013). The reason has been that an educated person is more likely to adopt modern practices easily, better innovations and hence could be a better producer. The study also reveals that majority of the farmers were civil servants (40%), while Business owners accounted (25%), fish farmers (21.7%) this means that they took fish farming as their primary occupation, and pensioners (13.3%). This agrees with Adewuyi *et al* (2010) as 79% of fish farmers were not full-time farmers. Farming experience accounted for (56.7%) which means that most farmers have been engaged in fish farming for 6-10 years.

Factors affecting the Viability and Profitability of Catfish Production

The explicit function is given as: Profitability = (Amount invested + Stocking density (number of fish per pound size), + fixed input, variable input + Labour employed + source of credit + nearness to market + feed (kg)+ error term). The viability of catfish production was best estimated using multiple regression model specifically, the coefficient of the variable input (0.05515) is positive with a standard error of 0.070512. It implies that an increase in the quantities used of this input would result to increase in output which would translate into increased profit, Amount invested has a coefficient of 0.34242 with a standard error of 0.004332. This result aligns with prior expectations. The implication is that amount invested increased the profit level of catfish farmers in the study area. This result agrees with Nwaobiala (2010), where output and profit levels of smallholder fish farmers related positively with the amount invested in the enterprise.

The results showed that the source of credit of the fish farmers was found to be positive and significant at 5%. The coefficient of the source of credit is 0.03129. This implies that the profitability of catfish production has the likelihood of being increased by 0.03129. It further implies that the more catfish farmers have accessed to the source of credit the greater they embark on large scale production thus higher returns. The results showed that nearness to market was found to be positive and significant at 5%. The coefficient of age is 0.01430. This implies that the viability of catfish likelihood is increased by 0.01430. This may be because the closer catfish farmers are closer to urban areas where the demand for catfish is high, the more viable and profitable it will be. Feed was found to be significant and positively related to the profitability of catfish farming. The coefficient for feed is 0.04545.

The results of the estimated parameters show that the feed consumed has a positive coefficient. This implies that feed contributes positively to the output of catfish, fish foods consist of natural food and artificial (supplementary) feeds. When fish have a balanced diet to eat, they grow fast and stay healthy. The other variables that have a negative relationship with the viability of catfish production are stocking density and Labour employed. These two variables have a diminishing impact on sources of livelihood in the study area. The result of the gross margin analysis of catfish production in the study area reveals that the respondents spent average of ₦224,673 on the average variable cost and ₦417,446. 01 on average total cost. Also the average revenue/income generated from catfish indicated ₦998,896 with average profit of ₦478, 235.5 and gross margin of ₦35,522,813 with average gross margin of ₦719,232. This implies with the capital invested in cat fish farming resulted in a high income realized from the fish farming. The results also show, that the higher the invested capital the higher the higher the income realized from cat fish farming. Furthermore, the analysis of gross margin indicated that catfish farming is profitable and viable and has contributed positively to the total income of respondents in the study area.

CONCLUSION

This study has shown clearly that catfish farming is not only profitable but equally viable in the study area. All stakeholders must, therefore, endeavor to play their part in ensuring the survival and sustainability of the fish production in the State. The high initial capital outlay could serve as a discouragement for would-be catfish farmers who may be resource-poor, thus resulting in fewer people engaging in catfish production, this will lead to low fish supply. Because of meeting the increasing demand for protein intake by filling the yawning gap between the demand and supply of catfish in the state. It is therefore recommended that Farmers should be encouraged to give more attention to farm activities such as supervision and management in other to gain the relevant experience in running a catfish farm and increase their technical efficiency and Young and energetic youths should be encouraged to engage in catfish farming especially around their homes. Also, government should fund researches aim at finding cheap alternatives source of feeds for feeding catfish. Government as a matter of legislation compels commercial banks to provide low interest loan to fish farmers.

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Table 1: Socioeconomic Characteristics of fish farmers

Variable	Frequency	Percentage
Age		
25-34	03	5.0
35-44	04	6.7
45-54	26	43.3
55-64	12	20.0
65 and above	15	25.0
	60	**100**
Gender		
Male	38	63.3
Female	22	36.7
	60	**100**
Educational background		
No formal Education	0	0
Primary Education	02	3.3
Secondary Education	10	16.7
Tertiary Education	48	80.0
	60	**100**
Occupation		
Fish farmer	13	21.7
Civil servant	24	40.0
Business owner	16	25.0
Pensioner	07	13.3
	60	**100**
Farming Experience		
<5	09	15.0
6-10	34	56.7
11-15	11	18.3
15 and above	06	10.0
	60	**100**

Field Survey 2021

Table 2: Factors affecting catfish production

Variables	**Coefficients**	**Standard Error**	**Marginal Effect**	**P-value**
Constant	0.32165	0.150485	-0,58432	0.560555
cost input	0.05515	0.070512	1.218233	0.015755
Amount invested (N)	0.34242	0.004332	1.038354	0.023354
Stocking density	-0.00875	0.002389	-0.73107	0.466321
Labour employed	-0.07985	0.030114	1.507704	0.137915
source of credit	0.03129	0.013324	1.624560	0.045751
nearness to market	0.01430	0.020874	11.53602	0.004206
Feed	0.04545	0.092947	0.496162	0.692978

Table 3: Cost and Returns of Catfish

Item/Cost	Cycle (4months) ₦
A. Variable Cost: Juveniles/fingerlings stock per pond, feeds, family labour, hired labour, medication, maintenance and transportation.	**14,579,301**
B. Fixed Cost: Depreciation ponds/equipment (land, pond, boreholes, generator, scales, and pipes, vehicles, pumping machine, septic tank, buildings and other structures.)	**9,261,362**
Total Cost A &B	23,840,663
Total Revenue: from sales of fish	50,102,114
Average Variable cost	224,673
Average total Cost	417,446. 01
Average total revenue	998,896
Profit (Total Revenue-Total cost)	29,956,321
Average profit	478, 235.5
Gross Margin(TR-TVC)	35,522,813
Average Gross margin	719,232
Average NET Margin (%)	70%

Spatial and temporal changes in length-weight relationship and condition factor of *Pseudotholithus elongatus* in Lagos Lagoon

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ABSTRACT
The length-weight relationship and condition factor of P. elongatus from three sampling stations (Apapa, Makoko and Ibeshe) along the Lagos Lagoon was evaluated in both dry and wet seasons between February and December, 2017. Fish samples (n = 575) of total body length ranging from 29.20-34.5cm and weighing between 53.01-95.21g were studied. The growth coefficient 'b' ranged from -2.804 to -2.589 and -2.597 to -2.473 in dry and wet seasons respectively. The 'b' differed significantly (P < 0.05, b < 3, t-test) between seasons and among the sampling stations. This indicates a negative allometric growth for all the fish samples. Generally, condition factor (K) ranged from 0.513-1.524 and 0.644-1.084 in dry and wet seasons respectively. The condition factors were within the recommended value for healthy fish species in the tropics. This study provided the first empirical data of spatial and temporal variation on LWRs and CF of P. elongatus collected from sampling stations along Lagos Lagoon

Keywords: length-weight relationship, condition factor, growth coefficient, Pseudotholithus elongatus, Lagos Lagoon

INTRODUCTION
Length-weight (LW) relationships are commonly used in fisheries science to derive a quantitative measure of biomass (Hilborn and Walters, 1992). The relative relationship between fish body length and weight is used as a proxy for fish condition, this is based on the assumption that heavier fish of a given length are in better condition, (Pope and Kruse, 2001) As such, estimation of LW relationships can provide important information to fisheries managers and is helpful in understanding both growth rates of fish populations and their dynamics, (Anderson *et al.,*1996). The relationship between fish length and weight is also important for determining or predicting the condition or relative "wellness" of fish communities (Reist, 1985; Jakob *et al.,* 1996; Blackwell *et al*., 2000). The arithmetical form of the relationship between length (L; in cm) and weight (W; in g) can be described by the power function ($W = aL^b$), and the parameters 'a' *and* 'b', can be estimated from linear regression applied to the log-transformed variables ($\log W = \log a + b \log L$). Generally, LW relationships are modelled assuming error structures on the observed weights are log-normally distributed, but this approach can result in biased estimates for stock assessment calculations (Hayes *et al*., 1995). As an alternative, it is possible to consider and control for the potential non-independence of estimated LW relationships for fish within and between different 'groups' by employing a mixed model approach (Lai and Helser, 2004). The smaller and younger *Pseudotolithus senegalensis* and *P. elongatus* prefer and move to mid-waters when bottom temperature falls below 18°C. *Pseudotolithus senegalensis* (Valenciennes, 1833) occurs in similar habitats as *P. seudotolithus* (fonticulus) *elongatus*. The two species are jointly harvested by artisanal and industrial fisheries, using set gillnets, beach seines, long lines and bottom trawls. These fish species are of considerable economic importance and contribute

significantly to national food security, and provide employment and revenue to the larger proportion of Africans (Longhurst, 1963). This study provided the first empirical data of spatial and temporal variation on LWRs and CF of *P. elongatus* collected from sampling stations along Lagos Lagoon. It also help in the management for fish food. The study is significant for estimation of growth parameters of *P. elongates,* which is essential for management of the fishery.

MATERIALS AND METHODS

Fish samples were collected from sampling stations: Apapa, Makoko and Ibeshe with the service of fishermen. A cast net of 50-55mm mesh size was used in the collection of fish in the wet and dry seasons from three sampling stations in Lagos Lagoon. At Apapa, *P. elongatus* n=136 was collected in the dry season and n=90 was collected in the wet season. At Makoko, *P. elongatus* n= 100 was collected in the dry season and n= 88 was collected in the wet season. At Ibeshe, *P. elongatus* n=93 was collected in the dry season and n=68 was collected in the wet season. The fish body weights were taken to the nearest 0.01g using Guflex Electronic Balance JT302N. Total lengths were measured with a measuring board taken to the nearest 0.1cm. The length-weight relationship was calculated by the least square methods for dry and wet season separately using the equation:

$$W = aL^b$$

Or its logarithmic form:
$\text{Log } W = \log a + b \log L$
Where, W is weight in grams, L is length of fish in cm, a is intercept and b is slope.

The condition factor was determined by using the expression:
$$K = 100W/L^b$$

Where, W is weight in grams, L is in cm and b is the exponent of the length-weight relationship. All data were analysed using Origin software (Originlab software, USA). One-way ANOVA with P significant at 0.05 was applied in b values among the sampling stations (Gokce *et al.*, 2010). To verify if 'b' is statistically significantly different from predictions assigned for isometric growth (b = 3) between dry and wet seasons student t-test comparison was performed (Yilmaz *et al.,* 2012). The coefficient of determination (r) is a measure of the quality of the linear regression's prediction (a value close to 1 means a better model) (Jisr *et al.,* 2018).

RESULTS AND DISCUSSION

The length-weight relationship and correlation coefficient (r) for *P. elongatus* in dry and wet season was logarithmic transformation as depicted in Fig 2a-4b. The value 'b' for fish in Apapa -2.804 and -2.539 for dry and wet season respectively. At Makoko, -2.756 and -2.473 for dry and wet season respectively. At Ibeshe-2.589 and -2.597 for dry and wet season respectively (Table 1). Generally, the 'b' differed significantly ($P < 0.05$, $b < 3$, t-test) between seasons and among the sampling stations. This indicates a negative allometric growth for all the fish samples suggesting that fish samples have a relatively slow growth rate and tend to be thinner. This may be related to environmental conditions of the habitats and phenotypic factors of fish species (Tsoumani *et al*., 2006; Getso *et al*., 2017). The variations in the obtained b values may be correlated with many factors such as seasons, food availability, species and sex (Yilmaz *et al.,* 2012; Ali *et al*., 2016). The correlation coefficient (r) in Apapa 0.864 and 0.631 for dry and wet season respectively. At Makoko, 0.8129 and 0.7639 for dry and wet season respectively and Ibeshe, 0.859 and 0.692 for dry and wet season respectively. The high coefficient of determination values obtained in the assessment of the LWRs of the fish indicates a good quality of prediction towards a linear regression for the fish samples. Improved growth was exhibited in dry seasons may be associated with higher temperatures which result in increase in metabolic activities and the digestion processes are sped up leading to faster growth (Jisr *et al*., 2018).

The equations for the length-weight relationship in this study were as follows:
For Apapa dry season: Log W = -0.07520 - 2.804 Log L (r = 0.8642)
For Apapa wet season: Log W = -0.5143 -2.539 Log L (r = 0.6317)
For Makoko dry season: Log W = -0.01278 -2.7567Log L (r = 0.8129)
For Makoko wet season: Log W = -0.3706 -2.473 Log L (r = 0.7639)
For Ibeshe dry season: Log W = -0.04001 -2.589 Log L (r = 0.859)
For Ibeshe wet season: Log W = -0.5156-2.5972 Log L (r = 0.692)

It is important to mentioned that the collected fish were not sexed, which may influence LWRs reported in the current study (Pardoe *et al*., 2008, Ayo-Olalusi, 2014). Sex is an important factor to consider because some fish species are monandric protogynous hermaphrodite changing from male to female with increase size (Mouine *et al*., 2007). Thus, future LWRS studies may consider the sex factor to depict a comprehensive analysis of the data. Also, the condition factor (K) which indicate the state of wellbeing of fish samples ranged from 0.513-1.524 and 0.644-1.084 in dry and wet seasons respectively. Many factors affect the growth condition of fish including seasons, availability of food, pollution and reproductive cycles (Morato *et al*., 2001; Getso *et al*., 2017). The high K values in dry season may be associated with increase in feeding intensity of this fish which may result in better fitness in this season. (De Giosa *et al*., 2014; Jisr *et al*., 2018). The condition factors were within the recommended value for healthy fish species in the tropics.

CONCLUSION

This study provided the first empirical data of spatial and temporal variation on LWRs and CF of *P. elongatus* collected from sampling stations along Lagos Lagoon. All the LWRs showed a negative allometric growth of fish in both dry and wet seasons at all the sampling stations, which might be related to habitat conditions. Condition factor was generally close to or equal to 1 at both seasons showing an overall state of wellbeing of fish. Generally, fish samples exhibited a better fitness in dry season compared to wet season which might be due to increase in feeding activity and food availability when temperature are higher. This study fulfilled the aims set for it and data from this study constitute a valuable guideline for establishing future biometric studies for fish of economic importance collected from Lagos Lagoon. . The study is significant for estimation of growth parameters of *P. elongates,* which is essential for fishery management, conservation and sustainability.

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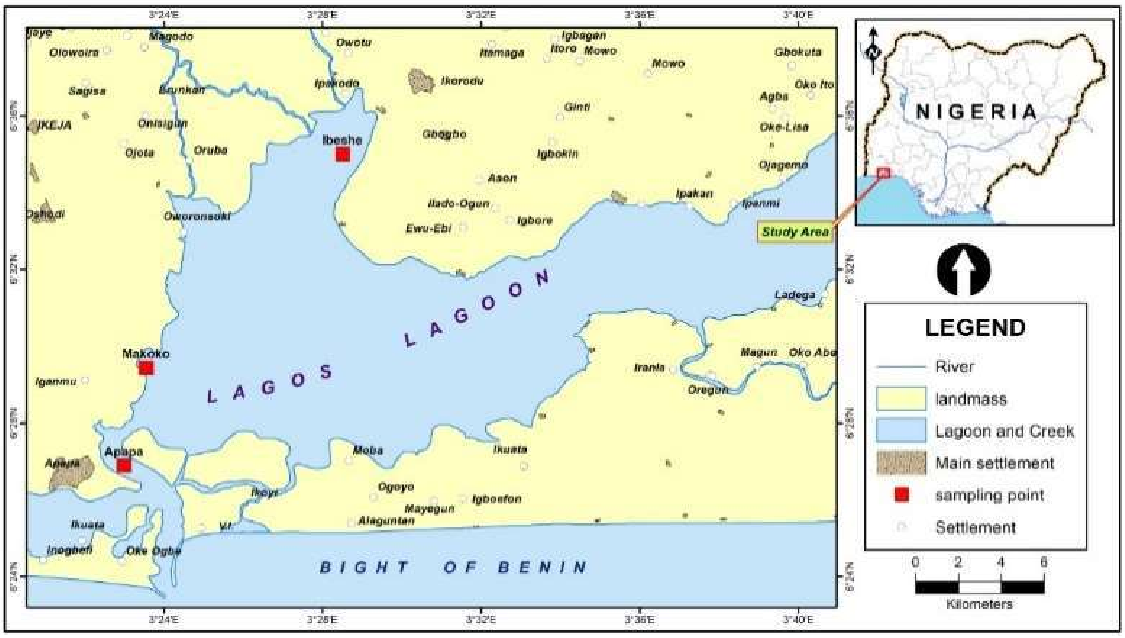

Fig 1: Map of Lagos Lagoon showing sampling stations

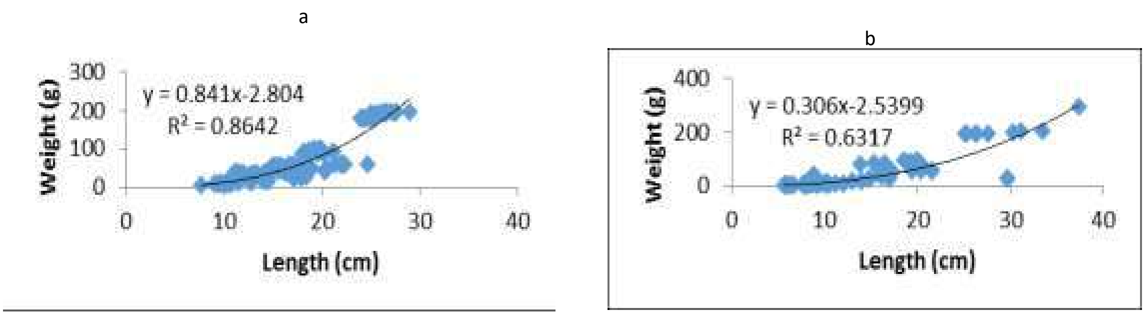

Fig 2: Length-weight relationship of P. elongates sampled from Apapa. A: dry season b: wet season

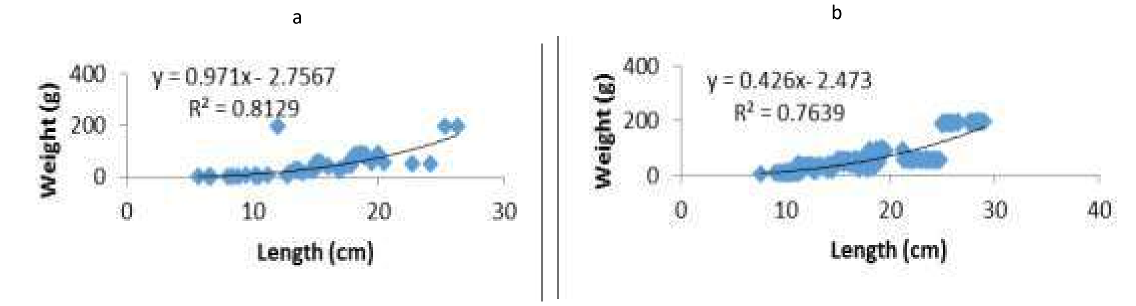

Fig. 3: Length-weight relationship of P. elongatus sampled from Makoko a: dry season b: wet season

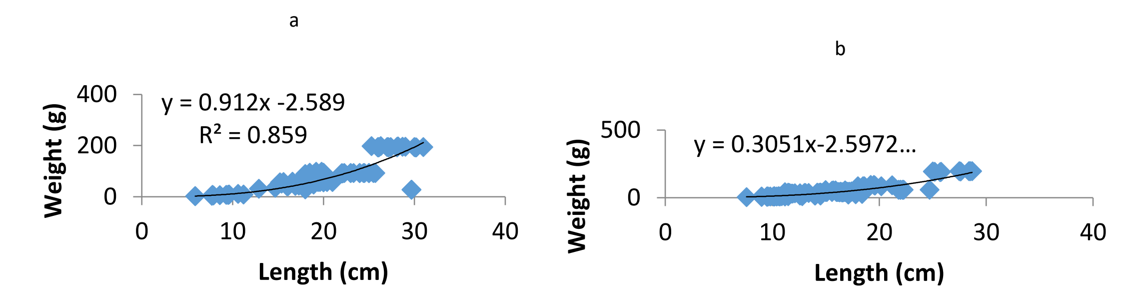

Fig. 4: Length-weight relationship of P. elongatus sampled from Ibeshe a: dry season b: wet season

Table 1: Regression coefficient of *P. elongatus* from Lagos Lagoon

Station	Mean CF (K)		Regression constant (a)		Regression coefficient (b)		Correlation coefficient (r)	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Apapa	1.11±0.39	1.42±0.82	0.841	0.306	-2.804	-2.5399	0.8642	0.6317
Makoko	1.07±1.58	1.59±0.44	0.971	0.426	-2.7567	-2.473	0.8129	0.7639
Ibeshe	1.19±0.44	0.86±0.30	0.912	0.3051	-2.589	-2.5972	0.8591	0.6921

Information Requirements and Accessibility Among Artisanal Fishers in Idah Local Government Area, Kogi State, Nigeria

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ABSTRACT
The study analyzed the information requirements and accessibility of artisanal fishers in Idah Local Government, Area, Kogi State, Nigeria. Multistage random sampling technique was adopted in selecting respondents for the study. A structured questionnaire was used to collect primary data from 128 respondents. Results showed that important areas of information requirements of the artisanal fishers were fisheries regulation (34.4%), construction of different hanging ratio (24.2%) and source of micro finance (13.3%) while 25.8% of the artisanal fishers had access to information on fish marketing, 18.8% on construction of different hanging ratio, 14.8% on source of micro finance. Also, 52.3% of artisanal fishers benefited more fund from information accessibility, 27.3% on more catches only 2% benefited through reduction in post-harvest losses. Almost 35% of the artisanal fishers strongly agreed that non-consistent Government policy is a constraint to information requirement while (68.0%, 64.8% and 32,8%) of the respondents reported problem of fund, inadequate awareness on information and Political affiliation respectively. It was recommended that extension packages that revolve around the information requirements of the artisanal fishers should be provided in fishing communities. Also, micro credit finance should be provided to the artisanal fishers by government to enhance their access to modern fishing gears and storage facilities.
Keywords: Accessibility, artisanal, constraint, information, requirement

INTRODUCTION
Fish makes vital contribution to the food and nutritional security for more than 200 million Africans and provides income for over 10 million people mostly small scale fisher folks and entrepreneurs who engage in fish production (World Fish Centre, 2015). Fishery activities are executed through two main methods in Nigeria namely artisanal or capture fishery and fish farming. Artisanal fishery is the harvesting of fish from rivers, streams, lakes and ponds by small scale fishermen using both traditional and modern fishing gears. It is the most important of fishery production in Nigeria and accounts for over 90% of her fishery production (Ogunbadejo *et al*., 2017). The artisanal fishery provides income and employment for the fisher folks and supplies cheap protein for the populace. Sustainable artisanal fishery practices are idea and hygienic for fish capturing, handling, processing, preservation and marketing. Knowledge and adherence to sustainable fishing practices would make fish to be available continually in the water bodies, ensure the production of good quality fish products and would

maximize the profit of the fisher folks (Adisa *et al.*, 2021). Dambatta and Sogbesan (2015) stated that enormous potentials of fisheries to help feed and improve the nutritional status of Nigerians are greatly under-realized and precious aquatic resources are being degraded. Motul'skij (2011) described information as the feeling of lacking something and wishing to fill the gap. All activities of living organisms and especially human activities always generate need for information about the changing environment and conditions of the tasks performed. The character of the human activity defines the character of information needed. For any activity to be executed, adequate information is required. Artisanal fisher folks also require basic information on their fish capture activities. Information on weather, fish species, breeding seasons, marketing, sources of credit, modern fish capture methods, fish processing and storage are all required by fishermen in order to have satisfactory fish production. (Pertiwi *et al.*, 2012) .In this increasingly information dependent age, the lack of information could certainly have serious or even, perilous consequences. Information is needed in all stages of human development. For information to be of optimum use, it must be relevant, accurate, timely, recent, clear and effective (Ogunremi, 2017).

Access to information is the right of humans and the use is dependent on the capacity to access and use. (Olojede *et al.* 2017). Artisanal fishers require a variety of information in order to meet the modern day challenges of fish production, processing, marketing and distribution. These areas of fisheries information needs are diverse and vary from one area to the other depending on the prevailing fishermen's practices and water bodies. Studies on artisanal fishers in Kogi State have also been undertaken but none of them is known to be in the area of information requirement and accessibility among artisanal fishers. It therefore becomes imperative to determine the information requirements and accessibility among fishers in Idah Local Government, Kogi State, Nigeria. The specific objectives of this study are: (i) Identify the major areas of information required by artisanal fishers (ii) Determine the accessibility to needed fisheries information among the artisanal fishers. (iii) Identify constraints to information accessibility.

MATERIALS AND METHODS

Idah Local Government Area of Kogi State is located in the East Central region of Nigeria. Idah is a town in Kogi State, Nigeria on the eastern bank of River Niger; it is the headquarters of the Igala Kingdom with an area of 36 km^2 and a population of 79,815. Artisanal fishing is practiced in three major communities of Idah Local Government, namely: Ofuruber, Egah and Opu-Attah which are in Riverine areas. The prominent River in Idah is River Niger however, there are other smaller rivers, streams and Lakes scattered all over the communities that serve as sites for intensive artisanal fishing. According to Agriculture Department in Idah Local Government Area, Fisheries unit recorded 150 artisanal fishers in the three communities selected as study area. Random sampling technique was adopted in selecting eighty-five percent (85%) of the total artisanal fishers in the study area, making a total sample size of one hundred and twenty-eight (128) respondents for the study. A descriptive statistic (frequency and percentages) were used to analyze the data.

RESULTS AND DISCUSSION

Table 1 showed the areas of information requirements of the artisanal fishers. Most of the respondents (34.4%) indicated fisheries regulation as their major area of information requirement. The other areas of information required are construction of different hanging ratio (24.2%), source of micro finance (13.3%), while electro fishing (0.8%) and fish marketing (0.8) are the least required. Information need portrays a desire by the artisanal fishers to have improvement in their fishing. This coupled with the fact that artisanal fishers are poor, may have informed the high level of information need in the area of micro-credit. In a similar study, Adisa *et al*, (2021) reported that artisanal fisheries could contribute to national economic growth if they received opportunities to become more productive as the population increases. In Table 2, only 25.8% of the artisanal fishers in the study area had access to information on fish marketing, 18.8% on construction of different hanging ratio, 14.8% on source of micro finance and prevention of post-harvest losses was 12.5% while subsidies on fishing input was the least with 1.6%. Artisanal fisher's accessibility to information was generally very low in the study area. This can be attributed to the fact that most artisanal fishers live in areas with bad terrain and poor access to extension services and other sources of information. Factors such as illiteracy and poverty hinder fisher folks' unfettered access to various information sources (Das *et al,* 2015 and Khanum 2013). Figure 1 showed the benefits of information accessibility among artisanal fishers. It indicated that majority of the respondents (52.3%) have the benefit of more fund from information accessibility, 27.3% indicated the benefit of more catches, and minority of only 2% benefited through reduction in post-harvest losses. This indicated that the only source of expanding artisanal fishing business was to have access to information through which they could contact the right source as at when due. More catches as benefit of information accessibility is an indication that no matter the fishing experience, with the advent of technology much can still be learnt for fishing efficiency which can translate into improved livelihood of the artisanal fishers. Constraints to information requirements and accessibility by the respondents is shown in Table 3, only 34.4% of the respondents strongly agreed that non-consistent Government policy is a constraint to information requirement while 18.0% strongly disagreed. On the problem of fund, 68.0% strongly agreed while only 0.8% disagreed. Also on inadequate awareness on information, majority (64.8%) of the respondents agreed with only 2.3% who strongly disagreed. (32.8%) of the sampled respondents agreed that political affiliation is a constraint to information requirement while (18.0%) of the artisanal fishers strongly disagreed. (54.7%) of the respondents showed that inadequate extension agent contact is a constraint to information requirement of the artisanal fishers while only 2.3% strongly disagreed. It is therefore clear that each of the factors listed above are constraints to information requirements and accessibility and therefore have effect on the performance and output of the artisanal fishers in the study area.

CONCLUSION

There was a very high need for information on improved fisheries practices among the fishers. The major areas of information requirement include fisheries regulation, construction of different hanging ratio, source of micro credit finance and prevention of post-harvest losses. The need to increase fish capture, acquire modern fishing tools and increase income level of fisher folks might have informed this high need for information in the study area. Accessibility to needed information was very low among the fishers. Poverty and lack of fisheries extension in fishing communities could have been responsible for the low access to needed information requirements among the respondents. More funds and more catches were the prominent benefits that the artisanal fishers enjoy through accessibility to information on their profession. Non consistent Government policy, inadequate awareness on information and inadequate extension agent contact were constraints to the respondents on information requirements. The study therefore recommended that extension packages that revolve around the information needs of fishers should be provided in fishing communities. Micro-credit finance should be provided to artisanal fishers to enhance their access to needed modern fishing gear and storage facilities.

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Table 1: Information requirements of the fisher folks

Information	Frequency	Percentage (%)
Use of outboard engine	8	6.3
Construction of different hanging ratio	31	24.2
Fisheries regulation	44	34.4
Subsidies on fishing input	4	3.1
Prevention of post-harvest losses	14	10.9
Source of micro finance	17	13.3
Modern fish processing	2	1.6
Electro fishing	1	0.8
Weather	6	4.7
Fish marketing	1	0.8
Total	**128**	**100**

Source: Field survey, 2021

Table 2: Information accessibility among the artisanal fishers

Information	Frequency	Percent (%)
use of outboard engine	6	4.7
construction of different hanging ratio	24	18.8
fisheries regulation	15	11.7
subsidies on fishing input	2	1.6
prevention of post-harvest losses	16	12.5
source of micro finance	19	14.8
modern fish processing	4	3.1
Weather	9	7.0
fish marketing	33	25.8
Total	**128**	**100.0**

Source: Field survey, 2021

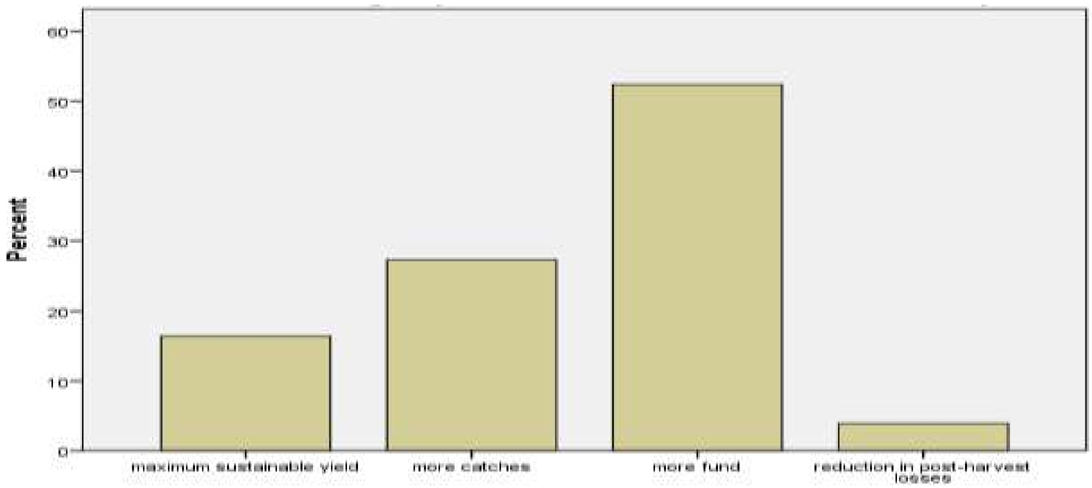

Fig. 1: Benefits of information accecibility among the artisanal fishers

Table 3: Constraints to information requirement and accessibility by the respondents

Variables	Strongly Agree	Agree	Strongly Disagree	Disagree	Undecided	Total
Non consistent Government policy						
Frequency	44	17	23	19	25	128
Percentage (%)	34.4	13.3	18.0	14.8	19.5	100
Problem of fund						
Frequency	87	40	-	1	-	-
Percentage (%)	68.0	31.3	-	0.8	-	-
Inadequate awareness on information						
Frequency	35	83	3	3	4	128
Percentage (%)	27.3	64.8	2.3	2.3	3.1	100
Political affiliation						
Frequency	11	42	23	29	23	128
Percentage (%)	8.6	32.8	18.0	22.7	18.0	100
Inadequate extension agent contact						
Frequency	70	43	3	5	7	128
Percentage (%)	54.7	33.6	2.3	3.9	5.5	100

Source: Field survey, 2021

Effect of Salinity on the Growth Performance of *Chaetoceros* and *thalassiosira* Species Isolated from the Coastal Water of Lagos, Nigeria

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ABSTRACT
Estuarine diatoms have been widely used as live feed in aquaculture. Salinity is one of the major factors that influence the growth rates of microalgae. Hence, the effect of different salinities (5, 10, 15, 20 25 and 30ppt) on the growth rates of two native estuarine diatoms, Chaetoceros sp. and Thalassiosira sp. isolated from Five Cowry creek, Lagos State was investigated to determine the optimum salinity for growth under laboratory conditions. Both Chaetoceros sp. and Thalassiosira sp. showed significantly higher (P<0.05) cell density and growth rate when cultured at salinity of 15ppt. Also, cell density and growth of Chaetoceros sp. and Thalassiosira sp. increased from a lower salinity to the optimum salinity (15ppt), but decreased as salinity increased from 15ppt to 30ppt. However, Thalassiosira sp. did not tolerate very low salinity of 5ppt. This study shows the euryhalinity of both Chaetoceros sp. and Thalassiosira sp. with the optimum salinity for growth at a low salinity of 15ppt.
Keywords: Chaetoceros, euryhalinity, microalgae, salinity, Thalassiosira

INTRODUCTION
The importance of microalgae cultivation has increased globally due to its fundamental usage in the feeding of many fish species in aquaculture, particularly crustacean rearing, and production of live food for fish larvae (Hemaiswarya *et al.*, 2011; Costard *et al.*, 2012; Adenan *et al*., 2013). *Chaetoceros* sp. and *Thalassiosira* sp. are widely used in aquaculture as source of feed for fry and larviculture in marine hatcheries due to their high nutritional properties, correct cell size, ease of culturing, lack of toxicity and digestible cell wall (Kent *et al*., 2011; Hemaiswarya *et al.*, 2011). Growth of microalgae is dependent on several environmental conditions such as pH, temperature, light intensity and nutrient but other factors such as salinity can be very important especially for both brackish and marine water microalgae (Araujo and Garcia, 2006; Banerjee *et al.,* 2011; Garcia *et al*., 2012). Salinity, which is one of the major limiting factors of microalgae growth vary in its influence from one species to another (Adenan *et al*., 2013). There is dearth of information on the effect of salinity on indigenous brackish and marine water microalgae in Nigeria. Thus, the study on the effect of salinity on the growth of two brackish water microalgae *Chaetoceros* sp. and *Thalassiosira* sp. isolated from the coastal water of Lagos, Nigeria was carried out to investigate their optimum salinity for growth.

MATERIALS AND METHODS
Sample collection and culture maintenance
Chaetoceros sp. and *Thalassiosira* sp. were isolated from Five Cowery creek, Lagos State and maintained at the Algae Culture Laboratory of Aquaculture Department, Nigerian Institute for Oceanography and Marine Research, Lagos State. The pure cultures of *Chaetoceros* sp. and

Thalassiosira sp. were sub-cultured every week in Guilliard F culture medium (Guillard and Ryther, 1969) at 25ppt salinity, to maintain pure and healthy stock culture. Prior to the growth experiments, cultures of *Chaetoceros* sp. and *Thalassiosira* sp. were pre-adapted to the different test salinities for 3 generations.

Media preparation and Experimental design

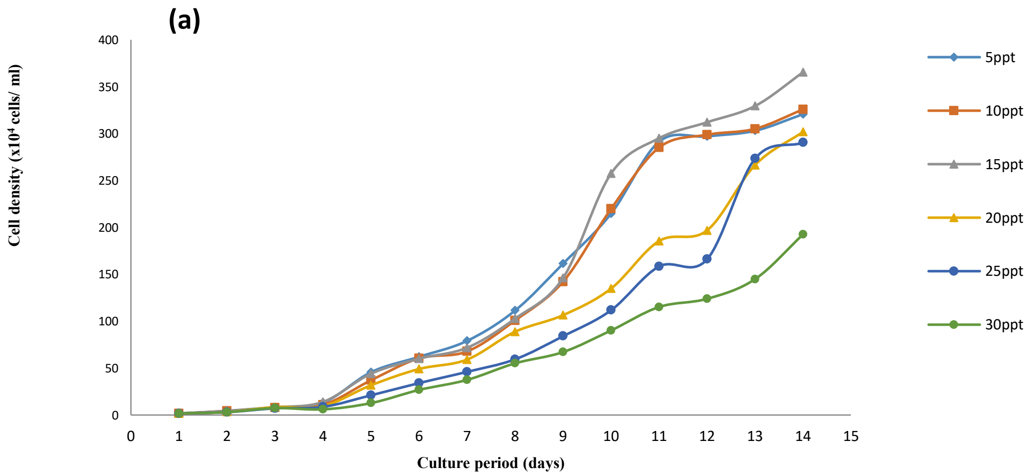
The culture media used was F medium (Guillard and Ryther, 1969). The salinity concentrations were 5, 10, 15, 20, 25 and 30ppt. Salinities lower than 30ppt was adjusted by the addition of distilled water. Each treatment was performed in triplicate. Cultures were grown in 250ml Erlenmeyer flasks containing 100ml of filtered growth medium, autoclaved for 15 min at 121°C. Inoculated flasks were incubated in the laboratory for 14 days at 24 ± 2°C temperature, 14:10 (light:dark) photoperiod with illumination from fluorescent "cool white" bulbs, with light intensity of 1000 lux. Light intensity was measured with Extech light meter, model 407026. The pH of 8 was adjusted using hydrochloric acid or sodium hydroxide solution (Guillard and Ryther, 1969). The initial cell density was $2x10^4$ cells/mL for each treatment. Growth in terms of cell density was measured every 24 hours for 14 days. Cells counts were performed every 24 h interval with a Neubauer haemocytometer (0.1 mm depth) under a compound light microscope equipped with a microscope digital camera (Scope Photo, DCM35E) to determine the maximum cell density, expressed as cells/ ml (Andersen, 2005). Specific growth rate (μ) day $^{-1}$ was calculated according to Garcia *et al.* (2007):

$$\mu = (\text{In } N_1 - \ln N_0) / t_1 - t_0$$

where N_0 and N_1 (cells ml^{-1}) are cell density values at the beginning (t_0) and the end (t_1) of the time interval between inoculation and maximum cell density, respectively. Statistical analysis included one-way analysis of variance (ANOVA) with significance level of $\alpha = 0.05$, for maximum cell density, specific growth rate.

RESULTS AND DISCUSSION

Average cell density and growth rates of *Chaetoceros* sp. varied significantly ($P<0.05$) amongst cultures of different salinities. In the 14-day culture period, cultures of *Chaetoceros* sp. at 15ppt recorded the highest cell density and growth rate of 366 ± 27.6 x 10^4 cells/ mL and 0.372 ± 0.005μ day^{-1} respectively at day 14. This was followed by cultures of 10ppt with average cell density of 326 ± 10.4 x 10^4 cells/ mL and growth rate of 0.364 ± 0.002μ day^{-1}. Whereas the least growth rate was recorded at 30ppt with growth rate of 0.326 ± 0.002μ day^{-1} and cell density of 193 x 10^4 cells/ mL at day 14 (Figure 1a and 2a). Meanwhile, *Thalassiosira* sp. also recorded the highest cell density and growth rate at 15ppt with 247 ± 27.6 x 10^4 cells/ mL and 0.344 ± 0.004μ day^{-1} respectively at day 14. This was followed by cultures at 20ppt with average cell density of 192 ± 10.4 x 10^4 cells/ mL and growth rate of 0.326 ± 0.005μ day^{-1} (Figure 1b and 2a). However, there was no growth at 5ppt. Cell density and growth of *Chaetoceros* sp. and *Thalassiosira* sp. increased from a lower salinity to the optimum salinity (15ppt), but decreased as salinity increased from 15ppt to 30ppt (Figure 2b).



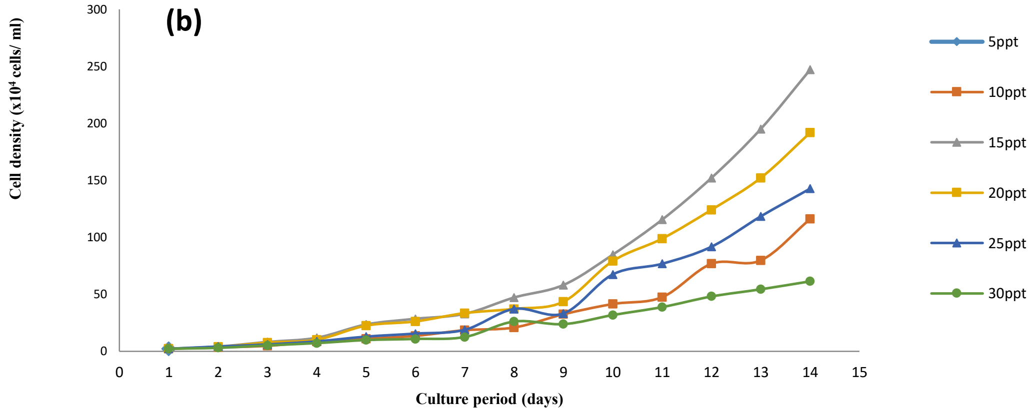
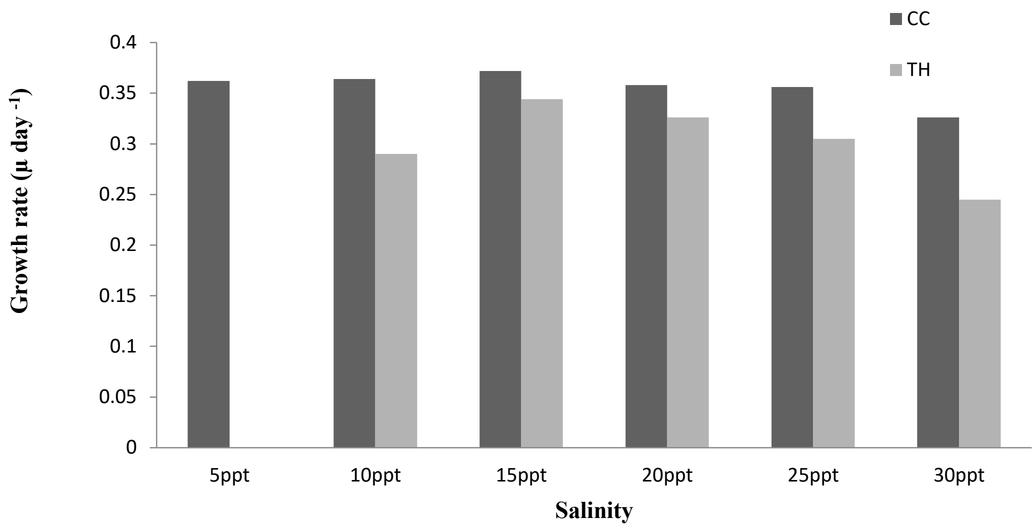


Figure 1(a, b): Mean cell densities (n=3) of (a) *Chaetoceros* sp. and (b) *Thalassiosira* sp. under different salinities during the 14-days culture period.



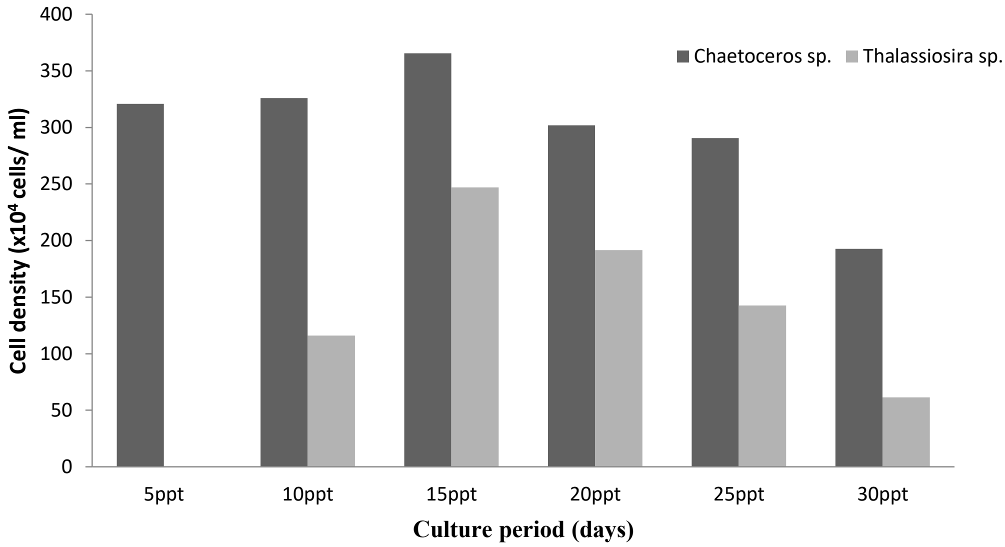


Figure 2(a, b): (a) Growth rates of Chaetoceros sp. and Thalassiosira sp. in response to different salinities. Vertical bars are means ±SD (n=3); (b) Chaetoceros sp. and (b) Thalassiosira sp. under different salinities

Growth of microalgae is dependent on several environmental conditions such as salinity which can be very important for both brackish and marine water microalgae (Araujo and Garcia, 2006; Banerjee *et al.*, 2011; Garcia *et al*., 2012). The effects of these factors vary from one species to another (Adenan *et al*., 2013). In this study, there were significant differences ($p<0.05$) in the growth rate and cell density amongst different salinities, indicating that salinity is an important factor to be considered when culturing *Chaetoceros* sp. and *Thalassiosira* sp. The high cell density and growth rates of *Chaetoceros* sp. in all treatments shows that it can tolerate a wide range of salinities, showing good growth from a very low salinity of 5ppt to near marine salinity of 30ppt. This is in agreement with previous works (Zhang *et al.*, 1999; Adenan *et al.*, 2013). Growth rate of microalgae is also dependent on species origin (Banerjee *et al.*, 2011; Adenan *et al*., 2013). This explains why higher values of growth rates of *Chaetoceros* sp. in this study was recorded at low salinities, contrary to increased growth rates with increasing salinity recorded in other studies (Adenan *et al*., 2013; Ebrahimi and Salazaden, 2016). However, *Thalassiosira* sp. showed a narrow range of tolerance for salinity. Cultures of *Thalassiosira* sp. only recorded high cell density and good growth at salinities between 10 – 25ppt, with the optimum salinity for growth at 15ppt. Growth rate declined with increasing salinity, from 20 - 30ppt. This is in agreement with the report of Garcia *et al*. (2012) on effect of salinity on *T. weissflogii*, however the optimal salinity was recorded at 25ppt.

CONCLUSION

The study determined the optimum salinity for both *Chaetoceros* sp. and *Thalassiosira* sp. isolated from the coastal water of Lagos, Nigeria. These microalgae can tolerate wide variation in salinity from 5- 30ppt, although a low salinity of 15ppt induced optimum growth. While *Chaetoceros* sp. had good growth at 5ppt, no growth was recorded for *Thalassiosira* sp. The study also revealed that growth of *Chaetoceros* sp. and *Thalassiosira* sp. increased from a lower salinity to the optimum salinity (15ppt), but decreased as salinity increased from 15ppt to 30ppt. Therefore, it can be concluded that both *Chaetoceros* sp. and *Thalassiosira* sp. had different ranges of tolerance and adaptability to environmental changes. The study also shows that both microalgae can be considered as suitable species for large outdoor culture due to their high growth rates.

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Amino acid profile of imported *Merluccius merluccius* and *Trachurus trachurus* consumed in Ilorin, Kwara State

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ABSTRACT
Fish has been widely used as an excellent source of animal protein and other nutrients, with a wide variety of species eaten in various parts of the world. This study examined the amino acid content of two imported fish species, Merluccius merluccius (European Hake) commonly known as Panla and Trachurus trachurus (Horse Mackerel commonly known as Kote) consumed in Ilorin, Nigeria. Results of the comparative study showed the two fish species contained eleven (11) of the twenty (20) amino acids needed by most biological systems. T. trachurus had amino acids (10) identified amino acids (with one unidentified one) as compared with M. merluccius which had only 5 identified amino acids (asides 2 unidentified ones). Concentrations of the various amino acids in M. merluccius ranged from 0.039-40.09mg/100g of protein with Alanine (40.09mg/100g protein) as its most abundant amino acid followed by Glyine (32.65mg/100g protein) and Leucine (26.90mg/100g protein). T. trachurus fish had an amino acid concentration range of 0.022 - 67.59mg/100g protein with Glycine (67.59mg/100g protein) as its most abundant amino acid, followed by Isoleucine (24.12mg/100g protein) and Leucine (3.02mg/100g protein). Tryrosine (0.0442mg/100g protein) and Methionine (0.02mg/100g protein). had the least concentrations in M. merluccius and T. trachurus fishes respectively. Since T. trachurus had appreciable amounts of the various amino acids, it could be said to be the more preferable.
Keywords: Imported fish, Amino Acids, Frozen, Merluccius merluccius, Trachurus trachurus

INTRODUCTION
Fish is a healthy food with high nutritional value that makes it extremely important for human chain food (Maktoof *et al*., 2020). An increase in the world's populace now consume fish based on its nutritional benefits and in recent the health benefits associated with it (Olopade, 2015). Its high protein content, low saturated fat and omega 3 fatty acids are known to support good health. In addition, fish oil is excellent source of vitamins A, D, E and K which are needed for their key roles in human health and metabolism (Kinsella,1987). Reports have it that fish consumption help consumers maintain good health while protecting them against diverse health conditions such as coronary heart disease, cancer, inflammatory disease and elevated blood pressure since fish contains omega-3 highly unsaturated fatty acids (HUFA), eicosapentaenoic (EPA), docosahexaenoic (DHA) acids, and amino acids (Abraha *et al*., 2018). Amino acids are the fundamental constituents of body proteins and serve as substrates for protein synthesis (Church *et al*.,2020). As important biomolecules, they are useful as precursors for the production of a wide range of biologically essential substances such as nucleotides, peptide hormones, and neurotransmitters. Essential amino acids are the amino acids that are not synthesized in the body, thus it is necessary to take them in diet (Akram *et al*.,2011). They include Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine,

Threonine, Tryptophan and Valine. Non-essential amino acids are the ones that are synthesized in the body and therefore it is not necessary to take them in diet. Non-essential amino acids include Norleucine, Proline, Arginine, Tyrosine, Cystine, Alanine, Glutamic acid, Serine and Aspartic acid. In Nigeria, the demand for fishery products has grown greatly resulting in the acute shortage of fresh fish even as Nigeria spends N100 billion on frozen fish importation annually. And the current fish demand consumption in Nigeria is more than 2.66million tons yearly, while the present importation rate exceeds 750,000 metric tons (Oota, 2012). 70% of Nigeria's sea food is supplied by the European Union while US provides about 1% (Nezeka, 2003). This has brought about the wide acceptance of frozen fish as various types are in great demand by Nigerian populace as a relatively cheaper source of animal protein (Arannilewa *et al*., 2005). Amongst major fish species imported are *Merluccius merluccius* (European Hake) and *Trachurus trachurus* (Atlantic horse Mackerel). *Merluccius merluccius* (European Hake) is a marine fish, with an elongate body, possessing a large head and large jaws on which are set a number of large curved teeth (Alwyne,1992). It occurs in the eastern Atlantic from Norway, Iceland and also in the Mediterranean Sea. It feeds mainly on fish (such cod fishes, anchovies, herring) and squids, while its young ones feed on crustaceans. This demersal fish is vulnerable to overfishing since it has a slow growth, with the females attaining sexual maturity at a relatively old age (Fernandes *et al*., 2016). *Trachurus trachurus* (Horse mackerel) is a marine fish species found in the Mediterranean Sea, and the Eastern Atlantic, Norway to South Africa. This pelagic fish feeds on fishes, crustaceans and cephalopods (Froese and Daniels, 2013). Given the importance of both marine fishes to consumers as a relatively cheaper source of animal protein, there is a need for information on the amino acid compositions of both fish species.

MATERIALS AND METHODS

Fresh samples of European Hake (*M. merluccius)* and Altantic Horse Mackerel (*T. trachurus)* fish species were purchased from retail cold rooms at Olorunsogo and Challenge axis respectively in Ilorin town. The protein profiling protocol was carried out as described by Saleethong *et al*. (2016). Fish samples were ground on ice while proteins were extracted using extraction buffer [30.0 mmol/L Tris-HCl (pH 8.0), 0.1 mmol/L EDTA, 6.0 mmol/L ascorbic acid, 5.0 mmol/L MgCl2, 1% polyvinyl pyrrolidone, 0.02% ù-mercaptoethanol, 1% glycerol]. The homogenate will be vortexed and incubated at -20 °C for 40 min, centrifuged at 13 000 r/min for 1 hour. Supernatant was collected and contaminating substances were removed by 2D-clean up kit. The protein sample was transferred to a microcentrifuge and centrifuged at 13 000 r/min for 5 min. The protein mixture was mixed by vortexing and incubated on ice (4–5 °C) for 15 min. The 300 µL co-precipitant was added to the reaction mixture and centrifuged at 13 000 r/min for 5 min while the supernatant was removed and discarded using a pipette tip. Distilled water was added on the top of the layer pellet. The tube was vortexed for several seconds. The pellet was washed with 1 mL wash buffer and 5 µL wash additive buffer at -20 °C for at least 1 h. The supernatant was then discarded, while the pellet was dried and solubilized with rehydration buffer [8.0 mol/L urea, 2% 3-[(3cholamidopropyl)- dimethylammonio]-1-propane slfonate (CHAPS), 0.002% bromophenol blue, 2.0 mmol/L dithiothreitol, 0.8% immobiline pH gradient gels (IPG) buffer]. The protein concentration was determined by Bradford (1976) assay. The samples were hydrolyzed in 6 M HCl under vacuum at 105°C for 24h. The amino acid analyses were done by reversed-phase LC with pre-column derivatization with AccQ-fluor reagent, as indicated by manufacturer (Waters AccQ-tag Chemistry Package, Instruction Manual Waters Corp) (Water Corporation, Milford, MA). Model hitachi's L-8900.

RESULTS AND DISCUSSION

The amino acid profile of the two marine fishes *M. merluccius* (European Hake) and *T. trachurus* (Horse Mackerel) examined in this study are shown in Tables 1and 2 respectively.

Table 1: Amino acid profile of *Merluccius merluccius* (European Hake)

Amino Acid	Concentration(mg/100g)
1. Alanine	40.0925
2. Glycine	32.6514
3. Leucine	26.9032
4. Lysine	0.1658
5. Tyrosine	0.0442
6. Unidentified	0.1041
7. Unidentified	0.0388

Table 2: Amino acid profile of *Trachurus trachurus* (Horse Mackerel)

Amino Acid	Concentration(mg/100g)
Glycine	67.5901
Isoleucine	24.1240
Leucine	3.0196
Threonine	1.7671
Serine	1.2694
Lysine	1.0488
Cysteine	0.9466
Unidentified	0.1330
Tryptophan	0.0556
Alanine	0.0235
Methionine	0.0224

Results of the study, showed the presence of eleven (11) amino acids in both fish samples. In *M. merluccius*, amino acid values ranged from 0.039-40.09mg/100g protein with the most abundant amino acid being Alanine (40.09mg/100g protein), followed by Glycine 32.65mg/100g protein and Leucine (26.90mg/100g protein).with the least one being Tyrosine (0.04/100g protein). *Trachurus trachurus* fish sample had amino acid values that ranged from 0.022-67.59mg/100gprotein. Glycine (67.59mg/100g protein) was its most abundant amino acid, followed by Isoleucine (24.12mg/100g protein) and Leucine (3.019mg/100g protein), with the least being Methionine (0.022mg/100g protein). Large amounts of Leucine in both marine fish species support the findings of Mohanty *et al*., (2014) who reported leucine in large amounts in marine species. The protein quality of a food can be determined by assessing the amino acids content of such protein food and thus examining the amino acid constituents of foods serves as a basis for establishing their potential nutritive value (Mohanty *et al*., 2014). In the present study, a total of 11 amino acids were reported. This consists of 6 essential amino acids (Leucine, Isoleucine, Lysine, Threonine, Tryptophan and Methionine), 2 non-essential amino acids (Alanine and Serine) and 3 conditionally essential amino acids (Glycine, Cysteine and Tyrosine). However, some amino acids were not detected in the two fish samples. This can be explained either by acid hydrolysis or oxidation (Gam *et al*, 2005, Diniz *et al*., 2013, James and Kumar, 2013) or by the mere absence of these amino acids. Amino acids are essential in the healing processes, thus a deficiency in any the essential amino acids may hinder the process of healing (Mat-Jis *et al*.,1994; Osibona *et al*.,2009). Leucine helps to promote the healing of bones, skin and muscle tissue. Isoleucine is required for the formation of haemoglobin which is essential for the transport of oxygen, stabilization and regulation of blood sugar and energy. Glycine, a major component of human skin collagen, alongside other essential amino acids such as alanine form a polypeptide that promotes regrowth and tissue healing (Heiman,1982; Witte *et al*., 2002).

CONCLUSION

The results of the study clearly indicate nutritional potential of the two species for human consumption considering their amino acid content. Since T. trachurus had appreciable amounts of the various amino acids when compared with *M. merluccius*, it could be said to be the more preferable from nutritional point of view.

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Trawling Vessels Characteristics and Fish Landings in Nigeria: An Empirical Investigation

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ABSTRACT
The study examined trawling vessels characteristics and their influence on fish landings in Nigeria. The list of licensed vessels operating in Nigeria was obtained from Federal Department of Fisheries from which 60 trawling vessels were randomly selected. Multiple regression analysis was used to test the relationship between vessels characteristics and catch per vessel. Results from the study show that size of vessel, captain's experience, educational qualification of captain and size of crew had a positive and significant effect on catch per vessel. Age of vessel had an inverse relationship with catch per vessel and was statistically significant at the 5 per cent level showing vessels catch less fish as they get older. The study recommends setting up a special fund to enable investors purchase new vessels at low interest rates. Maritime institutions should be established for training highly skilled captains of vessels.

INTRODUCTION
The emergence of trawling as a technologically efficient method in the exploitation of marine fishery resources is well recognized and has helped in no small way in increasing domestic fish production in Nigeria. However, Nigeria is still unable to produce enough fish to meet domestic fish demand which at the present stands at 3.97 metric tonnes. The shortfall in domestic fish production is augmented through importation. As at 2015, Nigeria imported 806,000 metric tonnes of fish valued at $1,126,428,414.41 (FDF, 2016). Massive importation of fish places Nigeria in an unfavourable balance of payment position. Massive investment in trawling vessels can go a long way in boosting domestic fish supplies by reducing reliance on fish imports thereby saving hard earned foreign exchange which can be used to develop other critical sectors of the economy. Trawling as a business is set up to make profit. The extent to which a trawling vessel is able to make profit is dependent on catch per vessel. Earnings of a trawling vessel is determined by the revenue generated from fish landings. The catch per vessel which is influenced by some factors together with prices of the fishery products landed by a vessel determine its revenue. This study was conceived to investigate the trawling vessel characteristics and fishing landing in Nigeria.

METHODOLOGY
All licensed trawling vessels operating in Nigeria, both Nigerian and foreign flagged registered vessels were involved in this study. The list of licensed vessels operating in Nigeria was obtained from Federal Department of Fisheries (FDF) from which 60 trawling vessels were randomly selected. A total of 60 copies of questionnaire were administered to the captains of these vessels. Hence n=60. Data used in this study are broad averages obtained from small vessels, large vessels, fishing, shrimping, Nigerian and foreign owned vessels.

Measurement of Variables
(i) Age of vessel is measured in number of years since the purchase of a new vessel
(ii) Size of vessel or Length Overall (LOA) is measured in metres.

(iii) Size of crew is measured by the number of people on board a vessel.
(iv) Educational qualification of captain is measured by the number of years spent in school.
(v) Captains experience in trawling is measured by number of years spent on the job.
(vii) Catch per vessel/Quantity of fish is measured per metric tonne (1000kg).

Method of Data Analysis and Models

Data collected was subjected to thorough analysis and relied essentially on the quantification of explicitly defined variables. Multiple regression analysis was used to test the relationship between the characteristics of vessels such as size of vessel (SOV), Age of vessel (AOV), captain's experience in trawling (CEX)). Educational qualification of captain (EQC), size of crew (SOC), and average catch per vessel (CPV). The above functional relationship can be stated as follows:

$$CPV=f\ (SOV, AOV, CEX, EQC, SOV, ei) \qquad (1)$$

Where,
CPV = Average catch per vessel
SOV = Size of vessel
AOV = Age of Vessel
CEX = Captain's experience in trawling
EQC = Educational qualification of captain
SOC = Size of crew
ei = Error term

A multiple regression model with average catch per vessel as dependent variable and size of vessel, age of vessel, captain's experience, educational qualification of captain and size of crew as independent variables was estimated. Data was fitted with four functional forms of the regression model, namely linear, exponential, semi-log and double log. The one that gave the best fit in terms of standard error, value of co-efficient of multiple determination, number of significant variables and other econometric criteria was chosen as the lead equation. The functional forms are given as:

Linear:

$$CPV= \beta_0+ \beta_1SOV+ \beta_2AOV+ \beta_3CEX+ \beta_4EQC+ \beta_5SOC+ei \qquad (2)$$

Exponential:

$$\log CPV= \beta_0+ \beta_1SOV+ \beta_2AOV+ \beta_3CEX+ \beta_4EQC+ \beta_5SOC+ei \qquad (3)$$

Semi-log:

$$CPV=\beta_0+\beta_1\log SOV+\beta_2\log AOV+\beta_3\log CEX+\beta_4\log EQC+\beta_5\log SOC+e \qquad (4)$$

Double Log:

$$\log CPV= \beta_0+ \beta_1\log SOV+ \beta_2\log AOV+ \beta_3\log CEX+ \beta_4\log EQC+\beta_5\log SOC+e \qquad (5)$$

RESULTS AND DISCUSSION

Characteristics of Trawling Vessels

Table 1 shows that majority (35%) of the trawling vessels in Nigeria are old vessels. This is followed by those vessels aged between 5-8 years. Older vessels often breakdown during operations, thereby, eliciting high repair and maintenance costs. It is risky taking such vessels for long fishing distances. Trawling vessels aged above 20 years constitute the least with 3.3%. These type of vessels could limit access to some fishing grounds and hence fish landings. New vessels are few as they constitute only 13.3%. These type of vessels are equipped with modern fish detection technology and sophisticated gears hence are used for long fishing distances. Fish landings from newer vessels are usually higher than that from older vessels. This result underscores the need to replace aging vessels with modern newer ones. It can be observed that smaller vessels constitute the highest trawling vessels with 68.34%. This could be due to the fact that larger vessels are much more expensive hence investor's recourse to lower price smaller sized trawling vessels. Smaller vessels are limited in terms of fishing capacity and power relative to larger ones. Larger vessels are few as they constitute 31.7% of the trawling vessels surveyed. Larger vessels have higher fishing capacity, are fitted with bigger fishing gears and storage holds relative to smaller vessels. This implies that larger vessels are able to catch more fish, generate higher revenue and hence more profit. Table 3 shows captains experience in trawling. Experience plays a critical role in the operation and management of trawling vessels. This is because the cognate experience of a captain can play out in his ability to catch more fish based on exposure, skill and practical knowledge acquired on the job over a period of time. The Captains with experience between 1-10 years constitute 40%. These groups of Captains are relatively new on the job and are acquiring experience with time. Experienced Captains constitute the majority with 60%. This is made up of Captains who acquired more dexterity on the job over many years and are thereby placed in a vantage position to perform better. Years spent in school by a Captain go a long way to affect his skill and competence. Those who spent between 1-8 years in school were only 20%. These people may be limited in terms of skill, competence which may affect their productivity. Those who spent between 9-12 years were the highest with 61%. Those who spent above 12 years in school were 18.3%. In this group are those who are well equipped with both intellectual and technical ability to able to land more fish. According to Kasika (2015), the higher the education level, the more are the effects of education and skill on job performance. A Captains ability to understand and use advanced fish detection technology is determined by the level of their education. Table 5 shows that majority (68%) of the trawling vessels surveyed had between 4-6 crew members. Those are mainly smaller vessels that have limited capacity. Those with crew size between 7-9 were 10% while those with crew size above 9 were 21.7%. Vessels with higher size of crew were mainly large vessels. Crew members in a vessel are required to perform various tasks from sorting of fish, packing of fish etc.

Influence of Characteristics of Trawlers on Average Catch per Vessel

Determinants of Catch per Vessel: Out of the four functional forms fitted with the data, result of the exponential form gave the best output in terms of economic, statistical and econometric criteria and was chosen as the lead equation. The result is presented in Table 6. The results show that 92.7 per cent of the variation in the dependent variable (catch per vessel) is accounted for by the independent variables i.e. size of vessel, age of vessel, captain's experience, educational qualification of captain and size of crew showing that the R^2 is highly significant. The results indicated that all the predictors (size of vessel, age of vessel, educational qualification of captain, captain's experience in trawling and size of crew) had the expected sign *a priori*. However, three of the predictors (SOV, AOV and EQC) were statistically significant at the 5% level of probability. This implies that these explanatory variables are indeed the major factors determining catch per vessels operating in Nigeria. Size of vessel with a beta coefficient of .654 had a positive and significant effect on catch per vessel. This implies that the larger the vessel the more the catch. This could be attributed to the fact that larger vessels by their capacity have higher fishing power relative to smaller trawling vessels. Effiong *et al,* (2017) linked higher fishing power to larger trawling vessels. It is expected that bigger trawling vessels are fitted with bigger fishing gears and storage holds relative to smaller vessels *ceteris paribus*. The corollary of this result is that with a higher volume of catch, larger vessels will generate more revenue and hence profit. The finding agrees with Chifamba (1995), Sumaila *et al*,(2002) on small versus large scale fishing operations and Effiong, *et al,* (2017) on financial performance of some classes of trawling vessels. Age of vessel had an inverse relationship with catch per vessel and was statistically significant at the 5 per cent level. This finding shows that vessels catch less fish/shrimps as they get older. Effiong *et al,* (2016c) reported that old vessels are known to attract higher repair and maintenance costs and may not be used for long fishing journeys as they break down more often at sea. This finding strongly suggests the need to establish a fund to help Nigerians buy new trawling vessels at minimal interest rates to replace aging vessels. This will help to eliminate drop in catch per vessel and as well serve to keep vessel operators in business. Educational qualification of captain had a positive influence on catch per vessel and was statistically significant. This implies that Captain's with higher academic and professional qualifications were able to catch more fish than their less educated counterparts. Education has the propensity to improve the intellectual capacity of an individual and equip him with skill to enhance performance. This calls for the establishment of maritime institutions within Nigeria for training of highly skilled manpower in the industrial fishery sub-sector. Essien (1982) reported that the level of fish landing in a vessel depends on the quality of the Captain and Engineer which can be attributed to the type of education acquired. This is the type of education which increases the productivity of the individual receiving it by making him acquire new skills and techniques. According to Kasika (2015) the higher the education level, the more are the effect of education and skill on job performance. As such people's ability to understand and use advanced technology is determined by the level of their education. Educated workers tend to be more responsive in receiving instructions and doing new tasks and easily adopt new technology which increases their ability to innovate and improve job performance. Captain's experience had a positive effect on catch per vessel but was not statistically significant at 5% level. This implies that the more experience a captain acquires on the job, the more it places him in a vantage position to catch more fish. According to Effiong (1998), the number of years an individual had spent in a job gives an indication of the practical knowledge and skill acquired over the years and which makes it possible to observe an improvement in performance. Although experience may not count in terms of risk taking, it may have some considerable influence on efficiency. Size of Crew also had a positive influence on catch per vessel but not statistically significant at the 5% level of probability. This implies that more hands are required in a trawling vessel that catches more fish. But the mere engagement of more crew members in a vessel cannot necessarily bring about an increase in the volume of catch per vessel as it is influenced by other factors. The F-value of the model is statistically significant at the 5 per cent level and suggests that the joint influence of all the explanatory variables on the catch per vessel is strong

CONCLUSION

Catch per trawling vessel operating in Nigeria's territorial waters was influenced by size of vessel, age of vessel and educational qualification of captain. Since fish is a major source of animal protein, there is need to boost local fish production from the marine capture fishery sub sector to domestic meet fish demand. This will go a long way to reduce fish imports which as at 2015 stood at 806,000 metric tonnes valued at $1126428414.41 (FDF, 2016). There is an urgent need to set up a special fund to enable indigenous investors to acquire new and large trawling vessels equipped with modern fish capture technology at minimal interest rates. Maritime training institutions should be established within Nigeria for training of highly skilled manpower for the industrial fishery sub-sector.

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Table 1: Distribution of Trawling Vessels According to Age

Age of Vessel	Frequency	Percentage
1-4	8	13.3
5-8	17	28.3
9-12	21	35
13-16	9	15
17-20	3	5
Above 20	2	3.3
Total	60	100

Source; Field Survey, 2020

Table 2: Distribution of Trawling Vessels According to Size

Size of Vessel (LOA) metres	Frequency	Percentage
10-12	30	50
13-14	7	11.6
15-17	4	6.67
18-20	16	26.7
Above 20	3	5
Total	60	100

Source; Field Survey, 2020

Table 3: Captain's Experience in Trawling

Years of Experience of Captain	Frequency	Percentage
1-5	15	25
6-10	9	15
11-15	16	26.7
16-20	11	18.3
Above 20	9	15
Total	60	100

Source; Field Survey, 2020

Table 4: Educational Qualification of Captain

Years Spent in School	Frequency	Percentage
1-4	0	0
5-8	12	20
9-12	11	18.3
Above 12	37	61.7
Total	60	100

Source; Field Survey, 2020

Table 5: Crew Size of Trawling Vessels

Size of Crew	Frequency	Percentage
1-3	0	0
4-6	41	68.3
7-9	6	10
Above 9	13	21.7
Total	60	100

Source; Field Survey, 2020

Table 6: Estimated Determinants of Catch per Vessel

Parameter	**Coefficient**	**T-ratio**	**Significant**
Constant term	1,280	18.571	.000
SOV	.654	12.372**	.000
AOV	-.147	-3.737**	.000
CEX	.068	1.607	.114
EQC	.284	5.468**	.000
SOC	.013	.312	.756
R2	.927		
R2 Adjusted	.920		
F-statistic	136.398		
Durbin Watson	1.908		

Source: Computed from survey data 2020
*Note: **= Significant at 5% level of probability*

Fish Production Practices and Constraints to Fish Farming in Ibi Local Government Area, Taraba State, Nigeria

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25-29 Oct., 2021

ABSTRACT

This study was carried out to determine the fish production practices and constraints to fish farming in Ibi Local Government Area, Taraba State, Nigeria. A sampling frame was drawn from the list of 740 fish farmers registered with the Department of Fisheries and Forestry of Ibi Local Government Area, Taraba State. A multistage stratified design was used for selecting the respondents for the study. The first stage involved stratification of the Local Government into Districts (Sarkin Kudu, Dampar and Ibi). The second stage was selection based on the prevalence of fish farmers in the districts. The third stage involved random selection of 30% fish farmers from each district to obtain a sample size of 222 respondents. Data from the study were collected through structured questionnaire and scheduled interview administered to the respondents. Data were analyzed using descriptive statistics and inferential statistics. Descriptive statistics used were frequency distribution and percentages while inferential statistics was non parametric test at coefficient of 0.116 and p-value of < 0.01. Results showed that concrete tanks were mostly used by fish farmers (35.0%) and sourced fingerlings for stocking through personal hatchery (34.9%), practiced poly culture (58.90%) and 56.50% monoculture techniques. The culture system was predominantly intensive (90.0%), Clarias Spp were cultured (68.9%) and fed on imported floating feed (72.0%). The major constraints to fish production are inadequate infrastructure, high cost of inputs; poor quality of fish seed and poor extension services on fish farming. The study recommends that the Government should grant import duty waiver on fish farming inputs and as well monitor the implementation so that the policy can benefit intending and existing fish farmers. More extension agents should be employed and well equipped to provide necessary training and other services needed by fish farmers.

Keywords: Constraints, culture, fish farming, fish production

INTRODUCTION

World fish farming production increased at an annual rate of 6.6% since 1995. It rose to 106 million tonnes in 2015 of which aquatic animals meant for human consumption were 76.6 million tonnes. The positive progression in fish production showed significant role of fish farming in contributing to food, security, poverty alleviation and economic development of the poor (FAO, 2017). Fish farming is regarded as a key agricultural and food-producing sector throughout the world. The promoters argue, while depleted fish catches can be re-filled, that aquaculture can meet the food security needs of millions of people in developing countries who will benefit from relatively cheap protein (Hagar, 2014; Wally, 2016). The aquaculture industry, which accounts for over 50 percent of global fish production, is the fastest-growing food-producing sector. About 424 aquatic species are cultivated globally, benefiting millions through the provision of nutrition, food security and sustainable lively-hood, and poverty reduction (Galappaththi *et al,* 2020). In Nigeria, aquaculture development has been driven by social and economic objectives, such as nutrition improvement in rural areas, generation of supplementary income, diversification of income activities, and the creation of employment (Anthony & Richard, 2016). The contribution of aquaculture to fisheries industry in Nigeria is an indication of growth in fish production through aquaculture activities as a result of global decline in supply of ocean fisheries associated with pressure on overfishing, habitat destruction and environmental pollutions (Adedeji *et al,* 2011).With an estimated annual *per caput* fish consumption of 13.3kg in 2013, fish represents an important dietary component and one of the few sources of animal protein available to 180 million Nigerians (Omitogun and Orisasona, 2018). No matter how well constructed a pond is, without adequate management the farmer cannot make any substantial profit. If fish farming is therefore, to be practiced as a profitable business venture, then proper farming practices of fish farm must be ensured (Omitoyin, 2013). Fish farming like any other area of agriculture is constrained by factors which hinder maximum productivity for meeting the protein demand and income generation of the populace. This study was carried out to determine the fish production practices and constraints to fish farming in the study area. Specifically, the objectives of the study are to :(i) identify fish rearing facilities (ii) fish farming systems in the study area (iii) ascertain constraints encountered during fish productions practices by the fish farmers.

METHODOLOGY

Ibi Local Government Area is one of the 16 Local Governments in Taraba State. It covers the total land area of 2,672km^2 and extends between latitude 8^0, 19' north of the equator and 9^0, 51' east of the Greenwich meridian (Taraba State Government, 2015). The town is located at the south bank of the Benue River, opposite the influx of much smaller Shemankar river. Both the Taraba River and the Donga River flow into the Benue within the Local Government Area. Ibi Local Government Area has two seasons; the rainy season which extend from April - October, and the dry season which last for 5 months extending from November - March. The annual rainfall ranges between 1058 mm and 1300 mm with the temperature range of 28^{0}C – 39^{o}C. A sampling frame was drawn from the list of 740 fish farmers registered with the Department of Fisheries and Forestry of Ibi Local Government Area, Taraba State. A multistage stratified design was used for selecting the respondents for the study. The first stage involved stratification of the Local Government into Districts (Sarkin Kudu, Dampar and Ibi). The second stage was selected based on the prevalence of fish farmers in the districts. The third stage involved random selection of thirty (30%) fish farmers from each district with a population size of Ibi district (300), Dampar district (230) and Sarkin- kudu (210) to obtain a sample size of 222 respondents. Data obtained from the study were collected through scheduled interview and structured questionnaire administered to the respondents. (Ogunremi *et, al.* 2019). Data obtained were analyzed using descriptive statistics - frequency distribution and percentages while constraints to fish production practices were measured with 5-point Likert-type scale of “very severe” (5), “severe” (4), “ not severe” (3), “ not a constraint” (2), “ undecided” (1) respectively and ranking. Kandell (non-parametric) test was used to test the hypothesis from the responses obtained which were ranked from 1 – 5 to represent undecided to very severe in that order. The Kandell coefficient of 0.116 and p-value of < 0.01 were recorded for all the constraints identified in the study.

RESULTS AND DISCUSSION

Table 1 indicated that about 58.11% of the respondents depended directly on either stream or river as their major water source for fish culture, only 23.87% used borehole while 18.2% depended on deep well. The use of stream/river was due to the geographical location of the studied area. River/stream are the cheapest sources of water for fish culture the only challenge is that the quality should be tested and if need be could be treated after impounding the pond before stocking with fish. Source and quantity of water available are most important factors to be considered when selecting a site for fish farming. The quantity of water needed for commercial fish farming varies with the production method employed, type of aquaculture chosen, scale of operation, and species cultured. Aniebone *et al,* (2018) reported that poor water quality can affect the production, growth, or quality of fish products by contaminating their flavour or causing bioaccumulation due to high concentrations of certain elements or toxic substances.

Table 1: sources of water for fish culture

Sources of water	Frequency	Percentage
River/Stream	129	58.11
Bore hole	53	23.87
Deep well	40	18.02
Total	222	100

Source: Field survey 2018

Personal hatcheries (34.90%), private hatcheries /commercial (31.50%) and 25% sourced fingerlings from Government owned farms as indicated in Fig. 1. Only (8.6%) of the fish farmers obtained their fingerlings from the wild. This was an indication that some respondents have acquired the skill required for fish breeding. The fact is that the fingerlings produced by fish farmers are likely to be of high genetic quality in terms of early maturity, high feed conversion rate and resistant to diseases compared to those sourced from the wild. Government farms and some commercial hatcheries are equally dependable as fingerling sources. Success in intensive aquaculture depends on the quality of fish seeds since it determines the growth of the fish and to some extent, the proliferation of bacteria in the system (Jamabo *et al,* 2019).

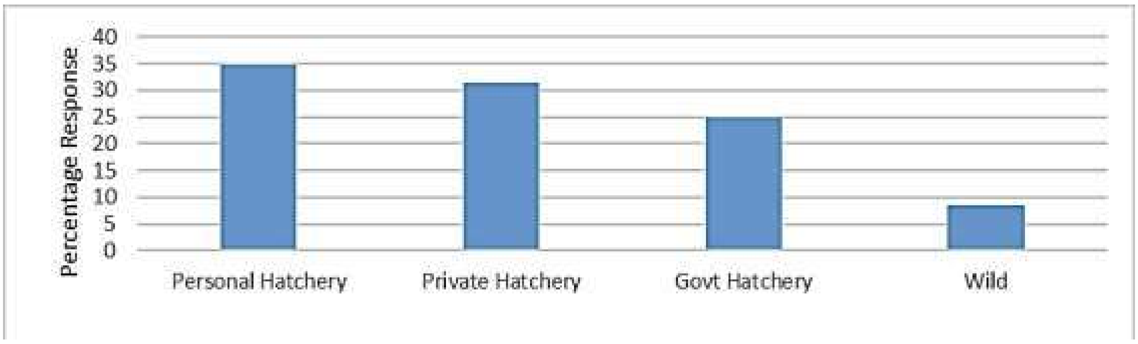

Figure 1: Sources of Fingerlings

Fish rearing facilities

The result in Figure 2 showed that 35% reared fish in concrete tanks, 31% in cages while 5% reared fish in other facilities. The advantage of concrete tanks like any other receptacles is that it can be easily managed although capital outlay is higher compared to earthen pond of same size. Nwachukwu and Onuegbu (2005) reported that most fish farmers in Nigeria operated small-scale farms ranging from homestead concrete ponds to small earthen ponds. Use of concrete tanks for fish culture is a new trend apart from the old method of earthen pond through soil excavation, land available can be maximized to the fullest. However, concrete tanks and other receptacles such as fibre tanks and tarpaulin require much water exchange especially flow through system where fresh water replenishes the water released through the outlet.

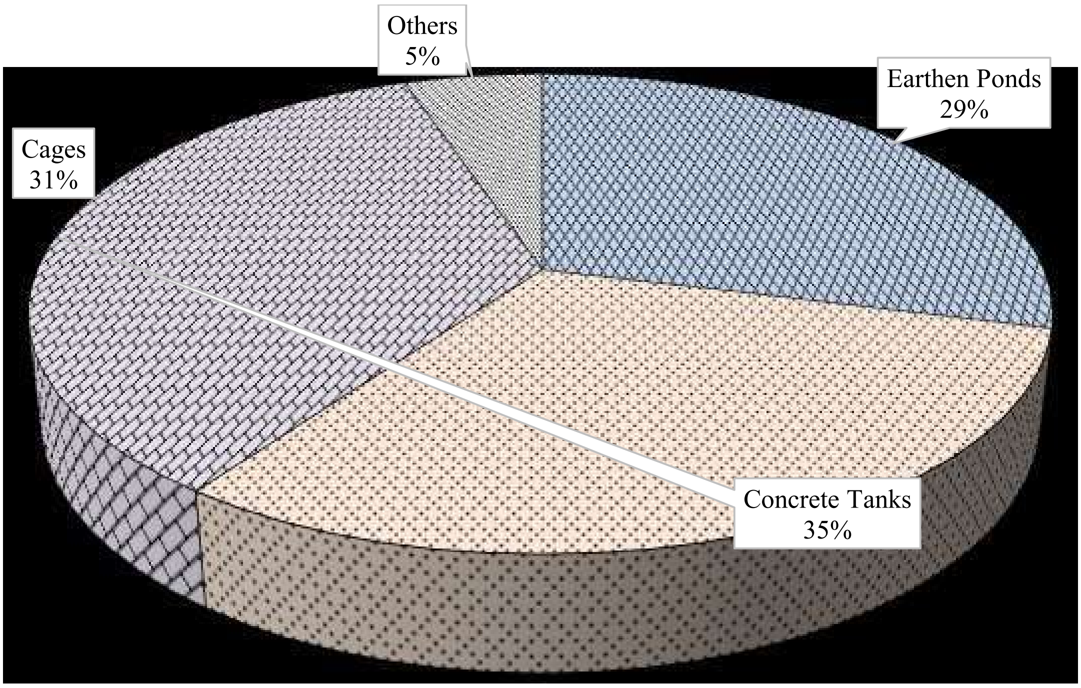

Figure 2: Fish rearing facilities used by the respondents

Fish farming techniques are presented in figure 2. Most of the respondents (58.90%) practiced poly culture while 56.50% practiced monoculture. Integrated fish farming system with crops was the least practiced (14.70%). Poly culture is a sure way of utilizing the nutrients in water efficiently because species cultured are bottom and surface feeders. Ecologists have long known that multiple species animal and plant communities are more stable and more efficient in the utilization and transfer of energy than single species systems. Caution with poly culture is that species to be cultured should be compactable for instance cat fish and Tilapia.

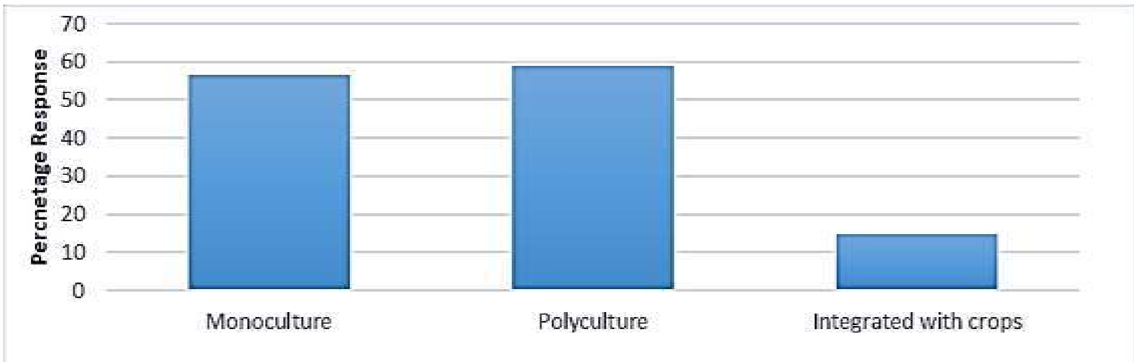

Figure 3: Fish farming techniques

Culture systems practiced by the respondents

Figure 4 indicated the culture systems used by the respondents, intensive culture system (90%); semi-intensive culture system (9%) and extensive culture system (1%). The majority (90%) agreed that intensive feeding can improve the quality and quantity of fish seed. This implies that with adequate feeding of brood stock, the quality of fish seed supply can be improved (Delgado *et al., 2003).* Much money is usually spent on purchase of feed in intensive system because fish stocked depend mostly on supplementary feeding unlike in extensive where feeding rate is not high and production capacity is small compared to intensive system.

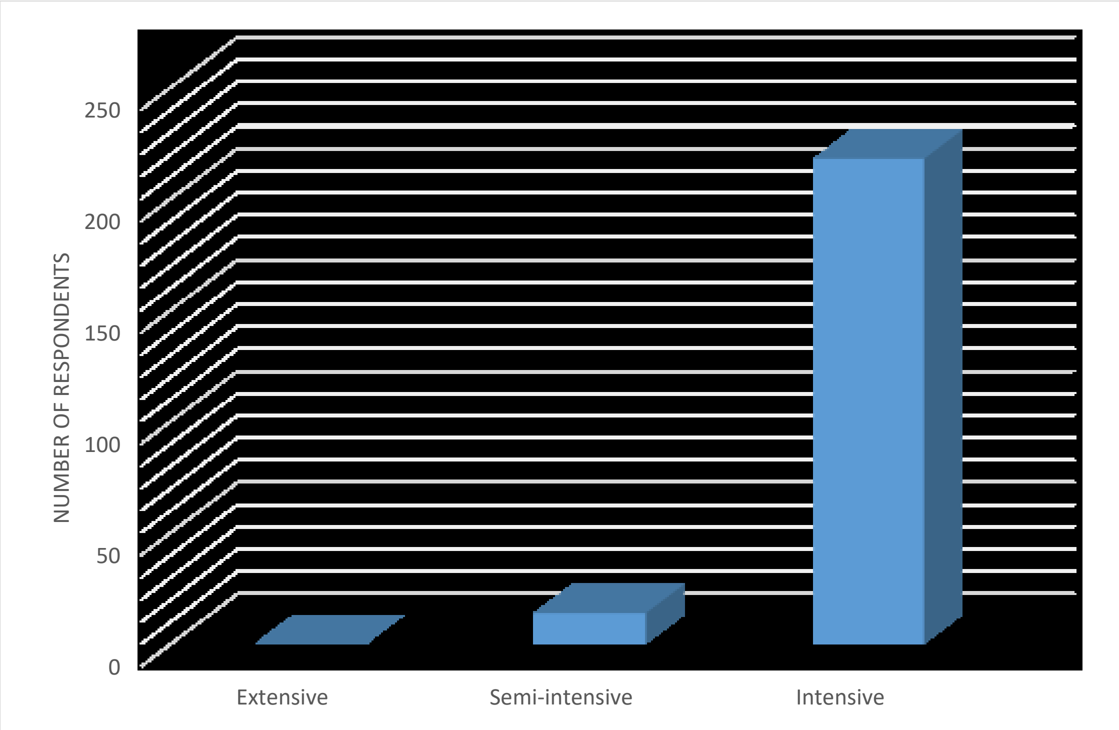

Figure 4: Culture systems

Type of fish species cultured by the farmers

The types of species farmed by the respondents are presented in figure 5. *Clarias spp* was reported to be farmed by 69.80% fish farmers; *Heterobranchus spp* 25.00% and *Tilapia spp* 5.2%. Based on the study area, *Clarias spp*. command high market price because of greater demand, preferences, hardiness of the stock, fast growth, high feed conversion ratio and high survival rate under captivity. Experience has shown that consumers prefer catfish because it is not as bony as Tilapia. *Tilapia spp* cannot withstand wide range water quality variation as a result most fish farmers hardly culture it coupled with low demand and low market value. The only advantage is that they are herbivorous and prolific breeders which when raised with carnivorous species at required stocking density the fry can be fed on. Ogundiran *et al* (2009) in a similar study reported that cat fish appears to be hardy, economical and generally accepted by people.

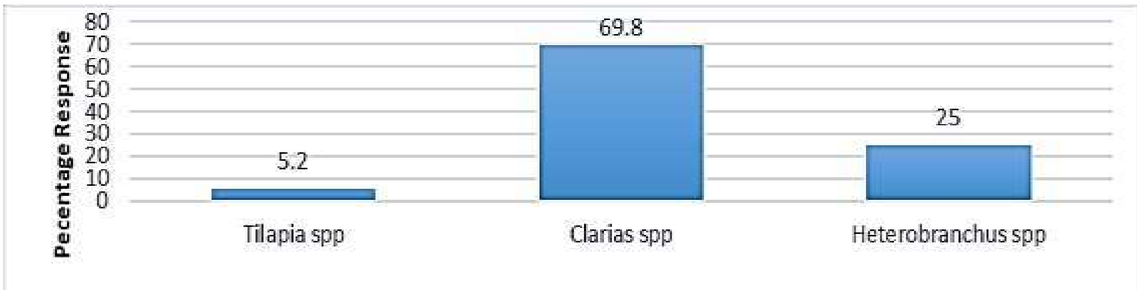

Figure 5: Types of species cultured

Types of feed used by the fish farmers

The types of feed used by the respondents are represented in figure 6. Only 72.0% of the respondents used imported floating pelted feed while 27.0% used locally produced sinking feed and less than 1% fed fish with maggot and agricultural waste. Floating pellet feeds are in high demand because when used fish response can be monitored and tendency of feed wastage can be reduced to the barest minimum since uneaten feed will normally float on water.

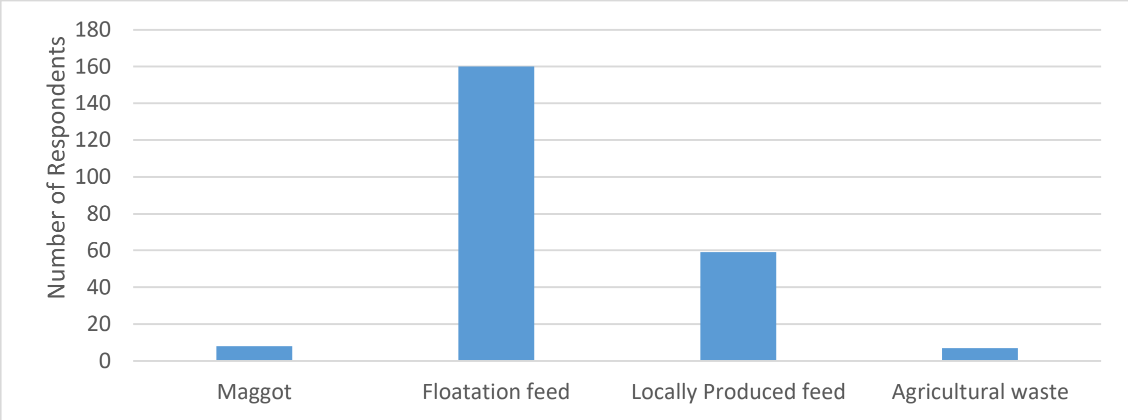

Figure 6 Types of feed used

Constraints encountered by Fish Farmers

Table 1 presented the constraints encountered by fish farmers in the study area. Respondents with strongly acceptance (SA) to 12 (65%) of the constraints identified in the study; weak acceptance 6 (30%) while 1 (5%) indicated no response arising from the inferences made on the hypothesis test. Considering the mean ranking of the constraints, the most critical constraint fish farmers faced in the study area was poor quality of fish seed (13.33%), high cost of inputs (13.03%), poor extension services (12.80), high cost of management (12.71%) and theft (12.14%). The above constraints are capable of hindering the expected high return from fish farming in the country. In a similar study Abegunrin *et al,* (2019) identified he major problem to fish farming as inadequacy of appropriate technologies, inadequate information on aquaculture technology, insufficient financial support, inadequate technical know-how, in-a-availability of extension agents, unfavorable environmental conditions, inadequate training, and technical support.

Table 2: Constraints Encountered by Fish Farmers

Constraints	Reponses				Ranking	Mean	Decision
	Very vere	Severe	Not Severe	Not a Constrain	Undecided		
Inadequate infrastructure	154 (66.50)	08 (3.40)	3 (1.30)	70 (30.20)	-	63.0	SA
Inadequate supply fish feed	75 (31.90)	87 (37.00)	70 (29.80)	3 (1.30)	-	0.25	SA
Irregular electricity supply	81 (34.50)	67 (28.50)	14 (6.00)	70 (29.80)	03 (1.30)	9.04	WA
Poor finance	73 (31.10)	22 (9.40)	67 (28.50)	70 (29.80)	03 (1.30)	10.46	WA
Hatchery facility	08 (3.40)	140 (59.60)	26 (11.10)	58 (24.70)	03 (1.30)	11.29	SA
Suitable land acquisition	73 (31.10)	08 (3.40)	137 (58.30)	14 (6.00)	03 (1.30)	8.86	WA
High cost of inputs	95 (40.40)	70 (29.80)	67 (28.50)	03 (1.30)	-	13.03	SA
Diseases	148 (63.00)	84 (35.70)	-	03 (1.30)	-	9.58	SA
Irregular water for stock.	08 (3.40)	73 (31.10)	137 (58.30)	14 (6.00)	03 (1.30)	11.06	WA
Poor water quality for stock.	73 (31.10)	08 (3.40)	70 (29.80)	81 (34.50)	03 (1.30)	10.12	WA
High cost of management	73 (31.10)	92 (39.10)	67 (28.50)	-	03 (1.30)	12.71	WA
Poor extension services	26 (11.10)	206 (87.70)	-	03 (1.30)	-	12.80	SA
Poor marketing	14 (6.00)	137 (58.30)	81 (34.50)		03 (1.30)	9.38	SA
Tech. experts for consultation	81 (34.50)	78 (33.20)	73 (31.10)	03 (1.30)	-	7.98	SA
Cannibalism	67 (28.50)	151 (64.30)	14 (6.00)		03 (1.30)	6.63	SA
Lack of production records	139 (59.10)	12 (5.10)	67 (28.50)	03 (1.30)	14 (6.00)	11.22	SA
Poor quality of fish seed	81 (34.50)	84 (35.70)	67 (28.50)	-	03 (1.30)	13.33	SA
Lack of capital	08 (3.40)	73 (31.10)	125 (53.20)	26 (11.10)	03 (1.30)	11.47	NO
Theft	84 (35.70)	148 (63.00)	-	-	03 (1.30)	12.14	SA

Kandell coefficient = 0.116, Chi-square = 509.37, df = 12, p-value = <0.01, N = 232. SA = strong acceptance, WA = weak acceptance, No = No response

CONCLUSION

The culture system was predominantly intensive, *Clarias Spp* were cultured and fed on imported floating feed. The major constraints to fish production are inadequate infrastructure, high cost of inputs; poor quality of fish seed and poor extension services on fish farming. The study recommends that the Government should grant import duty waiver on fish farming inputs and as well monitor the implementation so that the policy can benefit intending and existing fish farmers. More extension agents should be employed and well equipped to provide necessary training and other services needed by fish farmers. Fisheries Research Institutes and higher Institutions that offer Fisheries and Aquaculture should develop high quality strains of culture able fish species for effective fish production.

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Impact of Thermal Pollution on the Physical and Chemical Characteristics of the Sediment of the Lagos Lagoon

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ABSTRACT
Thermal pollution from power plants degrades aquatic ecosystems with ramifications beyond the natural environment. The effect of coolant water discharge on the sediment characteristics, at the Egbin area of the Lagos lagoon were investigated from March to August, 2012 at five (5) stations. During the study period, rain fall ranged between 104-476mm. The physical and chemical parameters (pH, moisture content, total organic content, total organic matter, nitrate, phosphate, copper, chromium, lead, nickel, zinc) of sediment were analysed using APHA standard protocol. Sediment type was predominantly sandy to muddy sand. The analysis of variance revealed that there were significant differences ($p<0.05$) in Cr and Zn across the stations in Egbin, Lagos Lagoon. The principal compoent analysis had 90.32% at component 1 and 6.66% at component 2. PCA 1 indicates the impact of thermal stress significantly influenced the Cu, Zn, Nitrate, TOC and TOM in the sediment at station 4. PCA 2, phosphate, Ni, pH and moisture content were significantly impacted at station 5 by the effluents of thermal stress generated from Egbin power station. These dynamics across energy-water systems highlight the need for high-resolution simulations, coherent planning to resolve the continuous discharge of coolant water into the Lagos Lagoon in order to achieve sustainability of aquatic resources.
Keywords: Thermal pollution, Lagoon, sediment, Phyiscal and chemical characteristics

INTRODUCTION
Warm coastal water temperatures and thermal effluents poses serious environmental concern. Thermal pollution is regulated under the Clean Water Act (CWA) section 316(a), which prohibits plants without variance permits from raising river temperatures above threshold limits to the extent that electricity generation may need to be curtailed (McCall *et al.,* 2016). The need to generate power worldwide had given rise to the use of various sources such as nuclear, gas, coal, wind, hydro, thermal and solar. Some of these are not environmentally friendly and create challenges particularly when the world is facing a major crisis, global warming. According to James (1971), the incidence of waste heat discharge in tropical coastal waters is even more critical as most marine organisms in the region already operate at the upper limits of their tolerance. In the marine environment of estuaries, lagoons and coastal water, waste heat discharge may alter the environment in several ways. For instance, the water chemistry may change (Sudihakar, 2010) altering the status of heavy metals (Bryan, 1971; Tomlinson *et al.,* 1980; Martin and Whitfield, 1983) creating favourable condition for opportunistic species and elimination of venerable species (Abbaspour 2005). In Nigeria, over 85% of all industries are located in the Lagos area. Some of these industries discharge their

waste through drainage systems into nearby storm water drains and coastal waters (Odiete, 1999). Of particular note are wastes from sewerage, saw mills, breweries and chemical facilities. Also important are gas turbines used for power generation which release waste heat into the aquatic environment. These turbines include adjoining facilities at Ijora in Lagos State. A farm-Imo river in River State, Oji river in Enugu State, Ugheli in Delta State and Egbin in Lagos State. The Egbin thermal station with a generation capacity of 1320 watts (Ukuoma, 1989) accounts for a quarter of Nigeria's installed power need. Thermal pollution from power plants degrades aquatic ecosystems with ramifications beyond the natural environment. Hence, the impact of the thermal the pollution on the physical and chemical characteristic of the sediment in Lagos Lagoon is hereby investigated in this study.

Plate 1: Station

Plate 2:Station

MATERIALS AND METHODS

Description of Study Area

The Lagos lagoon is one of several lagoon systems in the West Africa sub-region and the most extensive. The central body of the lagoon is located between longitude $3^0 23^1$ and $3^0 4^1$ and latitude $6^0 22^1$ and $6^0 28^1$ (Figure 1). The study was conducted for a period of six months from

March to August 2012 and collected from five selected stations around Egbin power plant within the Lagoon.

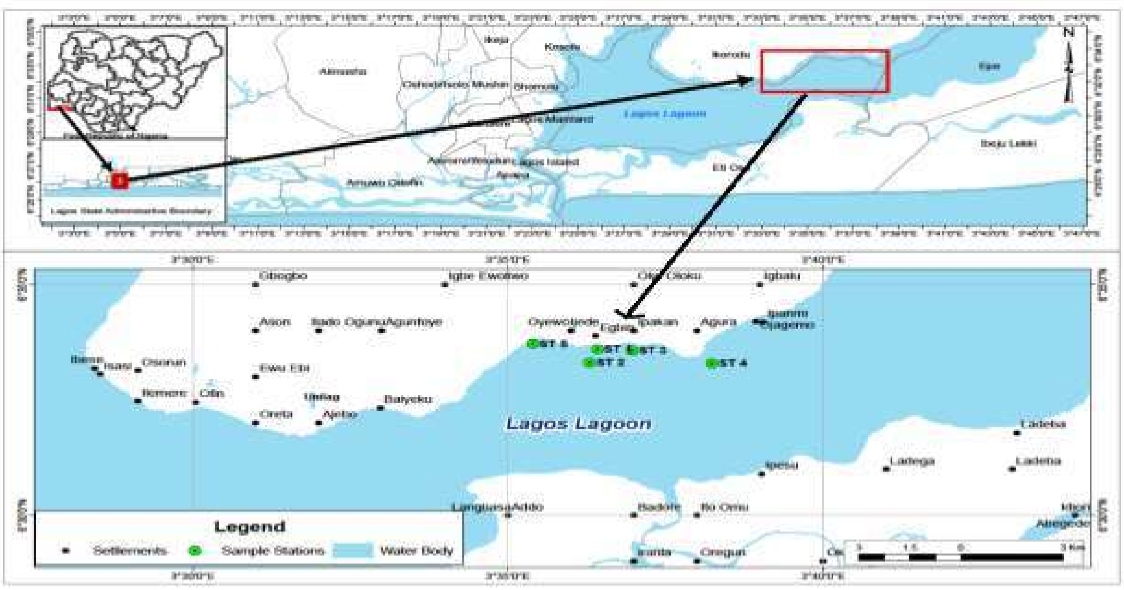


Figure 1: Map of the study area showing the five sample stations

Sediment Samples Collection

Sediment samples were collected at each station with a van-ven grab sampler ($0.52m^2$). The grab sampler was lowered into the water to collect 500g sediment. The collected samples were packed in labeled polythene bags, taken to the laboratory and were stored in the freezer for further analysis in the laboratory.

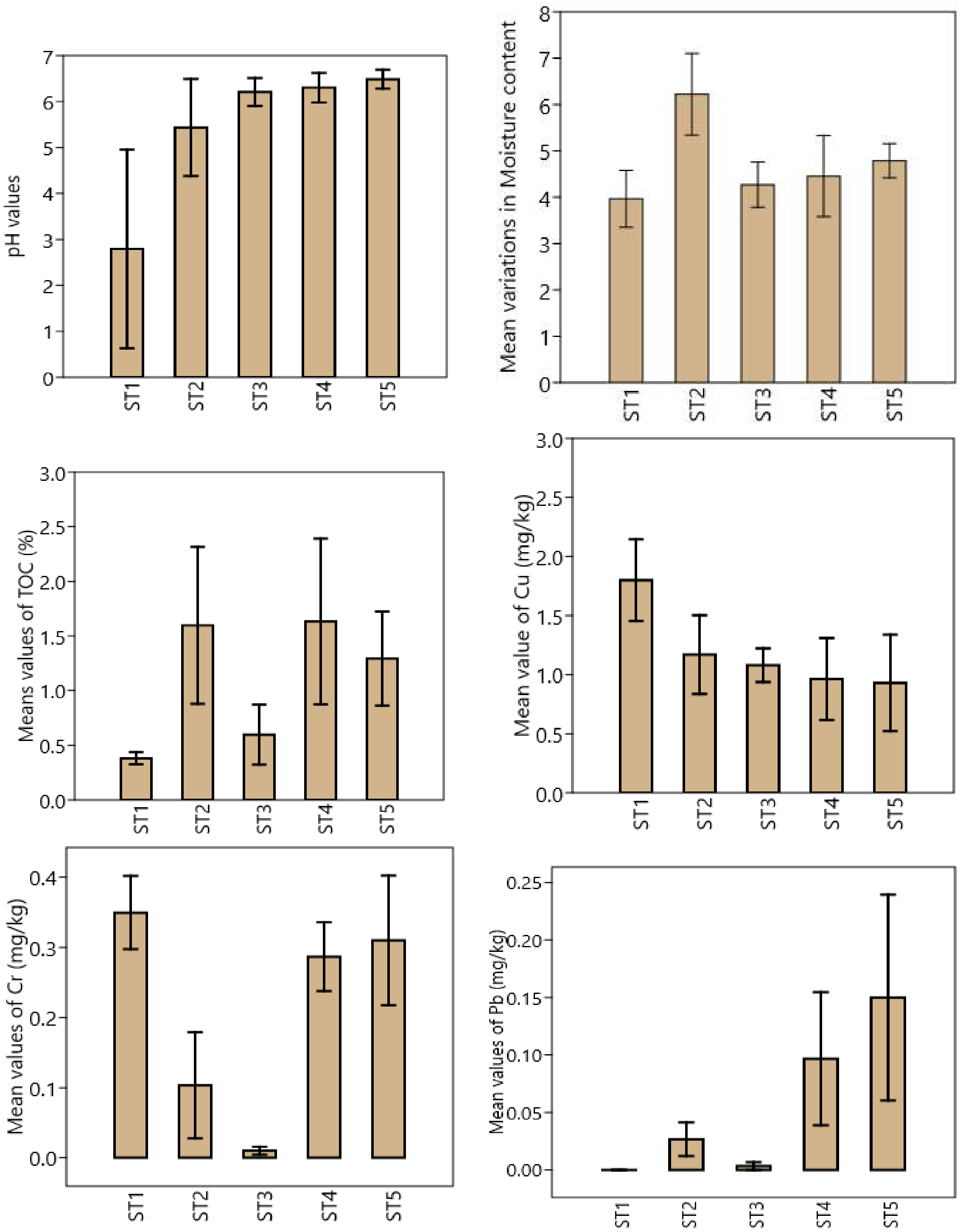
Determination of the physico-chemical parameters

The pH of each sample was determined by adding $CaCl_2$ solution to a measured quantity of the soil in ratio 1:2, soil: solution, Moisture content was determined by gravimetric method, The TOC and TOM were determined by titration method, Phosphate was determined colorimetrically using the ascorbic acid method, the metal content of this digest was thereafter determined by flame AAS against known standards using Perkin Elmer A Analyst 200 branded AAS instrument.

RESULTS AND DISCUSSION

Sediment Physico-Chemical Parameters

The physico-chemical characteristics of the sediment are presented in Figure 2. The mean pH across the stations was 5.45 which ranged between 0.60 and 7.12. The mean moisture content was 4.74 which ranged between 2.89 and 6.0. The mean TOC had 1.10 % which ranged between 0.19 and 3.0 %. The mean TOM had 1.91 % which ranged between 0.33 and 5.20 %. The mean Nitrate had 0.87 mg/kg which ranged between 0.25 and 2.23 mg/kg. The mean phosphate had 25.0 mg/kg which ranged between 0.01 and 92.47mg/kg. The mean copper had 1.19 mg/kg which ranged between 0.22 and 2.47mg/kg. The mean Cr had 0.21 mg/kg which ranged between 0.0 and 0.47mg/kg. The mean Pb had 0.06 mg/kg which ranged between 0.0 and 0.31mg/kg. The mean Ni had 0.27 mg/kg which ranged between 0.0 and 1.41mg/kg. The mean Zn had 1.33 mg/kg which ranged between 0.05 and 3.87mg/kg. The analysis of variance (ANOVA) revealed that there were significant differences ($p<0.05$) in Cr and Zn across the stations in Egbin, Lagos Lagoon.


pH values
0
1
2
3
4
5
6
7
ST1
ST2
ST3
ST4
ST5
Mean variations in Moisture content
0
1
2
3
4
5
6
7
8
ST1
ST2
ST3
ST4
ST5
Means values of TOC (%)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
ST1
ST2
ST3
ST4
ST5
Mean value of Cu (mg/kg)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
ST1
ST2
ST3
ST4
ST5
Mean values of Cr (mg/kg)
0.0
0.1
0.2
0.3
0.4
ST1
ST2
ST3
ST4
ST5
Mean values of Pb (mg/kg)
0.00
0.05
0.10
0.15
0.20
0.25
ST1
ST2
ST3
ST4
ST5

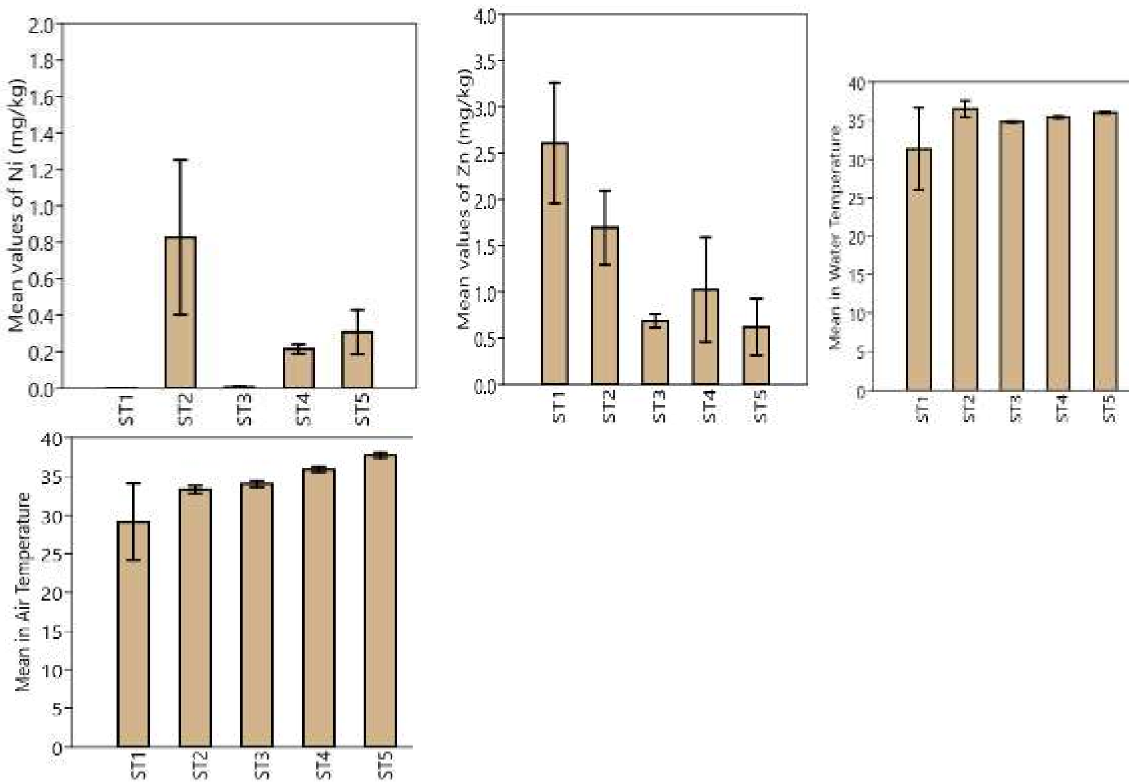


Figure 2: Mean variations of the physico-chemical parameters in sediment and water

Principal Component Analysis

The principal compoent analysis had 90.32% at component 1 and 6.66% at component 2 (Figure 3). At component 1, the impact of thermal stress significantly influenced the Cu, Zn, Nitrate, TOC and TOM in the sediment as observed in station 4. While at component 2, phosphate, Ni, pH and moisture content were significantly impacted at stsation 5 by the effluents of thermal stress generated from Egbin power station into the Lagos Lagoon. Figure 4a showed the hierarchical clustering using Bray-Curtis paired group of physico-chemical parameters of sediment at the Egbin Thermal Plant within the Lagos Lagoon which had three groups; group 1 was station 2, group 2 was station 3, 4 and 5 and group 3 was station 1. While at Figure 4b indicated similar properties with impact on the sediment quality which showed that Cr, Ni and Pb; TOC and TOM; Cu and Zn poses similar characteristics in the sediment at Egbin, Lagos Lagoon.

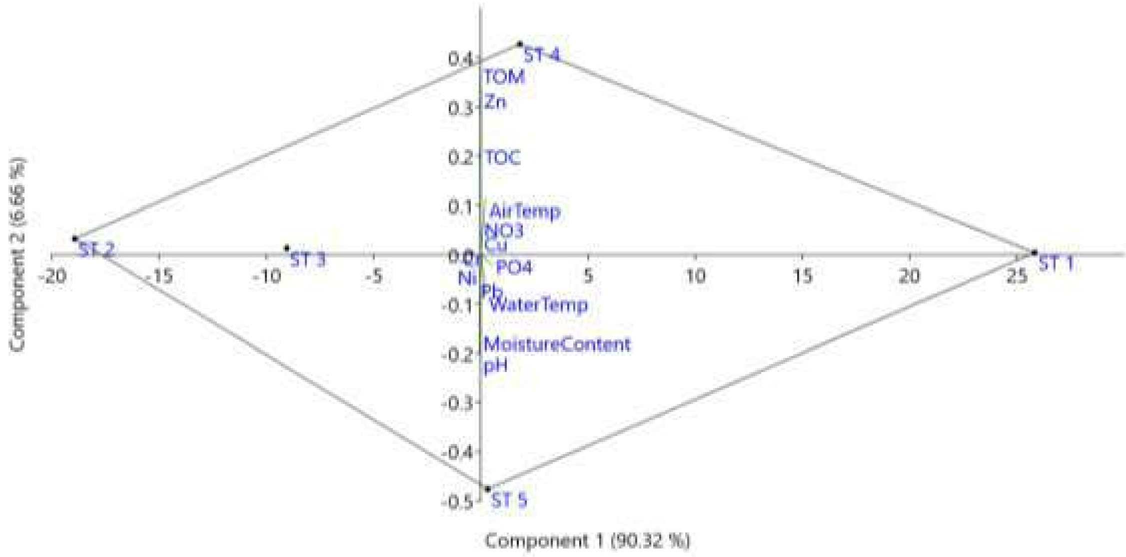
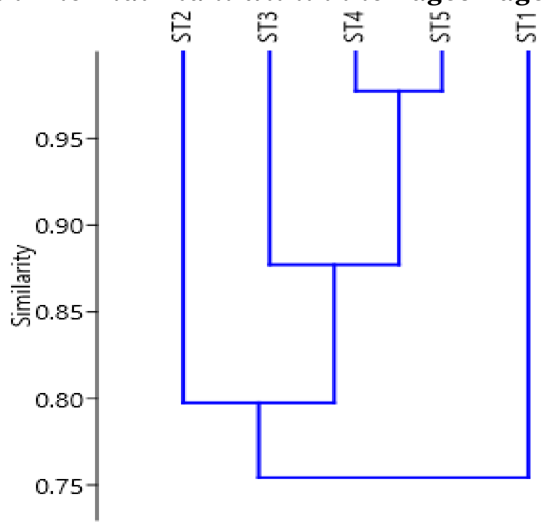


Figure 3: Principal component analysis of physico-chemical parameters of sediment and water at the Egbin Thermal Plant within the Lagos Lagoon



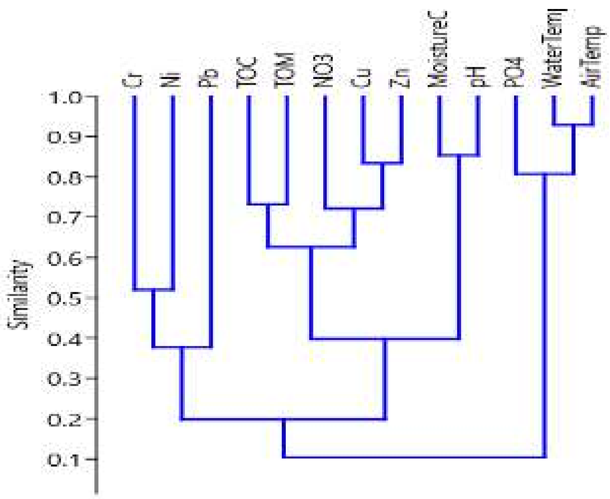


Figure 4: Hierarchical clustering using Bray-Curtis paired group of physico-chemical parameters of sediment at the Egbin Thermal Plant within the Lagos Lagoon

CONCLUSION

On the basis of observation made in this study due to irregular fluctuations in the physico-chemical parameters of sediments samples in Egbin area of Lagos lagoon, it was therefore noted that the level of coolant water has little or no significant effect on the bottom sediment of Lagos lagoon.

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PROCEEDINGS

55th Annual Conference

Agricultural Society of Nigeria

25-29 Oct., 2021

Rufus Giwa Polytechnic, Owo Ondo State

SUB-THEME 7

Agricultural Engineering and Mechanization

Comparative Study of Metal and Earth as Inner Container Material for Evaporative Cooling System

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ABSTRACT
An investigation into some selected materials (stainless steel and earth) was carried out to determine the favourite materials suitable as the heat exchanging mediums (inner wall) in evaporative cooling systems. A number of criteria, including influence on temperature and relative humidity as compare to ambient, ease of shape formation, durability, water-proof capability, contamination risk and cost, were considered for material selection, and final choice of the material would be able to offer enhanced cooling effect with reasonable durability, low contamination risk, easy to scale-up due to ease of shape forming and acceptable cost. A comparative analysis into the two material types was carried out, and the results showed that stainless steel and earth materials produced an average temperature reduction difference from ambient of 3.30 ^{0}C and 5.10 ^{0}C and increase in relative humidity of 9.6 and 62% respectively and stainless steel was determined to be more suitable based on most of the criteria considered though it has a higher price tag on it. Earth material is cheaper and provides a slightly better temperature reduction effect but due to its porous structure allowing for seepage of water, fragility affecting its durability, shape forming ability which will affect scalability and it difficulty in cleaning which make contamination risk higher Stainless steel was therefore found to be more suitable for this application.
Keywords: Evaporative cooling, material selection, food contact materials, African Spinach

INTRODUCTION
Storage of fresh fruits and vegetables after harvest is one of the most pressing problems of a tropical country like Nigeria. Due to their high moisture content, fruits and vegetables have very short life and are liable to spoil. Moreover, they are living entities and carry out transpiration, respiration and ripening even after harvest. Metabolism in fresh fruits and vegetables continues even after harvest and the deterioration rate increases due to ripening, senescence and unfavourable environmental factors. Hence, preserving these types of foods in their fresh form demands that the chemical, bio-chemical and physiological changes are restricted to a minimum by close control of space temperature and humidity (Chemin *et al*. 2018).

Due to the short shelf life of these crops and inadequate facilities to handle it, it is estimated that about 35 to 40% of Nigeria's total fruits and vegetables production is lost during harvest, storage, grading, transport, packaging and distribution in a year (Ugonna *et. al*, 2015). It was identified that the lack of use of cooling system for transporting and storage of fruits and vegetables is one of the factors responsible for the postharvest loss (Isaac, 2015).

The fruits and vegetables, being perishable, need immediate postharvest attention to reduce the microbial load and increase their shelf life, which can be achieved by storing them at low temperature and consequent relative humidity conditions. These conditions are not naturally occurring in tropical area and can usually be achieved in cold storages. Appropriate cool storage technologies are therefore required in Nigeria for on farm storage of fresh horticultural produce in remote and inaccessible areas, to reduce losses. Low-cost, low-energy, environmentally friendly cool chambers made from locally available materials, and which utilize the principles of evaporative cooling, were therefore developed in response to this problem. These cool chambers are able to maintain temperatures at 7–15 °C below ambient, as well as at a relative humidity of 90%, depending on the season (Amrat *et al*., 2013).

The evaporative cooled storage structure has proved to be useful for short term, on-farm storage of fruits and vegetables in hot and dry regions. Evaporative cooling is an efficient and economical means for reducing temperature and increasing the relative humidity of an enclosure, and has been extensively tried for enhancing the shelf life of horticultural produce (Jha and Chopra 2006; Dadhich *et al*. 2008; Odesola and Onyebuchi 2009) which is essential for maintaining the freshness of the commodities (Dadhich *et al.* 2008).

Evaporative cooling is an environmental friendly air conditioning system that operates using induced processes of heat and mass transfer where water and air are working fluids (Camargo 2007).

Principle

Figure 1 shows that typical layout of a pot evaporative cooler. The principle underlying evaporative cooling is the fact that water must have heat applied to it to change from a liquid to a vapour. When evaporation occurs, this heat is taken from the water that remains in the liquid state, resulting in a cooler liquid i.e. the evaporation of water is an endothermic process, the energy required is taken from the system, causing the temperature in the inner pot to drop by typically 5^0C to 10^0C below ambient temperature (Bresly 2007; Anyanwu, 2004).

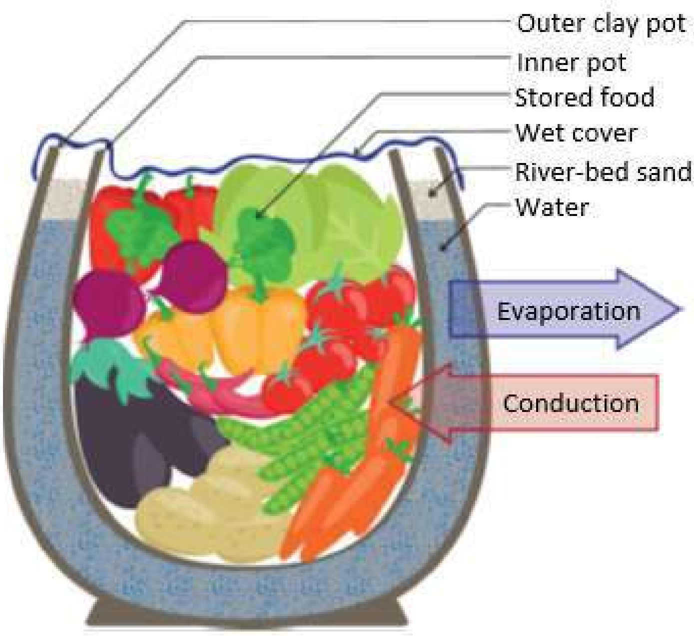

Figure 1. Sketch of a pot-in-pot cooler. Source: Chen *et al* (2018)

Water absorbs a relatively large amount of heat in order to evaporate (that is, it has a large enthalpy of vaporization). The amount of heat transfer depends on the evaporation rate, however for each kilogram of water vaporized 2,257 kJ of energy (about 890 BTU per pound of pure water, at 35 °C (95 °F)) are transferred. The evaporation rate depends on the temperature and humidity and speed of the ambient air.

The properties of the heat exchanging medium (inner wall material) are important as these would affect the cooling efficiency and performance of the evaporative cooling systems. A wide range of materials can be used for this purpose, and may be classified as metal, fibre, ceramics, earth, zeolite and carbon type (Zhao *et.al,* 2008).

An investigation into some selected materials (clay and stainless steel) as inner container of pot-evaporative cooler was carried out to determine the favourite material suitable for serving as the heat exchanging mediums (inner wall) in evaporative cooling systems. A number of criteria, including level of reduction in temperature and increase in relative humidity as compare to ambient, shape formation/holding ability, durability, compatibility to water-proof, contamination risk as well as cost, were applied for material selection, and final choice of the material would be able to offer enhanced cooling effect with reasonable durability, low contamination risk and acceptable cost.

African spinach (*Amaranthus species*) was used in this study. *Amaranthus species* is one of many African leafy vegetables which are described as plant species that are either genuinely native to a particular region, or were introduced to a region so long enough to have evolved through natural processes or farmer selection (Grany *et al*., 2018). Vegetables have potentially held a place in dietary guidance because of their concentrations of vitamins, especially vitamins C and A; minerals and phyto-chemicals in the form of antioxidants (USDA, 2010).

The objective of this study was to evaluate which material (clay or stainless steel) as inner container material for evaporative cooling system subjected to the same treatments such as quantity of water and frequency of wetting will store African spinach better and to evaluate the physical parameters such as: percentage weight loss, and moisture content; biochemical parameters such as: vitamin C, beta- carotene, total chlorophyll and the nitrogen free extract vis-a-vis carbohydrate; also to study the microbial involvement in it deterioration during storage. This study is expected to contribute to a broader scientific knowledge of importance that would aid the material selection when construction an evaporative cooling system and also storage of leafy vegetables in an evaporative cooling system.

MATERIALS AND METHOD

A double layer containers separated by river bed sand was used for this experiment. The outer container is made of porous material allowing for seepage of water encouraging evaporation. Earth pot was used for the outer container and earth pot and stainless steel pot were selected for inner containers. The outer pot has an average diameter of 46cm. The inner clay and stainless steel pots have diameter of 28cm and height of 50cm.

The experimental setup is as seen in picture 1. A thatch roof shed was constructed underneath which the experiment setup was placed. Watering of the sand was done as at when observation by sight show dampness is low and the temperature and relative humidity inside the coolers and ambient was measured every 15minutes using 'Temtop' PDF data loggers (Model: TemLog20H) as seen in picture 2. This experiment was carried out in Kano, Nigerian which lies in the Sudan Savannah zone.

Picture 1. Evaporative coolers (ECSs)

Picture 2. Temtop PDF data logger

Freshly harvested African spinach was cleaned, weighed and then stored in pot-in-pot, metal-in-pot and at ambient condition. The quality state of the vegetable was verified before storing it and at intervals during storage to ascertained the point at which deterioration occurs to a level that it no longer has the quality it should have in terms of biochemical, microbiological and physical integrity fit for human consumption.

Physical analysis

Physical property considered is percentage weight loss. It was measured using methods described by Nicoli (2012). The average temperature and relative humidity of the vegetable baskets and ambient were measured using Temtop PDF data logger (Figure 2).

Physiochemical analysis

Determination of Moisture Content

Moisture content was determined according to AOAC (2010) hot-air oven method o and was calculated as follows:

$$\%\text{Moisture content} = \frac{\text{Weight of } H_2O \text{ in sample}}{\text{Weight of wet sample}}$$

Determination of ß-carotene Content

ß-carotene was determined by the method described by Barros *et al.* (2010). ß-carotene was extracted by weighing 1.0g of macerated sample into a 5ml mixture of acetone and hexane (4:6). The extract was subjected to spectrophotometric measurements at wavelengths 453, 505, 645 and 663nm and was calculated as:

$$\text{ß-carotene (mg/100ml)} = 0.216\text{x}A_{663} - 1.22 \text{ x } A_{645} - 0.304 \text{ x } A_{505} + 0.452 \text{ x } A_{453}$$

Expressed in μg/100g.

Determination of Vitamin C Content

Vitamin C content was determined according to titration method (AOAC, 2010). About 2.0g of macerated sample was weighed into 10ml distilled water. 7ml of extraction solution containing 15g Metaphosphoric acid, 40ml acetic acid glacial in about 500ml distilled water was dispensed to 2.0 ml of sample aliquot. 2-3 drops of thymol blue indicator (0.1g thymol blue in 10.75ml of 0.03M NaOH diluted in 250ml water) was added to aliquot and then titrated with indophenol standard solution to rosy pink at end-point. Standard ascorbic acid solution prepared by dissolving 0.05 g in 50ml in extraction solution was then titrated in similar ways to samples. Vitamin C (mg/100g) was then calculated as:

$$\frac{\text{Average titer (sample -blank)}}{\text{Average titer of standard}} \text{ x } 100$$

Determination of Soluble Carbohydrate Content
About 1g of macerated sample was placed in 25ml conical flask containing 10ml distilled water which was shake vigorously and followed by 15ml of 52% perchloric acid. After 30 minutes of votexing, mixture was filtered and about 1.0ml of filtrate was was mixed with Anthrone reagent in a test tube and absorbance taken at wavelenght 620nm using a PG-T80 Spectrophotometer. The total soluble carbohydrates was then estimated using the standard curve of glucose (Pearson, *et al.*,1976).

Determination of total Chlorophyll Content
About 1.0g of macerated sample was measured into a mixture of 20ml of 80% acetone and 0.5g $MgCO_3$ powder according to a method described by Kamble *et al.* (2015). The mixture was incubated at 4°C for 3hours. The mixture was then centrifuged at 2500rpm for 5 minutes and the supernatant transferred into a 100ml volumetric flask and to the 100 mark, additional 80% acetone was added. The extract was now measured at 645 nm and 663nm using a PG-T80/T80+ spectrophotometer and was calculated as:

$$\text{Total chlorophyll content (mg/g)} = 20.2 \times A645 + 8.02\ (A663) \times V$$

Microbial analysis
The samples were plated on Nutrient and MacConckey agar; the bacterial isolates were identified with a battery of biochemical test specific for the suspected bacteria. The samples were plated on PDA for the enumeration of fungi.

Sample Preparation
The stock solution the stored vegetables were prepared by inserting approximately 1g of leaf in to 9ml of sterile distilled water. Ten-fold serial dilution was carried out and aliquot of 1ml of the 10^{-3} and 10^{-4} were plated on Nutrient agar and potato dextrose agar (PDA). The nutrient agar plates were incubated at 37°C for 18-24hours and the PDA plates were incubated at room temperature for up to 7days.

RESULTS

Physical analysis

Average temperature and Relative humidity
Effect of inner pot material (clay or stainless steel) on temperature and relative humidity gradient within the cooling system was measured. Figure 2 and figure 3 shows the temperature and relative humidity regime inside the pot coolers and the difference between the coolers and ambient. ECS with clay as inner container as highest temperature reduction (6.1°C) from ambient temperature as compared to reduction (5.6°C) for stainless steel as inner container.
Figures 2 shows the temperature trends inside the evaporative coolers in reaction to the ambient change in temperature and it was observed that clay as inner container material performs slightly better with reduction in temperature from ambient temperature. Figures 3 shows the relative humidity trends inside the evaporative coolers in reaction to the ambient change in relative humidity and this indicated that cooler with clay as inner container had relative humidity of almost 100% which indicated water seepage through the clay due to its porous structure and this will encourage rottenness of the store fruits and vegetables.

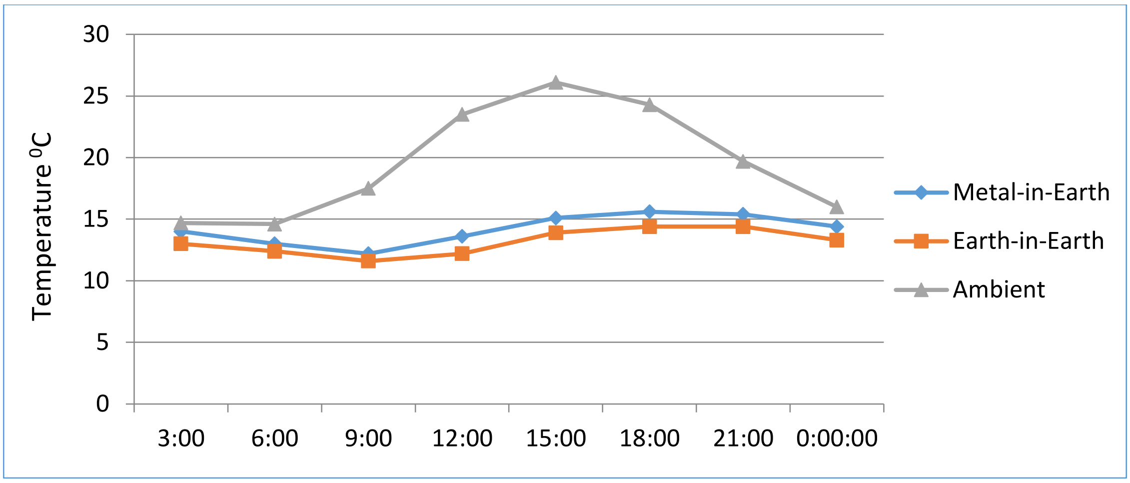

Figure 2: Average 3-hr Temperature trend recorded in the two types of ECS and ambient

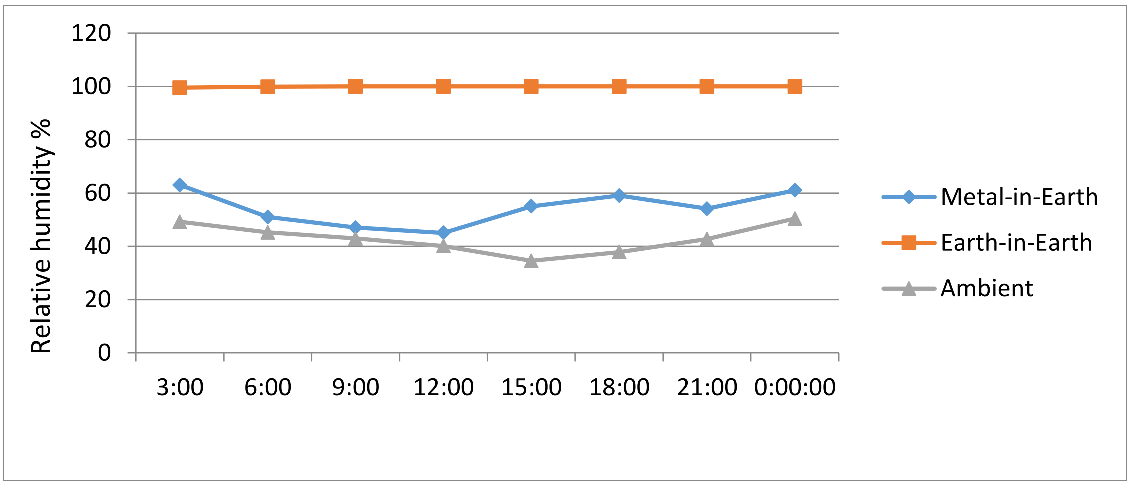

Figure 3: Average 3-hr Relative Humidity trend recorded in the two types of ECS and ambient

The reaction of a material to temperature change which is defined by its thermal conductivity is an important consideration for material selection in cold storage facility. Zhao *et.al* (2008), found that the heat transfer rate of ECS is in the range 392–399W/m^2, and moisture evaporation rate is between 0.57 and 0.58 l/m^{2}h. These rates are relatively low so that the thermal properties of the selected materials, i.e., thermal conductivity impose very little impact onto the process. In that case, these parameters play low key in selecting heat exchanging materials (inner container). Instead, shape formation/holding ability, durability, compatibility with coatings; contamination risk as well as cost become more important concerns in this regard.

Stainless steels are a family of ferrous alloys containing less than 1.2% carbon and over 10.5% chromium and are protected by a passive surface layer of chromium and iron oxides and hydroxides that protects them efficiently from corrosion (Pina e*t al.*, 2009) and this provides it with good characteristics as a food contact surface material especially those made specifically to be of food grade quality in comparison to clay on the other hand which has lose surface particles and porous structure.

Bacterial load, Fungal Load and Identification of Fungi

After overnight incubation, distinct colonies were counted on duplicate plates of nutrient agar manually to record the mean bacterial load. The fungal loads were determined by manually counting distinct colony on duplicate PDA plates after overnight incubation. The fungal

growth was identified after 7days of incubation using physical observation and lacto-phenol cotton blue staining technique.
Table 1 shows a lower bacterial load was observed in ECS pot with stainless steel as inner container material and an appealing physical appearance from the start of the experiment. The vegetables in the ECS pots stayed for seven days while that stored in ambient condition had dried up by the third day.

Table 1: Bacterial Load of African Spinach Leaves (*Amarantus species*)

S/No	Sample	Bacterial load(10^3) Day 1	Bacterial Load(10^3) Day3	Bacterial Load(10^3) Day7	X^2-Value *A vs* B	X^2-Value *A vs* B
1	Ambient	24	130	0		
2	Pot-in-pot	24	410	790	42.257	**0.0000***
3	Metal-in-pot	24	73	142	1.7695	0.1715

Table 2 shows that ECS pot with clay as inner container material had highest fungal counts (3.7 $x10^4$cfu/ml) with no significant difference from ambient fungal counts. *Aspergillusniger* was the predominant fungi identified across all the baskets.

Table 2: Occurrence and Frequency of Fungi in African Spinach Leaves (*Amarantus species*)

S/No	Sample	Fungal load(10^3) Day 1	Fungal Load(10^3) Day3	Fungal Load(10^3) Day7	Identified Fungi
1	Ambient	8	21	0	*Aspergillusniger, Aspergillusfumigatus, Aspergillusspecies*
2	Pot-in-pot	8	16	37	*Aspergillusniger, Fusariumspecies, Penicilliumchrysogenum*
3	Metal-in-pot	8	13	26	*Fusarium species, Aspergillusfumigatus, Penicilliumspecies*

Surface conditioning and microbial attachment

The surface properties of materials in contact with food changes with use, giving rise to a modified surface status. The very first event to occur when materials are used in handling food is the appearance of a so-called conditioning film (Pina e*t al.*, 2009). Organic and inorganic compounds in contact with materials accumulate very quickly at the solid-liquid interface and give rise to a conditioning film. These adsorbent compounds originated in the food themselves and also in the detergents used during cleaning and disinfestations procedures. The quantity and configuration of the adsorbed molecules depend on the substratum properties (Redsven *et al.,* 2007) and the molecular species present in the aqueous medium (Salo and Wirtanen, 2005). Recent studies have shown that the substratum surface properties, such as surface roughness (Chen *et al.,* 2012), surface hydrophobicity (Eginton *et al.,* 1995), and surface charge (Harkes *et al.,* 1992; Terada *et al.,* 2012), could affect bacterial cell attachment. The level of adsorbed materials is affected by the nature and/or the hydrophobic property of the material surface (Pina e*t al.*, 2009).

As the of the evaporative coolers continues to be in use and are always soaked with water, there would be a high chance to come up with bacterial growth within the porous structure of the earth material, particularly interior pores. To avoid this, a material allowing proper cleaning and sterilisation is desirable. In terms of cost, Earth is obviously cheaper than stainless steel but for factors such as durability, prevention of water seepage, ease of obtaining hygiene, ease of folding and forming the material to shape and, possibility of scaling up the storage structure, food grade metal (stainless steel) provides better performance as summarized in Table 3.

Table 3: Summary of the properties of the selected material types

Material type	Index						
	Thermal conductivity (W/m K)	Porosity (%)	shaping ability	Ease of cleaning	Contamination risk	Durability	Cost (₦) per square meter
Stainless steel	High	Non Porous	High	High	Low	High	15,500
Earth	Low	High	Low	Low	Medium	Low	7,500

Physiochemical Analysis

Table 4 and 5 shows significant different ($P< 0.05$) in the analyzed physicochemical parameters. In each case, carbohydrate increases with decrease in moisture content, hence more increase is recorded in the ambient stored samples.

Table 4: Physicochemical Parameters of Fresh Spinach Leaves Stored in pot-in-pot ECS against ambient

	Pot-in-pot					Storage at Ambient				
DAYS	I	III	V	VII	Percentage Loss	I	III	V	VII	Percentage Loss
Moisture Content (%)	35.07 ±0.02^{a}	33.97 ±2.03^{b}	32.99 ±5.12^{c}	30.19 ±2.05^{d}	13.9	35.07 ±0.0^{a}	19.94 ±0.02^{e}	8.62 ±0.03^{f}	6.07 ±0.58^{g}	82.7
Vitamin C (mg/100g)	42.08 ±3.07^{c}	35.12 ±0.99^{e}	32.88 ±0.55^{t}	30.90 ±0.08^{r}	26.6	42.08 ±3.07^{c}	10.72 ±0.27^{k}	6.55 ±0.55^{b}	2.05 ±0.01^{d}	95.1
Total Chlorophyll (mg/g)	5.11 ±0.55^{f}	5.05 ±0.10^{b}	5.00 ±0.22^{c}	4.30 ±0.03^{d}	15.9	5.11 ±0.55^{f}	2.31 ±0.10^{g}	1.06 ±0.03^{h}	0.12 ±0.03^{i}	97.7
ß-carotene (µg/100g)	234.03 ±11.30^{f}	230.28 ±7.99^{a}	220.99 ±10.50^{b}	219.45 ±12.05^{c}	6.2	234.03 ±11.30^{f}	125.36 ±11.02^{g}	100.46 ±7.00^{h}	52.19 ±7.07^{i}	77.7
Carbohydrate (mg/ml)	33.19 ±0.01^{f}	30.05 ±2.09^{e}	22.00 ±2.55^{d}	13.88 ±0.99^{a}	58.2	33.19 ±0.01^{f}	39.53 ±5.12^{g}	42.02 ±2.05^{h}	49.49 ±1.02^{i}	-49.1

Values are data expressed as mean ±SD of three replicates. Different superscript in the same row indicates significant difference at $P<0.05$.

Table 5: Physicochemical Parameters of Fresh Spinach Leaves Stored in metal-in-pot ECS against Ambient

	Metals-in-pot					Storage at Ambient				
DAYS	I	III	V	VII	% Loss	I	III	V	VII	% Loss
Moisture content (%)	35.07 $\pm 0.02^{a}$	32.99 ±2.00b	30.00 ±1.00c	27.79 ±1.01d	20.8	35.07 $\pm 0.02^{a}$	19.94 $\pm 0.02^{e}$	8.62 $\pm 0.03^{f}$	6.07 $\pm 0.58^{g}$	82.7
Vitamin C (mg/100g)	42.08 $\pm 3.07^{c}$	32.00 $\pm 1.00^{a}$	27.88 $\pm 1.02^{e}$	23.90 $\pm 1.30^{f}$	43.2	42.08 $\pm 3.07^{c}$	10.72 $\pm 0.27^{k}$	6.55 $\pm 0.55^{b}$	2.05 $\pm 0.01^{d}$	95.1
Total Chlorophyll (mg/g)	5.11 $\pm 0.55^{f}$	4.66 $\pm 0.02^{d}$	4.22 $\pm 0.00^{e}$	3.88 $\pm 0.02^{a}$	24.1	5.11 $\pm 0.55^{f}$	2.31 $\pm 0.10^{g}$	1.06 $\pm 0.03^{h}$	0.12 $\pm 0.03^{i}$	97.7
ß-carotene (μg/100g)	234.03 $\pm 11.30^{f}$	220.03 $\pm 12.00^{a}$	211.19 $\pm 9.00^{b}$	189.00 $\pm 12.90^{c}$	19.2	234.03 $\pm 11.30^{f}$	125.36 $\pm 11.02^{g}$	100.46 $\pm 7.00^{h}$	52.19 $\pm 7.07^{i}$	77.7
Carbohydrate (mg/ml)	33.19 $\pm 0.01^{f}$	29.56 $\pm 1.03^{a}$	20.00 $\pm 1.02^{b}$	8.78 $\pm 0.21^{c}$	73.6	33.19 $\pm 0.01^{f}$	39.53 $\pm 5.12^{g}$	42.02 $\pm 2.05^{h}$	49.49 $\pm 1.02^{i}$	-49.1

Values are data expressed as mean ±SD of three replicates. Different superscript in the same row indicates significant difference at P<0.05

Data obtained were subjected to analysis of variance and treatment means compared at Duncan multiple range tests at 5% probability level. There was significant difference at ($p<0.05$) in the physicochemical parameters between the two types of ECS and ambient but no significant difference was observed across the two types of ECS. There were decreasing trends in each of moisture, vitamin C, ß-carotene, total chlorophyll and carbohydrate contents. After a week of storage, Pot-in-pot performed best in terms of properties retention (73.4%, 84.1%, 93.8% and 41.8%) for vitamin C, total chlorophyll, ß-carotene and carbohydrate contents respectively.

CONCLUSION

This research established that for consideration of either clay or stainless steel as material for inner container of ECS, temperature reduction ability is not an importance factor has their performance in this regard is not significantly different but factors such as durability, prevention of water seepage, ease of obtaining hygiene, ease of folding and forming the material to shape for possibility of scaling up, and cost will be used in the selection of material for inner container. food grade metal (stainless steel) out-perform clay in all the consideration listed above expect in cost. It can therefore be concluded that stainless steel is a better choice of inner container material for pot evaporative coolers since it performs better when considering microbial attachment non-suitability and surface conditioning.

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Impact of Agricultural Mechanization on Crop Production in Soba Local Government Area of Kaduna State, Guinea Savanna Agro-Ecological Zone of Nigeria

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ABSTRACT
A study was conducted in 2020 to ascertain the impact of agricultural mechanization on crop production in Soba LGA of Kaduna State, Guinea Savanna Agro-Ecological Zone of Nigeria Descriptive research survey design was used with a sample size of 155 from a population of 200 contact farmers. Simple statistical analysis involving percentages, averages (weighted averages) were used in the analysis, while ranking technique was used to ascertain the importance of the constraints and problems of agricultural mechanization in Soba LGA. The study revealed that most of the farmers (43.23%) are within the ages of 26-35years, married (82.58%) and mainly illiterate (53.55%). About 70.97% of farmers in Soba LGA do not own any farm machinery, though desirous to own one. Maize is the main arable crop grown (29.05%). Majority of the farmers (50.97%) produce vegetables and minor crops (ginger and millet). About 77.42% of the farmers have access to the use of tractors for land preparation while increased area cropped (59.20%) is the most important benefit of agricultural mechanization to farmers in Soba LGA while ease of harvesting farm produce using machinery comes second with 17.00%. Cost of purchase of agricultural machinery and poor terrain were the most important constraints militating against the use of agricultural machinery in Soba LGA. This study has revealed that agricultural mechanization could significantly increase area cropped, eased harvesting, reduced drudgery in farm operations thereby making agriculture attractive and rewarding.
Key words: Agricultural mechanization, crop production, Soba Local Government Area, Kaduna State, Nigeria

INTRODUCTION
Agriculture is one of the sectors that significantly affect the growth of societies. The agricultural sector, which has an important place in meeting the food needs of the society, increased national income through export, and supporting the industrial sector is strategic in sustainable development of countries and societies. It is a major occupation providing employment for about 70 percent of the people in Africa (Idrissa *et al*, 2008). Despite this, Nigeria is unable to produce enough food and fiber to meet her demand. This could be attributed among others, to the fact that majority of Nigerian farmers are subsistence smallholder farmers who cultivate between 1-2 hectares, which is usually scattered over a wide area (Akande, 2006). The wide spread hunger and malnutrition along with low and stagnating productivity in agriculture tends to be at the top of the list of food and agricultural concerns in developing countries. Food crisis has been the major problem of the rural households in Nigeria (Mohammed, *et al*. 2009).

It has been reported by Faborode (2001) that less than 2% of the agricultural production in Nigeria is mechanized in the real sense, leaving 98% of the production in the hands of traditional producers. The effect of this dependence on hand tool technology is low output as the technology cannot transform agriculture (Amadi and Ekezie,2016). It is very clear that the current crop production is not enough to meet the demand of the growing population in the states of the federation. This production pattern in which the farmers cannot feed themselves not to talk of surplus for market to meet up with other necessities of life, means that there are problems with the present production system. It is based on this premix that the need for this study arose in order to determine the influence of agricultural mechanization on area cropped, and the productivity of farmers in Soba Local Government Area (LGA) of Kaduna State, Guinea Savanna Agro-Ecological Zone of Nigeria.

MATERIALS AND METHODS

In building up this study, we used descriptive research survey design because of its advantages of identifying attributes of a large population from a group of individuals. Questionnaires were used as sampling instrument for data collection. The questionnaires were administered to 200 respondents in the study area but only 155 were fully completed and returned. The questionnaires were designed to obtain sufficient and relevant information from the respondents.

Farmers were asked to list in order of importance the main constraints to the use of farm machinery using a scale of 1-5 as indicated below:

1 = not important   4 = very important
2 = fairly important   5 = most important
3 = important

Simple statistical analysis involving percentages, averages (weighted averages) were used in the analysis. Weighted averages were used because it is desirable to find the average of various observations of more than one variable knowing that the observations are of different importance (Everitt and Skrondal, 2010). Because of the relative importance of two or more components, there should be a weight thereby obtaining the weighted average by using the function:

$$M = \frac{W1\,x1 + W2x2 + W3x3 \ldots + Wnxn}{W1 + W2 + W3 \ldots + Wn}$$

$$M = \frac{Wx}{W}$$

Where M= weighted average
Wn = importance of observations (weights)
Xn = number of observations
Σ = summation

RESULTS AND DISCUSSION

Age of respondents

Personal characteristics of the respondents with respect to their ages are as presented in Table 1. Table1 shows the age of respondents. Most of the farmers (43.23%) are within the ages of 26-35years, this showed that majority of farmers in Soba LGA are youths, 18.06% are within the ages of 18-25, while 18.71% were above 46years of age.

Table 1: Age of respondents

Variables	Frequency	Percentage
Age (in years)		
18-25	28	18.06
26-35	31	20
36-45	67	43.23
46 and above	29	18.71
Total	**155**	**100**

Source: Field survey, 2020

Sex and Marital Status of the Respondents

Table 2 shows the sex and marital status of the respondent farmers. Majority of the farmers in Soba LGA are males (70.97%) while 29.03% are females. Also 82.58% are married while 14.19% are singles and 3.23% are divorced.

Table 2: Sex and marital status of the respondents

Variables	**Frequency**	**Percentage**
Sex		
Male	110	70.97
Female	45	29.03
Total	**155**	**100**
Marital status		
Married	128	82.58
Single	22	14.19
Divorced	05	3.23
Total	**155**	**100**

Source: Field survey, 2020

Educational qualifications of the respondents

Table 3 presents the educational qualification of the farmers. About 53.55% of the farmers are illiterates while 24.52% of them had primary school certificate and only 1.94% had degree certificates.

Table 3: Educational qualifications of the respondents

Variables	**Frequency**	**Percentage**
Educational qualification		
Primary school	38	24.52
Secondary	20	12.90
OND/HND	11	7.10
Degree	03	1.94
Illiterate (no qualification)	83	53.55
Total	**155**	**100**

Source: Field survey, 2020

From table 4, Farmers (50.97%) in Soba LGA grow other crops like ginger, millet, tomato and pepper and 29.03% of them produce maize while cowpea recorded lowest with a percentage of 8.39%. About 50.97% of farmers in Soba LGA keep of other livestock like chickens, duck and turkey and 29.03% of them keep goat.

Table 4: Type of crops grown and livestock kept by respondents

Variables	Frequency	Percentage
Crops grown		
Maize	45	29.03
Groundnut	18	11.61
Cowpea	13	8.39
Ginger, millet, tomato and pepper	79	50.97
Total	155	100
Livestock kept		
Goat	45	29.03
Sheep	13	8.39
Ram	18	11.61
Birds (chicken, duck and turkey)	79	50.97
Total	**155**	**100**

Source: Field survey, 2020

Ownership of farm machinery

Table 5 presents the number of farmers in the local government that own one type of farm machinery or the other. From Table 5 above, about 70.97% of farmers in Soba LGA do not own any farm machinery while 29.03% agreed that they own a farm machinery.

Table 5: Ownership of farm machinery

Variable	Frequency	Percentage
Ownership		
Yes	45	29.03
No	110	70.97
Total	**155**	**100**

Source: Field survey, 2020

Influence of Agricultural Mechanization on Area Cropped in Soba LGA

Table 6 presents the total area cropped by farmers as a result of the use of farm machinery. Table 6 showed that agricultural mechanization has influence on area cropped by farmers in Soba LGA. About 77.42% of the farmers agreed that additional agricultural tools brought about increased hectares of land cultivated.

Desire to own Farm Machinery in Soba LGA?

Table 6: Contribution to Area Cropped

Area cropped(Ha)	**Frequency**	**Percentage**
1-5	100	64.52
6-10	40	25.81
11-15	10	6.45
16 and above	05	3.23
Total	**155**	**100**
No of farmers that increased area cropped		
Yes	120	77.42
No	35	22.58
Total	155	100

Source: Field survey, 2020

Table 7 presents the number of farmers that are desirous to own farm machinery in Soba LGA. From table 7, about 83.87% of farmers desire to own a farm machinery, while 16.13% did not see the need to own one in Soba LGA.

Table 7: Desire to own farm machinery in Soba LGA

Desire	Frequency	Percentage
Yes	130	83.87
No	25	16.13
Total	**155**	**100**

Source: Field survey, 2020

Benefits of Agricultural Mechanization on Yield per Hectare in Soba LGA?

Table 8 presents the benefits accruing to the farmers as a result of agricultural mechanization in Soba LGA using average ranking. Table 8 above revealed that agricultural mechanization increased area cropped (59.20%), being the most important benefit of agricultural mechanization to farmers in Soba LGA. Ease of harvesting farm produce using machinery comes second with 17.00%. Improved income arising from mechanization was the least considered by farmers.

Table 8: Benefits of agricultural mechanization in Soba LGA

Benefits	Average Ranking	Percentage
Increases area cropped	8.80	59.20
Makes harvesting easy	2.54	17.00
Reduces drudgery in processing	1.36	9.00
Saves time	1.10	8.20
Improves income from more harvest	1.05	7.00
Aggregate mean	14.85	100.40

Source: Field survey, 2020

Problems Affecting Agricultural Mechanization in Soba LGA

Table 9 presents the problems militating against the use of agricultural mechanization in Soba LGA. Table 9 revealed that the cost of purchase of agricultural machinery was the most important constraint militating against the use of agricultural machinery in Soba LGA. This was followed by unsuitability of land for tractorization. Availability of machinery to purchase is not a constraint to farmers as these machineries are easily available in the open market.

Table 9: Problems of Agricultural Mechanization in Soba LGA of Kaduna State

Problems	Ranking	Remarks
Cost of purchase	5	Most important
Availability to purchase	1	Not important
Maintenance	3	Important
Suitability of Land for tractorization	4	Very important

Key:
1 = not important
1 = fairly important
2 = important
3 = very important
4 = most important

Majority of the farmers in Soba Local Government Area of Kaduna State fall within the middle age (36-45 years). This is a reflection of the abundance of farm labour in both rural and urban areas of northern Nigeria (Yusuf, 2018 and Tijani *et al*, 2015). The authors opined that as a result of population growth in this part of Nigeria coupled with their low educational qualification, agriculture becomes the main source of employment of these surplus labour.

On the sexes and educational qualifications of the farmers in the study area, the study revealed that 70.97% of the farmers were males indicating that male members of the population are more into farming than the females. This confirms the works of Oseni, *et al* (2013) that most farmers in this part of Nigeria are males with low educational qualifications. About 53.55% are considered to be illiterate.

On crops grown by farmers in Soba LGA, the study revealed that 50.97% of the farmers cultivate other crops like tomato, okra and leafy vegetables. Chama and Chukuezi (1999) in their study that farmers in Zaria, Kaduna State are more into irrigated farming than rain fed agriculture as it has more production cycles thus fetches more income. These authors further opined that commercial vegetable entrepreneurs are mainly poorly educated migrant farmers who engage in vegetable production as an off-season income-generating activity.

On ownership of farm machinery, the study revealed that most of the farmers (70.97%) could not afford to purchase and own farm machinery though majority (83.87) of them are desirous to own one. The main reason given was the prohibitive cost of these agricultural machines. This finding is in consonance with Asoegwu and Asoegwu (2007) who said that farmers in Nigeria rarely could purchase a farm machinery like tractor due to its high cost. Majority of the Nigerian farmers are poor and they lack the fund needed to purchase sophisticated farming machines (Anazodo, 1975) and even the few farmers that could afford these sophisticated farming machines suffer setbacks like frequent breakdowns and cost of spare parts (Aikins and Okyere 2012).

On benefits accruing from the use of farm machinery, the study revealed a number of benefits to include increased area cropped, ease of harvesting and processing and reduction in drudgery that usually accompany farm work. These findings are in line with Anazodo, (1975).

Despite these enormous benefits of farm mechanization, there are a number of drawbacks. These include high cost of purchase which is the most important problem followed by scarcity of spare parts and experienced technicians and uneven terrain for tractor operations (Anazodo, 1975; Kumi and Tiawo, 2014).

The findings of the study also revealed that agricultural mechanization has positively influenced profit margin and efficiency of farm operations (Anyanwu, *et al*, 2008; Aikins and Okyere, 2012).

CONCLUSION

It is evidenced that the current crop production system is not enough to meet the demand of the growing population in the states. It has been reported that agricultural production in Nigeria is grossly under mechanized in the real sense, leaving production majorly in the hands of traditional producers. The effect of this dependence on hand tool technology is low output as the technology cannot transform agriculture. This study has revealed that agricultural mechanization could significantly increase the area cropped, ease of harvesting and reduction in drudgery of farm operations thereby making agriculture attractive and rewarding.

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The Analysis of the Physico-Chemical Characteristics of Groundwater in Kafanchan Town, Kaduna State

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ABSTRACT
Groundwater (hand dug wells and boreholes) quality in Kafanchan Town, Kaduna State is facing challenges. The present study involves determination of some physico-chemical properties in drinking water samples. Fifteen (15) samples of groundwater were collected from the study area. The samples were analyzed for the following physical and chemical parameters turbidity, electrical conductivity, total dissolved solids (TDS), iron, nitrate, pH, chloride, fluoride, and biological oxygen demand (BOD) using standard methods. The data showed variation of the investigated parameters as follows: pH 5.45-7.50, electrical conductivity (EC) 23.8-106.5µS/cm, turbidity 2.0-7.1NTU, nitrate 0.03-0.45mg/l, BOD 0.54-2.42mg/l, iron 0.02-0.63mg/l, magnesium 0.02-0.72mg/l and fluoride0.04-0.29mg/l. The concentration of some of the investigated parameters of the study area were above permissible limits of the World Health Organization standard (WHO), and the Nigeria Standard for Drinking Water Quality (NSDWQ) specified for drinking water quality guidelines. The Chi square (X^2) test showed that there are no statistically significant differences between the observed concentration of turbidity, iron, fluoride, and magnesium and the standard set by WHO and NSDWQ. Also, statistical analysis, showed that there are statistically significant differences between the observed concentrations of chloride, nitrate, electrical conductivity, TDS, and BOD and the standards set by WHO and NSDWQ.

INTRODUCTION
The term "groundwater" comprises of water that exists beneath the land surface, held within openings or pores of soil and geological formations. Groundwater is the water that naturally occurs in porous rock materials underground (Pawari and Gavande, 2013).

The quality of groundwater depends on various chemical constituents and their concentrations, which are mostly derived from geological data of a particular region. The addition of different kinds of pollutants through sewage, industrial effluents and agricultural run-off into the water main stream brings about a series of changes in the physicochemical characteristics of groundwater which have been subjected to several investigations (WHO/UNEP, 1989; Ayodele and Abubakar, 1998). Groundwater analysis for physical, chemical and biological properties is very important for public health studies (Pawari and Gavande, 2013). Groundwater quality is thus analyzed for its physical, chemical and biological parameters which are closely interlinked (Obiefuna and Orazulike, 2010). The quality parameters focused upon in this present study are the physical quality parameters which include turbidity, total dissolved solids (TDS), and electrical conductivity (EC), and also some chemical quality parameters which include pH, biological oxygen demand (BOD) and the concentrations of iron, magnesium, fluoride, nitrate and chloride.

METHODOLOGY

Study area

Kafanchan Town is located in Jema'a Local Government Area of Kaduna State which lies between latitude 9^0.58' and Longitude 8^0.29', situated at an elevation of 733 metres above sea level. The area is designated Koppen's Aw climate with two distinct seasons: a wet season and a dry season. Rainfall occurs between the months of April to October with a peak in August. The mean annual rainfall is about 1400mm and the mean monthly temperature is 30^{O}C, while the relative humidity is about 69%. The main type of soil is the ferruginous tropical soil which is related to the climate, vegetation, lithology and the topography of the area. The relief is relatively flat and undulating. These influence the drainage pattern of the area (Abaje et al, 2009).

The vegetation of the area with an annual rainfall of about 1000mm-1400mm is typical Guinea Savannah. The few trees are scattered here and there with common species such as: the local beans, shea-butter among others (Bako, 2012). The geology of Kafanchan area has been investigated in the past by a number of scholars. Igneous and metamorphic rocks predominantly underlay the Jema'a region. These belong mainly to Precambrian to lower palaezoic basement complex. There is also occurrence of late tertiary to quaternary, volcanic lava, which are found mostly within the region (Adamu, 2003).

Three main soil types are found over the study area, the sandy gravels of the hill slopes, the sandy loam of the upland areas of the plain and the deposits of the fadamas on river valleys (Bako, 2012). The major crops cultivated are sorghum, Millet, Cassava, Maize and yam. Others are acha, cocoyam and rice.

Methods

The data requirements for this research work include; empirical information on the physico-chemical parameters of sampled water collected from fifteen different points within the area. For the purpose of this study, the sources of data were grouped into two broad groups, that is, primary sources and secondary sources. The primary data used for this study was based on laboratory analysis of the sampled groundwater collected from the study area, so as to obtain the physico-chemical characteristics of groundwater. The data obtained from secondary sources were mainly from existing published documents in various libraries, governmental agencies, the internet, maps, journals and textbooks.

A total of fifteen samples were collected from two types of groundwater sources in the area. Ten (10) wells and five (5) boreholes water were sampled. Purposive sampling was done at random. To collect the water samples, an approximate 2litre plastic bottle was used to collect the sample water. Each of the bottles was sterilized using methylated spirit, rinsed rigorously with the sample water, and properly labeled with ink and masking tape. The borehole was allowed to run for five minutes so as to avoid impurities before the samples was taken.

Method of Analysis

Sample of collected ground water taken to the laboratory for analysis using standard procedures to determine the followings: pH (APHA, 1998), turbidity, chloride, fluoride, nitrate, magnesium and iron (Gimba, 2008).

Statistical Analysis

SPSS 2.0 was used for the statistical analysis.
The chi-square X^2 test was employed in evaluating statistical significance of the phyisco-chemical elements observed. This statistical test is a non-parametric test of the differences

between the observed concentrations of the elements and the expected level set by WHO (2011) and NSDWQ (2007) standard for drinking water.

Table 1: Sampling sites, their codes, coordinates, and water type

S/N	Sampling Sites	Codes	Coordinates		Water Type
			Latitude (N)	Longitude (E)	
1	Kanikon	Sample 1	9°33'59.9''	8°17'18.2''	Well
2	Angwan Grammar	Sample 2	9°33'7.19''	8°17'14.9''	Well
3	Takau Quarters	Sample 3	9°34'31.8''	8°17'6.5''	Boole
4	Adamawa Street	Sample 4	9°35'17.4''	8°17'49.7''	Well
5	Angwan Maighizo	Sample 5	9°35'29.8''	8°19'6.81''	Well
6	Makabarta Street	Sample 6	9°35'6.4''	8°17'54.4''	Well
7	Kofan Sarki	Sample 7	9°35'7.4''	8°17'53.2''	Well
8	Takau Gida	Sample 8	9°34'44.9''	8°18'8.85''	Well
9	Binzom	Sample 9	9°34'8.6''	8°17'29.1''	Borehole
10	Angwan Masara	Sample 10	9°34'48.8''	8°18'9.42''	Well
11	After Railway Line	Sample 11	9°34'54''	8°17'55.4''	Well
12	Jama'a Street	Sample 12	9°35'18''	8°17'56''	Well
13	Sokoto Street	Sample 13	9°35'10.6''	8°17'46.9''	Borehole
14	Magajiyah Street	Sample 14	9°35'23''	8°17'6.16''	Borehole
15	Hayin Gada	Sample 15	9°34'8.02''	8°17'6.67''	Borehole

Source: Author's field survey, 2017

RESULTS AND DISCUSSION

The nature of the physico-chemical parameters of groundwater in Kafanchan Town

The results of the physical and chemical characteristics of the sampled groundwater of the study area as obtained from laboratory analysis are presented in the Table 2 and 3 respectively. The level of some of the parameters showed remarkable variations which can be attributed to the differences in the anthropogenic activities of the area such as the agricultural activities, poor drainage system and channelization.

TDS - The TDS of the water samples ranged from 75.8-998.5mg/l. All the sample were within the acceptable limit of 500mg/l set by WHO (2011) and NSDWQ (2007) with the exception of sample 3 and 4 that were above the acceptable limit. The high concentration of TDS might be as a result of sewages, urban run-offs and use of chemicals for agriculture (Akande, 2015). Drinking water with elevated amount of TDS for longer periods will expose the body to various chemicals, toxins and may cause chronic health conditions like cancer, liver, kidney and several diseases like nausea, lung, irritation rashes and vomiting (WHO, 2017).

Turbidity - Ranged from 2.0-7.1 NTU. All except sample 3 and 4 that fell outside the maximum permissible limit of 5 NTU. The result obtained on the level of turbidity in the sampled groundwater is in line with the findings of (Ehiowemwenguan *et al* (2014) carried out in Edo State, Nigeria. High turbidity in source water can habour microbial pathogens which can be attached to particles and impair disinfection (Joel and Ronnie, 1999).

Table 2: The result of the physical parameters of the sampled groundwater of the study area

Samples	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	WHO (2011)	NSDWQ (2007)
Turbidity (NTU)	2.5	3.9	5.3	7.1	2.0	3.5	4.2	2.6	4.3	2.8	3.6	4.2	3.0	3.4	2.0	**5.0**	**5.0**
Conductivity (μS/cm)	23.8	40.2	34.5	106.5	35.7	43.1	42.9	67.4	56.8	31.1	68.4	52.2	55.8	97.6	71.9	**1000.0**	**1000.0**
TDS (mg/l)	75.8	93.4	998.5	874.9	87.3	367.4	450.5	197.8	473.2	90.3	379.8	498.3	157.0	214.1	145.3	**500.0**	**500.0**

Source: Author's field survey, 2017

Table 3: The result of the chemical parameters of the sampled groundwater of the study area

Samples	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	WHO (2011)	NSDWQ (2007)
pH	5.45	5.78	6.52	7.50	6.21	6.10	5.87	6.61	5.87	6.34	6.73	6.30	6.55	7.31	6.76	**6.5-8.5**	**6.5-8.5**
Nitrate (mg/l)	0.03	0.17	0.04	0.07	0.15	0.12	0.09	0.10	0.45	0.18	0.25	0.30	0.24	0.20	0.14	**50.0**	**50.0**
Fluoride (mg/l)	0.04	0.17	0.27	0.18	0.11	0.29	0.13	0.06	0.07	0.17	0.22	0.14	0.12	0.16	0.07	**1.5**	**1.5**
Iron (mg/l)	0.52	0.02	0.09	0.43	0.29	0.08	0.05	0.63	0.38	0.33	0.13	0.32	0.18	0.15	0.41	**0.3**	**0.3**
BOD (mg/l)	0.54	1.20	2.42	1.87	1.70	0.66	0.81	1.67	1.06	2.13	1.56	1.36	0.44	0.40	1.70	**5.0**	**-**
Chloride (mg/l)	24.2	37.6	25.5	43.7	41.3	66.1	70.8	45.6	57.0	44.2	48.3	74.4	49.9	78.6	44.1	**250.0**	**250.0**
Magnesium (mg/l)	0.31	0.04	0.02	0.18	0.40	0.62	0.04	0.32	0.21	0.05	0.07	0.03	0.18	0.72	0.04	**0.20**	**0.20**

Source: Author's field survey, 2017

Conductivity - The conductivity of the sampled groundwater was found to be within the range of 23.8μS/cm to 106.5μS/cm. All the groundwater samples fell within the maximum permissible limit of 1000μS/cm of WHO (2011) and NSDWQ (2007).

Interpretation of the Chemical Parameters of the Groundwater Analysis

pH –Most of the samples do not meet up with the standard set by WHO (2011) and NSDWQ (2007) as the pH of the groundwater was found to be within the range of 5.45 - 7.50 which makes some of the water acidic except for sample 3, 4, 8, 11, 13, 14 and 15. When pH is less than 6.5 it can leach metals such as iron from the well affect pipes that brings water through corrosion of metals as well as disinfection efficiency which may have an indirect effect on health (WHO, 2017).

Iron - The concentration of iron in the sampled groundwater ranges from 0.02-0.63mg/l with sample 2, 3,5, 6, 7, 11, 13 and 14 fell within the permissible limit of 0.3mg/l of WHO (2011) and NSDWQ (2007). While sample 1, 4, 8, 9, 10, 12, and 15 were above the permissible limit. According to WHO (2012) high iron in water content leads to an overload which can cause diabetes, stomach problems, hemochromatosis and nausea. Others are staining of laundry and porcelain.

Magnesium - From the result of the analysis, the concentration of magnesium ranges between 0.02-0.72mg/l. Sample 2, 3, 4, 7, 10, 11, 12, 13, and 15 fell within the maximum permissible limit of 0.20mg/l of WHO (2011) and NSDWQ (2007). While sample 1, 5, 6, 8, 9, and 14 were above the maximum permissible limit. Excess intake of magnesium inhibits the absorption of other essential elements and may cause diarrhea while the inadequate uptake of magnesium also poses health threats (WHO, 2017)

Fluoride - From the result obtained, the concentration of fluoride ranges between 0.04-0.29mg/l. All the samples fell within the maximum permissible limit of 1.5mg/l of WHO (2011) and NSDWQ (2007).

Nitrate - The concentration of nitrate of the sampled groundwater were found to be within the range of 0.03mg/l to 0.45mg/l. Thus fell within the maximum permissible limit of 50mg/l of WHO (2011) and NSDWQ (2007). The concentration of nitrate from the findings is in line with the findings of (Bernard and Ayeni, 2012).

Chloride - The concentration of chloride found in the sample ground water is within the range of 24.20-74.40mg/l. All the samples fell within the permissible limit of 250mg/l set by WHO (2011) and NSDWQ (2007)

BOD - From the result of the analysis of groundwater samples from the study area, the level of BOD ranges within 0.40-2.42mg/l. This makes the samples water fell within the maximum permissible limit of 5mg/l of (WHO, 2011).

CONCLUSION

The results showed that some of the physicochemical parameters e.g. electrical conductivity, BOD, nitrate, fluoride and chloride concentrations were within the maximum permissible limits of WHO and NSDWQ recommended standards. However, pH, turbidity, magnesium and iron in some locations were found to exceed the maximum permissible limit. Further analysis showed that there are no statistically significant differences between the standard set by WHO and NSDWQ and observed concentrations of chloride, nitrate, electrical conductivity TDS. However, there was significant differences between the observed concentrations of chloride, nitrate, electrical conductivity, TDS, and BOD

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PROCEEDINGS

55th Annual Conference

Agricultural Society of Nigeria

25-29 Oct., 2021

Rufus Giwa Polytechnic, Owo Ondo State

SUB-THEME 8

Agricultural Modelling and Climate Change

Agroforestry as a Climate Change Mitigation and Adaptation Tool for Agriculture

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PROCEEDINGS
55th Annual Conference
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ABSTRACT
Sustainable agriculture based on agroforestry is multi-functional and diversified, and based on agro ecological methods adapted to the specific ecosystem. Agroforestry promotes, nutrient management, soil and water conservation, tillage and residue management, land restoration and rehabilitation, integrated livestock management, integrated pest management, and sustainable energy, also provide food, improve income. This paper aimed to provide solution to climate change mitigation and adaptation tool for agriculture through sustainable Agro-forestry practices and climate change integrated strategy to promote environmental sustainability, food security, improve income and stable biodiversity
Keywords: ***Agro forestry, Biodiversity, Sustainability, Climate Change and Conservation***

INTRODUCTION
Climate change has become one of the most intervening global issues facing human kind and earth's natural system. Intergovernmental Panel on Climate Change (IPCC) (2007) refers climate change to a change in the state of the climate that can be identified by changes in the mean or the variability of its properties which persists for an extended period, typically decades or longer. According to Amajath Babu, *et al.* (2016), climate change is a global challenge facing humans and their socioeconomic activities, health, livelihood and food security with a more serious threat than global terrorism (King, 2004). Nmadu *et al.* (2017) posited that about 90% of the total population in Nigeria depends on rain fed agriculture for food production. Therefore, any changes in climate will have an impact on productivity and their social economic activities in the country. The effects can be measured in term of its effects on crop growth, soil erosion, incidence of pests and diseases and availability of soil water. In Nigeria, the adverse impacts of climate change are already having their toll on the livelihood of people as farmland are being destroyed by floods, due to heavy rain falls.

According to Stem (2007) climate change is threatening to undo decades of development efforts due to its negative impacts on agriculture, health, environment, roads, and buildings especially in developing countries. It affects both food and water resources that are critical for livelihood in Africa, where most population especially the poor, rely on local supply system that are sensitive to climate change to survive. However, adaptation to climate change requires that farmers must first perceive that climate has changed, identify useful adaptations and implement necessary mitigating responses (Maddison, 2006). Obioha (2019) noted that the sustainability of the environments to provide all life support system and the materials for fulfilling all developmental severity to man depend on suitability of the climate which is undergoing constant changes. The effect of these changes is posing threat to food security in Nigeria.

What is Agroforestry?

Agroforestry, generally refers to land used system or farming system in which trees or shrubs are grown in association with agricultural crops, pastures or livestock and in which there is ecological and economic interaction between the trees and other components. Agroforestry practice is a distinctive arrangement of components in space and time. It is a specific local example of a practice, e.g. Taungya. It is characterized by environment, plant species, and arrangement, management, social and economic functions.

Types of Agroforestry Systems

Trees on farmland: The farmers plant or retain trees on their farmland, both for food, income, soil improvement and environmental amelioration and for shade during the harsh weather period.

Parkland /scattered trees: Parklands are characterized by well grown scattered trees on cultivated and recently fallowed land (CTA, 2003). These parklands develop when crop cultivation on a piece of land becomes more permanent. The trees are scattered far apart so that they do not compete with their neighbours. Parklands consist of indigenous trees like *Parkia biglobosa*, *Vitellaria paradoxa*, *Tamarindus indica*, *Azadirachta indica*, etc. Parkland trees have the following characteristics: They are deep rooting, preferably reaching ground water table. They have capacity to fix nitrogen produce litter that decomposes well and add as much as possible to soil organic matter.

Alley cropping as described by (CTA, 2003) is a system in which strips of annual crops are grown between rows of trees or shrubs. Lining up the woody plants in hedges should ensure that there is little interference with cultivation of the field. The extension of alley cropping to include animal husbandry by the International Livestock Research Institute (ILRI) has led to the concept of alley farming (Okali and Submerge, 1985).

Wind breakers and shelter belts. Their major purpose is primarily to control wind erosion. The species used include, *Azadirachta indica, Khaya senegalenses, Eucalyptus camaldulensis* etc.

Benefit of Agroforestry

Agroforestry on Agricultural Crop and Animal Functioning

The shade provided by the trees helps in moderating microclimate and reducing crops and livestock stress and helps to improve crop yields (World Bank, 2012). One of the most promising fertilizer tree species is *Faidherbia albida*, an Acacia species native to Africa and the Middle East. *Faidherbia albida* is widespread throughout Africa, thrives on a range of soils, and occurs in different ecosystems ranging from dry lands to wet tropical climates. It fixes nitrogen and has the special feature of reversed leaf phenology, a characteristic that makes it dormant and sheds its leaves during the early rainy season and leafs out at the onset of the dry season. This makes *F. albida* compatible with food crop production; because, it does not compete for light, nutrients, and water. According to Dawson *et al*. (2014) report, agroforestry practices can have the potential to mitigate climate change impacts on animal production and productivity Agroforestry can have the budding as tree fodder, reduces carbon dioxide emission through reducing carbon footprint and carbon sequestration in roots and stems.

Agroforestry on Soil Improvement and Carbon Sequestration

The N (nitrogen), OC (organic carbon) and K (potassium) levels were 42, 31 and 25% respectively higher under the canopies of *F. albida* than outside which is found in Zambia (Umar, 2013). Planting of agroforestry trees is thus an option for the households that will have secure tenure to their land use type. Abatement rates of agroforestry systems, integrated land-use systems combining trees and shrubs with crops and livestock, are fairly high. This is due to the relatively large time-averaged biomass of trees compared to crops. The average abatement rates in tone per ha per year are 7.6 for alley farming (the growing of crops simultaneously in alleys of perennial, preferably leguminous trees or shrubs), 7.5 for tree-crop

farming, 8.7 for improved fallow (involving the use of fast-growing trees to accelerate soil rehabilitation), 4.6 to 6.3 for intercropping (the growing of crops near existing trees), and 4.3 to 6.7 for croplands where trees are introduce (World Bank, 2012).
The integration of *Faidherbia* trees into the farming systems is highly efficient and the trees have multiple functions (Hadgu *et. al*., 2011).

Minimizing runoff and soil erosion
Soil aggregation is higher in fertilizer trees/shrubs agroforestry system and this enhances water infiltration and water holding capacity (Phiri *et al*., 2003). Leucaena contour hedges have effectively controlled soil erosion on steep slopes in Malawi (Banda *et al*., 1994).
The benefits of fertilizer trees/shrubs to household food security and their potential to contribute ecosystem services and respond to climate change is summarized in Table 1.

Table 1: Yield and ecosystem service benefits of agroforestry-based fertilizer trees/shrubs at farm and community levels

Farm level	Community
2-3 folds maize yield increase	Carbon sequestration
• Increase in maize stover for livestock	• Reduced soil erosion through better soil water conservation
• Fuel wood available in field, reduces time spent searching for wood	• Enhanced biodiversity
•Potential to mitigate the effects of drought during maize growing season	•Wind breaks
•Stakes for curing tobacco leaves	•Sources of fuel wood and potentially avoided deforestation

Figure 1: Yellow Maize Production in Agroforestry farm

Climate Change Mitigation and Adaptation

Climate Change Integrated Strategy

There are five main categories of agroforestry practices in Nigeria, with a growing sixth category—Special applications for agroforestry technologies being adapted to address emerging needs across rural/urban landscapes, such as storm water treatment and bio feed stock production. As a suite of practices to assist in creating productive and healthy farm and ranch operations, agroforestry has the potential to contribute to both CC mitigation and adaptation (M&A) by sequestering carbon (C), reducing GHG emissions, enhancing resiliency, and reducing threats while facilitating migration to more favorable conditions in the highly fragmented agricultural landscapes. Although agroforestry's CC M&A potential is better recognized in the tropics (Verchot *et al.,* 2007), awareness of its potential for temperate and boreal systems is growing (CAST, 2011).

Adaptation

Agroforestry add a high level of diversity within agricultural lands and increased capacity for supporting numerous ecological and production services that impart resiliency to climate change impacts (Verchot *et al*., 2007). From a landowner's perspective, the most valued services would be those that can dampen the negative effects of CC and weather extremes while augmenting the positive benefits provided by tree-based systems. CC risk management is difficult in annual-only systems due to the increasing uncertainty and volatility of inter annual variability in rainfall and temperatures. The mixing of woody plants into crop, forage, and livestock operations provides greater resiliency to this inter annual variability through crop diversification produced seasonally, as well as through increased resource-use efficiency (Olson *et al*., 2000). Deep-rooted trees allow better access to nutrients and water during droughts and, when appropriately integrated into annual cropping or forage systems, may extract from a different pool of resources and/or from resources that would otherwise be lost from the system (*van Noordwijk et al*., 1996).

Sustainable Agro-forestry practices

Table 1: Sustainable Agro-forestry practices that are capable of reducing the effects of climate change and adaptation in the 3 major agro-ecological zone

Technology	Forest Zone	Savanna Zone	Sudan/Sahel Zone
Mixed faming	X	X	X
Mixed cropping	X	X	X
Crop rotation	X	X	X
Cover crop	X	X	X
Minimum/zero tillage	X	X	X
Compost manure	X	X	_
Green/plough in crop residues	X	X	X
Controlled/Zero burning	X	X	X
Farm yard	X	X	_
Mulching	X	X	-
Terracing	X	X	X
Drip Irrigation	X	X	X
Alley farming	X	X	X
Alley cropping	X	X	X
Scattered tree planting	X	X	X
Boundary/Perimeter	X	X	X
Orchard	X	X	X
Woodlot/Cluster planting	X	X	X
Taugya farming	X	X	X
Silvo-pastoral farming	X	X	X

Key = X (present). Key = - (not present)

CONCLUSION

Agroforestry practices offer practical ways of applying various specialized knowledge and skills to the development of sustainable rural production systems. Human activities are wreaking havoc on the atmosphere, and this poses a threat to communities globally, but particularly in poorer countries where the ability to adapt is lower. Sub-Saharan African countries and in particular, southern African region faces the challenge to implement policies for achieving livelihood needs, promote environmental stewardship and respond to the challenges of climate change. The challenge however is not so much, the absence of science and technological options that can help improve their productivity and respond to climate change, given the availability of proven sustainable agricultural and land use practices such as fertilizer trees/shrubs to meet some of the challenges. Beyond having the "right" field technologies and land use practices that adapt to climate change, there should be complementary "right" politics, market and policies that are conducive to the scaling up of these field practices. We therefore recommend that responses to the challenges of climate change should be made within the context of sustainable agroforestry development taking into consideration livelihood and food security.

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Probability Indicator Function for Assessing the Impact of Rainfall on the Production of Yam in Southeast Region of Nigeria

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ABSTRACT
This study was on the effect of some micro-climate on yam production in southeast Nigeria using a Probability Indicator Function. The Function was developed in such a way that it indicates the effect of climate change impact on rainfall above 50% if the probability of having the rainfall condition for yam production is less than and or equal to 0.5, otherwise impact is below 50%. The rainfall forty (40) years data on monthly rainfall amount (mm) was used. The result showed that climate change has impacted negatively (above 50%) on rainfall for the different growth phases (March – December) of yam production. Thus, this study recommends that climate change mitigation such as irrigation-based agriculture be considered against rain-fed agriculture being presently practiced in Nigeria.
Keywords: irrigation-based agriculture, micro-climate, rain-fed agriculture, yam production

INTRODUCTION
Climate change is a global phenomenon, its threat and vulnerability differ not only from one continent to another, but among sub regions, countries and even communities (Agada *et al*., 2019). The climate of an area is determined by considering the climatic elements such as precipitation, rainfall, temperature, wind, relative humidity, sunshine solar radiation etc, and their variability plays a significant role in the performance of agricultural production (Adejuwon, 2019). Recent studies have showed that important climatic variables for crop growth and yield are temperature, solar radiation and rainfall (Elijah *et al.,* 2018). Crops generally require certain threshold of rainfall during growth periods for maximum yield and when these become excess it leads to yield decline due to its impact on the activities of soil micro-organism and consequently on plant developmental processes (Emaziye, 2015).

Yam (*Dioscorea spp*) is one of the largely cultivated, climate sensitive food crop grown in Nigeria with over 600 species, out of which six are socially and economically important in terms of food (Okongor, 2021). It`s tuber is the storage organ of crop and constitutes the most significant economic part used majorly for human consumption in Nigeria. *Dioscorea rotundata* (white yam) and *D. alata* (water yam) are important staple food and sources of carbohydrate to Nigerian's diet. Yam production in Nigeria is vulnerable to the effect of climate change and variability. This has impacted on the crop growth and yield negatively (Elijah, 2019). This is imperative because 60% of Nigerians are farmers and also studies on the effect of climate change on agricultural production has received limited attention (Olah, 2019).

This work is an improvement of Agada *et al* (2019) who assumed that annual rainfall amount is evenly distributed across yam growth phases (months). Here we assume that the rainfall requirement for yam production is proportionally distributed across the growth phases (months).

MATERIALS AND METHODS

Source of Data

The monthly rainfall (1972 to 2020) was collected from National Root Crops Research Institute (NRCRI), Umudike Meteorological Department.

Data transformation

The specific crop (yam) used in this work has certain climate requirements for growth. The ecology of yam growth shows that yam requires an annual rainfall amount of 1035-1500mm within a growing phase of 9 months. However, in-order to obtain a mean monthly rainfall amount for this growth phase, the annual rainfall amount would be proportionally distributed across these months shown below.

Let the random variable X_{ij} represent rainfall amount, where j represents the months; j= 1,2,3, … ,12 and i represents the number of years under study; i=1,2,3, … , 47. Then the monthly proportion P_{ij} for the period of 47 years is given by:

$$P_{ij} = \begin{array}{ccccc} Year & January & February & \cdots & December \\ 1 & \frac{X_{11}}{\sum_j X_{1j}} & \frac{X_{12}}{\sum_j X_{1j}} & \cdots & \frac{X_{1,12}}{\sum_j X_{1j}} \\ 2 & \frac{X_{21}}{\sum_j X_{2j}} & \frac{X_{22}}{\sum_j X_{2j}} & \cdots & \frac{X_{2,12}}{\sum_j X_{2j}} \\ & & \vdots & & \\ 47 & \frac{X_{47,1}}{\sum_j X_{47,j}} & \frac{X_{47,2}}{\sum_j X_{47,j}} & \cdots & \frac{X_{47,12}}{\sum_j X_{47,j}} \end{array}$$

However, the distribution of proportional monthly rainfall amount for this growth phase is shown below;

$$\bar{p}_{January} = \frac{1}{47}\left[\frac{X_{11}}{\sum_j X_{1j}} + \frac{X_{21}}{\sum_j X_{2j}} + \cdots + \frac{X_{47,1}}{\sum_j X_{47,j}}\right]$$

$$\bar{p}_{February} = \frac{1}{47}\left[\frac{X_{12}}{\sum_j X_{1j}} + \frac{X_{22}}{\sum_j X_{2j}} + \cdots + \frac{X_{47,2}}{\sum_j X_{47,j}}\right]$$

$$\vdots$$

$$\bar{p}_{December} = \frac{1}{47}\left[\frac{X_{1,12}}{\sum_j X_{1j}} + \frac{X_{2,12}}{\sum_j X_{2j}} + \cdots + \frac{X_{47,12}}{\sum_j X_{47,j}}\right]$$

Therefore, the mean monthly rainfall requirements for yam growth are given below as:

Monthly minimum rainfall requirement for yam growth: $(1035)\begin{pmatrix} \bar{p}_{January} \\ \bar{p}_{February} \\ \bar{p}_{March} \\ \vdots \\ \bar{p}_{December} \end{pmatrix}$

Monthly maximum rainfall requirement for yam growth: $(1500)\begin{pmatrix} \bar{p}_{January} \\ \bar{p}_{February} \\ \bar{p}_{March} \\ \vdots \\ \bar{p}_{December} \end{pmatrix}$

Distribution Fit

The normal distribution was selected as the best fit probability distribution for the monthly rainfall in southeast Nigeria. The Anderson-Darling goodness-of-fit test was used at α (0.05) level of significance for the selection of the best fit distribution. The best fitted distribution is selected based on the maximum p-value.

The test statistic A^2 is defined as:

$$A^2 = -\sum_{i=1}^{n}[(2i-1)\{ln F_X(x_i) + ln[1 - F_X(x_{n+1-i})]\}/n] - n$$

Where F_X is the cumulative distribution function of the specified distribution and x_i is the ordered data.

Probability Indicator Function for measuring the impact of climate change on yam growth

Let I_G represents the indictor function of growth, then the indicator function for impact of rainfall on yam production is given as:

$$I_G \Pr(yamG)_{condition} = \begin{cases} above\ 50\%,\ if\ \Pr(yamG)_{condition} \leq 0.5 \\ below\ 50\%, \Pr(yamG)_{condition} > 0.5 \end{cases}$$

$\Pr(yamG)_{condition}$ is the probability of yam growth condition based on the rainfall change considered in this work. $I_G \Pr(yamG)_{condition}$ is a measure of Probability Indicator Function for the impact of rainfall on yam production. All analyses were carried out in an open-source R environment version 4.0.4.

RESULTS AND DISCUSSION

All the growth phases (March – November) of yam production except the month of December fitted the normal probability distribution with p-values greater than the level of significance (p-value> 0.05). The month of and December did not fit any known probability distribution.

The chance of occurrence of the rainfall condition for yam production across the growth phases is captured in Table 1 below, for the months of March to November. The monthly conditions for yam production recorded a very low chances of occurrence (below 0.5, i.e. below 50%). This implies that there are very low chances of occurrence of rainfall requirement in the growth phases for yam production. Without the effect of climate change, the study area should record and continue to record high chance of occurrence of rainfall climatic requirement for yam production (i.e. probability above 50%). But due to the impact of climate change, probabilities below 50% were recorded. The indicator function for quantifying the impact of climate change on growth of yam indicated that climate change has impacted above 50% (Table 1). This result is consistent with that of Agada *et al* (2019) who observed for the months of April to October a low chance of occurrence of rainfall conditions (above 50% impact). for yam growth in Makurdi Benue state. This impact may cause a change of yield pattern of yam as collaborated by (Emaziye, 2015) who found a negative correlation between rainfall and yam which implies that an increase in rainfall will cause a decrease in yam yield.

Table 1: The distribution of the chance of occurrence of the rainfall condition for yam growth

Months	Monthly conditions	Probability of Occurrence	Rainfall impact
Mar	$57.62 \le R_F \le 83.50$	0.0133	Above 50%
Apr	$88.31 \le R_F \le 127.98$	0.1475	Above 50%
May	$137.96 \le R_F \le 199.94$	0.1445	Above 50%
Jun	$149.80 \le R_F \le 217.11$	0.1491	Above 50%
Jul	$146.20 \le R_F \le 211.89$	0.1443	Above 50%
Aug	$159.25 \le R_F \le 230.80$	0.1489	Above 50%
Sep	$174.80 \le R_F \le 253.33$	0.1253	Above 50%
Oct	$132.04 \le R_F \le 191.36$	0.1494	Above 50%
Nov	$28.20 \le R_F \le 40.87$	0.0996	Above 50%
Dec	-	-	-

NB: '-' means that rainfall data for the months of December do not fit any known distribution

CONCLUSION

The probability indicator function was developed to quantify the impact of climate change on the rainfall condition for yam production in southeast region of Nigeria. Rainfall climatic condition across the growth phase of yam production witnessed a low chance of occurrence indicating a negative impact (above 50%) of climate change on rainfall requirement for yam production.

Rain-fed agricultural practices should be discouraged and government are advised to opt for irrigation-based agricultural practices to mitigate the effect of rainfall.

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Climate Change Impacts on Forest Resources

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ABSTRACT
The world climate is changing. Increased temperatures and levels of atmospheric carbon dioxide as well as changes in precipitation and in the frequency and severity of extreme climatic events. These changes are having notable negative impacts on the world forests and the forest sector. This paper, explores the impact of climate change on forest resources, such as forest health, indirect impacts on species diversity, forest productivity, effect on forest processes and changes in nutrient availability. However, the increasing effect on forest ecology, are the chief shortfalls of potential forest production and economic value.
Keywords: Climate change, Forest production, Economic value, species, diversity

INTRODUCTION
The climate is changing, globally becoming warmer almost every year in recent decades. Risk associated with this warming are high, sometimes manifesting into multiple, broad threats to humanity and the economy (Brade, 2009). The recent Intergovernmental Panel on Climate Change (IPCC) report on the impacts of global warming of 1.5°C above pre-industrial levels, and in comparison to impacts of 2.0°C, describes many 'Reasons for Concern' related to efforts to strengthen the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty (Onuoha, 2012). Even so, with current pledges in the Paris Agreement on Climate Change, ~2.6–3.2°C of warming is projected by 2100, though the agreement aims to limit global warming "well below 2°C" and to "pursue efforts" to limit temperatures above pre-industrial levels to 1.5°C (Palmer, 2010). The biodiversity implications of these various levels of warming are huge, as outlined in (Pidwimy, 2006), where climatically determined geographic range losses exceeding 50% were projected for 44%, 16%, and 8% of plants by 2100, corresponding to warming of 3.2°, 2.0°, and 1.0°C respectively. Even though climatically determined range losses do not equate with actual distributions of plants because trees live a long time while harboring great genetic diversity, the potential effects of climate change on the biota as a consequence of the range of these potential changes, models are needed to provide a suite of possible outcomes, by species, to assist decision makers to minimize biological impacts and to adapt to the coming changes.

Concept of Forest resources
Forest resources are biological resources which are harvested from either natural or managed forests. Examples include timber, fruits, nuts, oil seeds, latexes, resins, gums, medicinal plants, spices, wildlife and wildlife products. Others are dyes, ornamental plants, raw materials such as bamboo and rattan. (Kimmins, 1997). Forests are highly valued with their leaves, roots, barks or fruits. They are the forest treasure that sustains rural dwellers by providing income, foods and medicinal materials. As a matter of fact, majority of the rural dwellers all over Africa would have been showing obvious signs of malnutrition if not for the food provided by forest

resources to them in form of forest fruits and vegetables. Forest foods help to supplement and complement the daily diet of the rural dwellers (FAO, 2009)

Forest and Climate change

Forests play a critical role in the Earth's climate system, in a number of different ways. Most importantly for global climate change, they capture carbon dioxide from the atmosphere and convert it, through photosynthesis, into living biomass: tree trunks, roots, branches and leaves. (Nguyen and Bui, 2000). Forests play a role in mitigating climate change by absorbing the carbon dioxide emitted into the atmosphere from human activities, chiefly the burning of fossil fuels for energy and other purposes, into the terrestrial carbon sink. Together, forests and oceans form a natural buffer against climate change (though increasing concentrations of carbon dioxide in seawater gradually acidify the oceans, with negative impacts on marine life) (Pfeifer and Habeck, 2002).

Importance of Forest

Consensus on the need for international co-operation to combat climate change has resulted in increased attention to the role of forests in storing carbon and the large quantity of $C0_2$ emissions that could be avoided if deforestation was halted. (Sheppard, 1995). Furthermore, tropical forests capture and store carbon since the turn of the century tropical forests are estimated to have removed 22 -26% of all human caused carbon emissions (Pfeifer and Habeck, 2002). Forests are also important storehouses of biodiversity and provide livelihoods for over a billion people worldwide including many living in extreme poverty (Beck *et, al*., 1991)

Causes of climate change

Climate change is attributed to two major causes namely natural and anthropogenic (or human) activity, with the latter being a major player over the last few decades globally (IPCC, 2007).

Natural causes

i. Volcanic eruptions – This discharged carbon dioxides, they may also emit aerosols, such as volcanic ash or dust and sulpur dioxides. Volcanic aerosols, can block percentage of sunlight and cause a cooling that may last up to one to two years.
ii. Variation in solar radiation - Total amount of solar radiation varies by very small amount. Energy emitted by the sun only vary by 1.3 W/m^2. This change in solar radiation is related to the number of sunspots. Sunspots are darker areas on the sun surface.
iii. Movement of Crustal plates – as tectonic plate moves over geological time scales, land masses are carried along to different position and latitudes. this changes affect global circulation pattern of air, ocean water and the climate of the continents.

Human causes

Deforestation: This is a phenomenon, where forests are indiscriminately felled without replacement. It is a major contributor to climate change and accounts for 20 percent of the world's carbon emissions (more than what the entire transport sector produces) (IPCC, 2007). Growing Population: As the world's population grows, there are more people who need food, livestock and energy. Nigeria has an estimated population of 170.1million as at mid- 2012 which is projected to rise to 402.4million by mid-2050 (USAID, 2012). This has a corollary increasing demand for clearing the forest for land, processing of food, household, and industrial goods which contribute to the emission of carbon and other hazardous substances to the environment.

Urbanization: This is the way the population shift from rural to urban area, the gradual increase in the proportion of people living in urban area and the ways in each society adapt to the change.

Climate Change Impacts

In general, Nigeria is strongly predisposed to severe negative impacts of climate change due to its fragile economy, weak resilience and low adaptive capacity. Much of the sensitive economic resources are dependent on climate. For example, the agriculture, forestry and fishing sectors employ up to 70% of the workforce (IPCC ,2002). The heavy concentration of GDP generating industry in locations that are highly vulnerable to climate change - induced sea level rise, e.g. Lagos and the Niger Delta makes the country extremely vulnerable. The 2011 Climate Change Vulnerability Index (CCVI) published by the UK - based risk company, Maplecroft, classifies Nigeria as being of high risk (Ravindranath and Ostwald, 2009).

Change in Forest Productivity

Forest productivity and species diversity typically increase with increasing temperature, precipitation and nutrient availability, although species may differ in terms of their tolerance (Bett, 2006). As a key factor that regulates many terrestrial biogeochemical processes, such as soil respiration, litter decomposition, nitrogen mineralization and nitrification, denitrification, methane emission, fine root dynamics, plant productivity and nutrient uptake, temperature changes are likely to drastically alter forests and ecosystem dynamics in many ways (Parmesan and Yohe, 2003). Longer, warmer growing seasons can intensify these effects resulting in severe moisture stress and drought. Such conditions can lead to reductions in the growth and health of trees although the severity of the impacts depends on the forest characteristics, age-class structure and soil depth and type. Young plants such as seedlings and saplings are particularly susceptible whereas large trees with a more developed rooting system and greater stores of nutrients and carbohydrates tend to be less sensitive to drought, though they are affected by more severe conditions.

Climate Change effect on forest health

Forest ecosystem pests and pathogens are likely to increase, either through the direct effect of climate change on their abundance or distribution, or the indirect effect of increased water stress or wind damage which will increase the susceptibility of trees to attack. Climate change alter the disturbance dynamics of native forest, insect pests and pathogens, as well as facilitating the establishment and spread of non-indigenous species. (Wooden *et al*., .2008) Pathogens can take advantage of changing climate; it could have major effects on tree health and survivorship. Forest pathogens may be viral, bacterial or fungal, viral or bacterial infection and transmission rates seem to vary with temperature and moisture in the forest ecosystem. Pathogens like fungal can survive and remain infective over a wide range of temperatures. However, the conditions that favor epidemic growth for most fungal pathogens are constrained to within a band of a few degrees Celsius. Incident of pests and disease.

Indirect impacts on species diversity

Climate change is expected to alter the relationships between pests, their environment and other species, such as natural enemies, competitors and mutualists, leading to changes in the structure and composition of natural communities (Mark, 2004). The observed and predicted changes on species abundance and in phenological patterns and distributions of individual species are likely to alter species interactions within communities (Mark, 2004).

Effects of climate change on forest processes

Trees require light, heat, carbon dioxide and water nutrient to grow through the process of photosynthesis. Increasing temperature, atmospheric carbon dioxide concentrations are altering photosynthesis rates and growth. Naturally plants have their own mechanism to tolerate a certain level of increased temperature. Soil decomposition rate of organic matter will increase as temperature increase and then nutrient mineralization and availability for plants uptake become increased. Thus, the interaction and different combination effect of rise carbon dioxide concentration and temperature is determined by soil properties, water, mineral and nutrient availability.

The availability of forest resources will determine whether a tree will grow well or not, altering the balance between growth and mortality and therefore determining forest productivity (Mark, 2004).

Changes in nutrient availability

Increasing temperature is likely to affect nutrient availability in the soil through the stimulation of organic matter decomposition and mineralization of soil nutrients. There are important links between trees and soil nutrient availability. The recycling of nutrients between the soil and plants is one of the main factors of forest ecosystem functioning. Climate change affect availability of nutrients for plant uptake and limit the productivity, survival of forest ecosystems. Nutrient availability affects forest ecosystem and net primary productivity. Warming temperature has direct physiological effects on rate photosynthesis, macronutrient concentration in soils and leaves of tree, shrubs and herbs. Increase in temperature can lead to reductions in nutrient availability

Mitigation and Adaptation of Climate Changes

1. Agroforestry practices can be separated into three sub-system classifications - Agrisilviculture, Silvopastoral and Agrosilvopastoral (Weiwei, 2014).

• *Agrisilviculture* combines annual and perennial crops with woody perennials (trees, shrubs, vines),

• *Silvopastoral* combines trees with pastures and animals, and

• *Agrosilvopastoral* combines crops, pastures, animal and trees Silvopasture

2. Urban forests reduce GHG emission by capturing carbon from the air and reducing energy use. However, carbon storage by urban trees is a significant contribution to reduce global, national or even local emission. An urban forest management can increase carbon capture by increasing the urban canopy cover. Bigger and younger trees capture more carbon, and the urban forest could be optimized to follow such a growth and structure.

Adaptation

This is the adjustment of a system in response to changing environmental conditions that depends on the system's vulnerability. Trees curb climate change directly by removing carbon dioxide from the atmosphere through the process of photosynthesis. Forests offsets 10-20% of the country greenhouse gas emissions each year. Additionally, trees help protect against climate impacts such as flooding, which is getting worse with more locally heavy precipitation.

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Climate Change Impact on Food Security

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ABSTRACT

Climate change poses a considerable threat to global food security, with potentially existential economic, political, and social outcomes for humanity. As climate impacts worsen and further stress an already hungry world, with negative developmental consequences for the continent and its people. This is because about 70% of the people of Africa live in rural areas and mostly depend largely on agriculture and natural resource based activities for their livelihoods. These livelihood options are dependent on climate-sensitive factors making the people vulnerable. This paper, therefore, explores the effects of agriculture on climate change and impact of Climate Change on the agricultural productivity which has reduced the production of food supply to meet the demand of Nigerian community.

Keywords: Climate change, Agricultural productivity, Food supply, Developmental and Livelihood

INTRODUCTION

Over the years, the world has continued to experience an increase in the temperature of the earth's atmosphere, the soil and the ocean due to the accumulation of the 'Green House Gases' (GHG) principally carbon dioxide (CO_2) in the atmosphere (Ishaya, 2008). A 2007 IPCC report concluded that the temperature increase must not exceed 2ºC globally since any larger increase would have catastrophic consequences for developing countries, where droughts, increased bad weather, rising sea levels and warming of the oceans could put millions of people at risk of food insecurity.

According to the Food and Agriculture Organisation (FAO, 2009), "Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". Food security is built on four pillars (Ericksen, 2008): food availability (i.e. sufficient quantities of food produced and supplied on a consistent basis); food access (i.e. physical access and affordability); food utilisation (i.e. proper use of food based on basic nutrition knowledge); and stability in food availability, access and utilization. The concept of food security (FS) has been central in the discussion on sustainable development. Indeed, the first Millennium Development Goal (MDG) aimed to "Eradicate extreme poverty and hunger" (United Nations, 2015). More recently, from 2016 on, the second Sustainable Development Goal (SDG) "Zero Hunger" aims to "End hunger, achieve food security and improved nutrition and promote sustainable agriculture" (United Nations, 2015). However, despite efforts made over the last decades, food insecurity is still a pressing issue in many countries, especially developing ones. Food insecurity is a symptom of the dysfunction of the global food system (Capone *et al*., 2016, El Bilali *et al*., 2018; El Bilali, 2018; El Bilali, 2019), which is under the unprecedented confluence of various pressures (FAO, 2014) such as climate change (FAO, 2016). Indeed, FAO (2016) puts that "Through its impacts on agriculture, climate change will have negative effects on food security in all of its dimensions. While food security will be affected through other channels – for example, by extreme weather events that reduce urban dwellers' incomes and thus access to food – agriculture is a key channel through which climate change affects food security". Climate change affects the natural resources (e.g. water, land) used in agricultural production (Cadro *et al.,* 2019; Čustović *et al.* 2012) Beyond its impacts on agriculture and food security, climate change (CC) is one of the most pressing challenges facing humanity (IPCC, 2007).

What is Climate Change?

The Intergovernmental Panel on Climate Change (IPCC, 2007), and the United Nations Framework Convention on Climate Change (UNFCC) refer to Climate Change as any change in climate over time whether due to natural variability or as a result of human activity, which alters the composition of the global atmosphere. Thus, climate change can be defined as the slow change in the composition of the global atmosphere, which is caused directly and indirectly by various human activities in addition to natural climate variability over time. Climate is the long-term average of individual weather situations, taken over sufficiently long periods of time. Whereas weather impacts our daily lives, climate influences our decisions about where to live, where, what and how to grow food, which consequently have direct influences on how communities and economies develop and thrive. Changes in climate are associated with more fundamental changes to the global climate system, involving interactions and feedbacks between the atmosphere, the oceans, land and ice surfaces and all living things in these spaces. Climate change can be described as a complex biophysical process influenced by interaction of gases at the earth's atmosphere to cause land and sea temperature rise. Climate change can therefore also be defined as any long-term and significant change in the expected patterns of a specific region's average weather for an appropriately significant period of time.

Impact of Climate Change

Climate change causes floods and droughts as witnessed in parts of Africa have health implications. Rift valley fever which afflicts both human and livestock is related to heavy rainfall. Increased temperature and related heat and drought are known to negatively affect animals and plant health and production. These developments can reduce agricultural labour potential of humans needed to support and manage farms, and cost of food production will also increase, and translate into higher food prices which in turn is likely to impact on food security leading to under-nutrition on the continent.

Effect of Climate change on Agricultural production

- Reduction in crop yields and agriculture productivity: There is growing evidence that in the tropical arid and semi-arid areas, where crops have reached their maximum tolerance, crop yields are likely to decrease due to an increase in the temperature. The reduction holds or forest and its products (like wild foods), and rangeland. Arable land suitable for agricultural production and soil fertility will decline in quality. Other agriculture sectors like fisheries and poultry are all sensitive to climate. Production processes for food, feed, fibre, beverages, energy, industrial crops, livestock, poultry, fish or forest will be impacted.
- Higher cost on food distribution: Higher temperatures from climate change will increase the need for refrigeration in the food distribution network. The transport system could suffer extra cost because of destroyed roads and bridges, railway lines, waterways, affected harbours due to sea level rise, and disrupted air transport due to increased precipitation or bad weather.
- Increased incidence of pest attacks: An increase in temperature is also likely to be conducive for a proliferation of pests that are detrimental to crop and livestock production.
- Limit the availability of water: It is expected that the availability of water in most parts of Africa would decrease as a result of climate change. Particularly, there will be a severe down trend in the rainfall in Southern African, Sahel and Horn of Africa countries and in the dry areas of countries around Mediterranean Sea. When water bodies recede, there would be a decline in water availability for irrigation purposes, and reduction fish production. When large

water bodies recede, whole economies suffer. Examples: Egypt and Kenya are reliant on the Nile for irrigation; Guinea, Mali, Niger and Nigeria depend on the river Niger, for food, water transport, and Ghana on Volta River for same. Women's work load will increase and livelihood reduce**.**

• Exacerbation of drought periods: An increase in temperature and low precipitation as a result of climate change throughout the continent are predicted to cause recurrent droughts in most of the region. Frequent droughts lead to outmigration of natural resources dependents

• Reduction in soil fertility. An increase in temperature is likely to reduce soil moisture, moisture storage capacity and the quality of the soil, which are vital nutrient for agricultural crops.

• Low livestock productivity and high production cost: Climate change will affect livestock productivity directly by influencing the balance between heat dissipation and heat production and indirectly through its effect on the availability of feed and fodder. For optimum performance, the livestock may even need air conditions. Higher feed prices caused by climate change will result in higher meat prices. Heat stress and drought are likely to have a negative impact on animal health, production of dairy products, meat and reproduction and in turn could impact on food security leading to protein deficiency and under-nutrition.

• Availability of human resource: Climate change is likely to cause the manifestation of vector and vector borne diseases, where an increase in temperature and humidity will create ideal conditions for malaria, sleeping sickness and other infectious diseases that will directly affect the availability of human resources for the agriculture sector.

• Low health profile of population: increased incidence of malaria, sleeping sickness, outbreak of cholera etc. Malaria has spread into the malaria-free areas of Rwanda, Burundi, Kenya, and Ethiopia already. Rift valley fever which afflicts people and livestock is associated with rainfall events and likely to increase with climate change. Availability of farm labour is expected to decrease when many people are affected with illness.

• Outmigration and low availability of labour for agriculture: The poor performance of the agricultural sector and exacerbated by climate change is causing migration of able body out of rural areas.

• Tensions/ conflict and displaced people: The consequences of climate induced changes on agriculture and natural resources will lead to movement of people and livestock in search of water, food/feed and create competition over scarce resources which is likely to generate into social unrest in host countries. Example is the movement of Fulani herdsmen and their cattle from the Sahel region of West Africa to farming communities in the south e.g Ghana, all in an effort to meet food security needs.

These changes in agricultural production will impact on food security in these ways: food production will affect food supply differently even within Africa; all forms of agricultural production will affect livelihoods and ability to access food. The differential access has implication for the poor and marginalized households with inference for nutrition of its members.

Climate Change Impact/ Vulnerability

These climate-sensitive natural resources based activities and agriculture production contributes to the vulnerability of the people. These factors, coupled with limited institutional and technological capabilities, have contributed to the region's predicament. This situation is worsened by low adaptive capacity, poor governance, limited infrastructural and economic development.

The vulnerable sectors are all agriculture based livelihood systems like:

• Crop failure and low yields
• Loss of livestock and fish stock
• Increasing water scarcities
• Destruction of productive assets
• Pastoralist systems
• Inland and coastal fishing

• Aquaculture communities
• Forest –based systems
• Rural communities especially in coastal, flood plains, dry land etc
• Deterioration in nutritional status for women of reproductive age, children, elderly, ill and socially disabled people

Adaptation measures
- Climate smart agricultural production
• Diversification of livelihoods/ alternatives
• Decentralisation of local governance of resources
• Alternative eco-friendly energy uses
• Infrastructural development
• Climate information
• Early warning systems
• Insurance schemes

CONCLUSION
There are various climate change synthesis and assessment report builds on an extensive scientific literature and series of recent assessments of the historical and potential impacts of climate change on food security. However, climate change affect food security at the global, regional, and local level. Climate change can disrupt food availability, reduce access to food, and affect food quality. For example, projected increases in temperatures, changes in precipitation patterns, changes in extreme weather events, and reductions in water availability may all result in reduced agricultural productivity. Increases in the frequency and severity extreme weather events can also interrupt food delivery, and resulting hikes in food prices

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Long-term Rainfall Trend Detection in a Tropical Savannah Climate

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ABSTRACT
Trend analysis has been widely used as a tool to detect changes in climatic data such as rainfall. In view of this, a study was conducted in Samaru to identify long-term variability of rainfall in the temporal structure of 1953-2020. Mann-Kendall trend test and Sen Slope estimator were used to detect possible rainfall trend in the total annual rainfall and the four annual seasons experienced in the area. This include; December-January-February (DJF), March-April-May (MAM), June-July-August (JJA) and September-October-November (SON). The results show a high statistical significant trend ($p > 0.01$) was observed in DJF season while the total annual rainfall and the other three seasons showed a statistically non-significant trend. The Sen's Slope estimator was negative (-0.376) only in SON season, thus, indicating a decreasing trend. While in the other three seasons (DJF, MAM, and JJA) and the total annual rainfall an increasing trend was observed. The trend in DJF season was found to be statistically highly significant ($p > 0.01$), which may be as a result of possible effect of climate change.
Keywords: Rainfall, trend detection, Mann-Kendall test, Sen's slope estimator, Samaru.

INTRODUCTION
Understanding of past and recent climate change has received considerable attention through improvements and extensions of numerous datasets and more sophisticated data analyses across the globe (Kumar *et al*. 2010). Global climate changes may influence long-term rainfall patterns impacting the availability of water, along with the danger of increasing occurrences of droughts and floods (Pal and Mishra 2017). Rainfall and temperature (Singh *et al*. 2013) are the most important components of climatic parameters, as they determine the environmental condition of the particular region which affects the agricultural productivity. Agriculture and other related sectors, food security and energy security of any region are crucially dependent on the timely availability of sufficient amount of water and a favorable climate. Rainfall received in an area is an important factor in determining the amount of water available to meet various demands such as agricultural, industrial, domestic water supply and for hydroelectric power generation.

Changes in savanna structure, composition and function as a result of ongoing and future climate change can have major implications for human wellbeing and ecosystem processes (Osborne *et al*. 2018). However, the focus on the effects of altered rainfall regimes, specifically droughts, on savanna dynamics is prompted by the recognition that: (a) water availability is a key determinant of savanna structure and function (D'Onofrio *et al*. 2018), (b) changes in precipitation regimes, coupled with warmer temperatures that increase evaporative demand, are projected to lead to more intense and frequent regional-scale droughts across large parts of the globe, including savanna regions (Pachauri *et al*. 2014), (c) savannas are expected to be particularly responsive to rainfall changes given the tight coupling between rainfall and production in these systems and (d) in contrast to forests, the role of droughts in regulating tropical savanna dynamics has received relatively less attention.

Although several researches have been conducted that involved trend analysis of rainfall data in recent years, few of these researches were conducted in Samaru. While other studies focus only on few data set, this research attempted to analyzed the variability of rainfall over the period of 1953-2020 for possible climate change. Furthermore, apart from identifying the possible trends in the data, data preparation involving quality assurance (QA) and quality control (QC) was carried out in this study. The aim of the current study is to identify the variability of rainfall in Samaru in the temporal structure for the period of 1953-2020.

METHODOLOGY

Study Region

The region of study is located in Samaru, Zaria, in the Northern Guinea Savanna ecology of Nigeria. The Institute for Agricultural Research (IAR) farm, Samaru is located sat N 11º 09.943', E 007º 37.958' and an altitude of 686m above the sea level. Alfisols and Ultisols are the soils mostly found in the area (Odunze *et al*., 1997). The area has a mean daily temperature of 24 ℃ (IAR Meteorological Station, 2016).

Trend detection

Mann-Kendall test is one of a widely used test for observing trend in hydrological data such as rainfall and stream flow data where positive values show an increase in constituent concentrations over time and vice versa was used in this study (Fathian *et al*., 2014). The trend analysis was done in two phases. First the presence of a monotonic increasing or decreasing trend was tested with the nonparametric Mann-Kendall test and secondly the slope of a linear trend is estimated with the nonparametric Sen's slope estimator. Mann -Kendall test has several advantages such as its simplicity, capability of handling non-normal and missing data distributions and robustness to the effects of outliers and gross data errors (Adnan *et al*., 2016). The strength of the trend is proportional to the magnitude of the Mann-Kendall statistic. Mann-Kendall is carried out in a series xi where $i=1,2,\ldots n-1$ and xj where $j=1,2,\ldots.n$. Each data point xi is taken as a reference point that compared with the data point xj. The Mann-Kendall test used the following equation:

$$S = \sum_{k-1}^{n-1} \sum_{j-k=i}^{n} sign(xj - xk) \tag{1}$$

Where, $i=1,2,\ldots n-1$ *and* xj $j=1,2,\ldots.n$.

The values of S and $Var(S)$ are used to compute the test statistic Z as follows:

$$Z = \begin{cases} \frac{S-}{\sqrt{var}} If\ S > 0 \\ \quad 0 \qquad If\ S = 0 \\ \frac{S+}{\sqrt{var}}\ If\ S > 0 \end{cases} \tag{2}$$

The presence of a statistically significant trend is evaluated using the Z value. Thus, in a two-sided test for the trend, H_1 should be accepted if $|Z| > \ Z_{\alpha/2}$ where $F_n \left(Z\alpha_{/2}\right) = {}^{\alpha}/_{2}$being the standard normal cumulative distribution function and $\propto$ being the significance level for the test. Positive values of Z indicate an upward trend and negative values indicate a downward trend.

Sen's slope estimator is one of the statistical tests used with Mann-Kendall test to determine the magnitude of changes taking place in that area. Sen's Slope will indicate the increase and decrease the magnitude of the slope in correspondence with the Mann-Kendall values (Adnan *et al*., 2016) The Sen's Slope test proves that the true slope can be estimated using a simple non-parametric procedure if linear trend is present.

RESULTS AND DISCUSSION

QA and QC was carried out on the rainfall data. The months of June and October were found to have some missing values in 2008 and 1958, 1961, 1981, 1983, 1986, 1990 and 2001 respectively. Missing entries were replaced using multiple imputation method.

Rainfall trends in Samaru

Mann-Kendall non-parametric test was carried out on the annual and seasonal rainfall data to verify the trends. The seasonal data include that of December-January-February (DJF), March-April-May (MAM), June-July-August (JJA) and September-October-November (SON). The Kendall's tau, Kendall's statistics (S), Sen's slope and *p*-value were calculated on the data from 1953-2020 to determine climate change through the trend. Figure 1 shows the graphical presentation of monthly, seasonal and annual rainfall trends in Samaru while Table 1 presents the Mann-Kendall's nonparametric tests results, as well as an estimate in the computed test statistics and p-value. P-values are the smallest level of significance (5% or 1%) at which null hypothesis will be rejected. This non-parametric test has been widely adopted by numerous scientists such as Fathian *et al*. (2014); Abdulkareem and Sulaiman (2016); Adnan *et al*., (2016) to test for trends in various climatic parameters.

According to Mann-Kendall test, as the computed p-value is greater than the significance level, one cannot reject the null hypothesis (H_o), whereas the alternate hypothesis (H_α) is accepted when p-value is lower than the significance level and vice-versa. However, as a result of rainfall not been consistent during DJF season, a statistically high significant decreasing trend was detected, and the p-value recorded (0.009) was found to be lower than the significance level (1%). Therefore, going by the study, the null hypothesis will be rejected while the alternate hypothesis will be accepted, which simply indicates the presence of decreasing trend in the series. Evidence of climate change from observations of atmosphere and surface has grown significantly in recent years (Hartmann *et al*., 2013). As the climate changes, several direct influences alter the amount of rainfall, intensity, frequency and type (Trenberth, 2011). According to the current study, fluctuations in rainfall were observed during DJF season, with constant dryness from 1992-2020 but for 2014 that received trace amount of 0.4 mm. However, these alterations and decreasing rainfall amount are among the climatic changes experienced in the region during the study period. While a non-significant increasing trend was detected in MAM, JJA and SON seasons, as well as for the annual average. Zaria and Kafanchan have unique amount of rainfall, with Kafanchan having the highest and Zaria receiving the lowest. The decline of rainfall in Samaru, Zaria and some locations in the southern part of Kaduna may be attributed to West African monsoon. Similarly, their research on rainfall trends and variation characteristics across Kaduna state using eleven selected stations in the Southern, Central and Northern parts of the state for a period of 50 years (1966-2015), revealed that the southern part has the highest total rainfall, yet there was no any significant trend in the periods that were analyzed.

Table 1 Mann-Kendall results for Rainfall in Samaru from 1953-2020

	Kendall's tau	*S*	*p*-value (two-tailed)	Sen's slope	Unit	Level of Significance
DJF	-0.253	-302.000	0.009	0.000	mm	**
MAM	0.061	140.000	0.462	0.222	mm	NS
JJA	0.052	118.000	0.536	0.437	mm	NS
SON	-0.050	-115.000	0.546	-0.376	mm	NS
ANNUAL	0.036	81.000	0.672	0.050	mm	NS

CONCLUSION

Mann–Kendall test was employed to detect annual trends in rainfall of Samaru. The results obtained showed a highly statistical significant trend ($p > 0.01$) observed in DJF season while the total annual rainfall and the other three seasons showed a statistically non-significant trend. DJF season is usually a dry season in Samaru with little or no rainfall. Results of the Sen's Slope estimator was negative (-0.376) only SON season, thus, indicating a decreasing trend. This is an indication increasing rainfall trend in the other seasons (DJF, MAM, and JJA) and the total annual rainfall although the trend in DJF was found to be statistically highly significant ($p > 0.01$). Therefore, it can be concluded that DJF season in Samaru, Zaria is been affected by climate change from 1953-2020.

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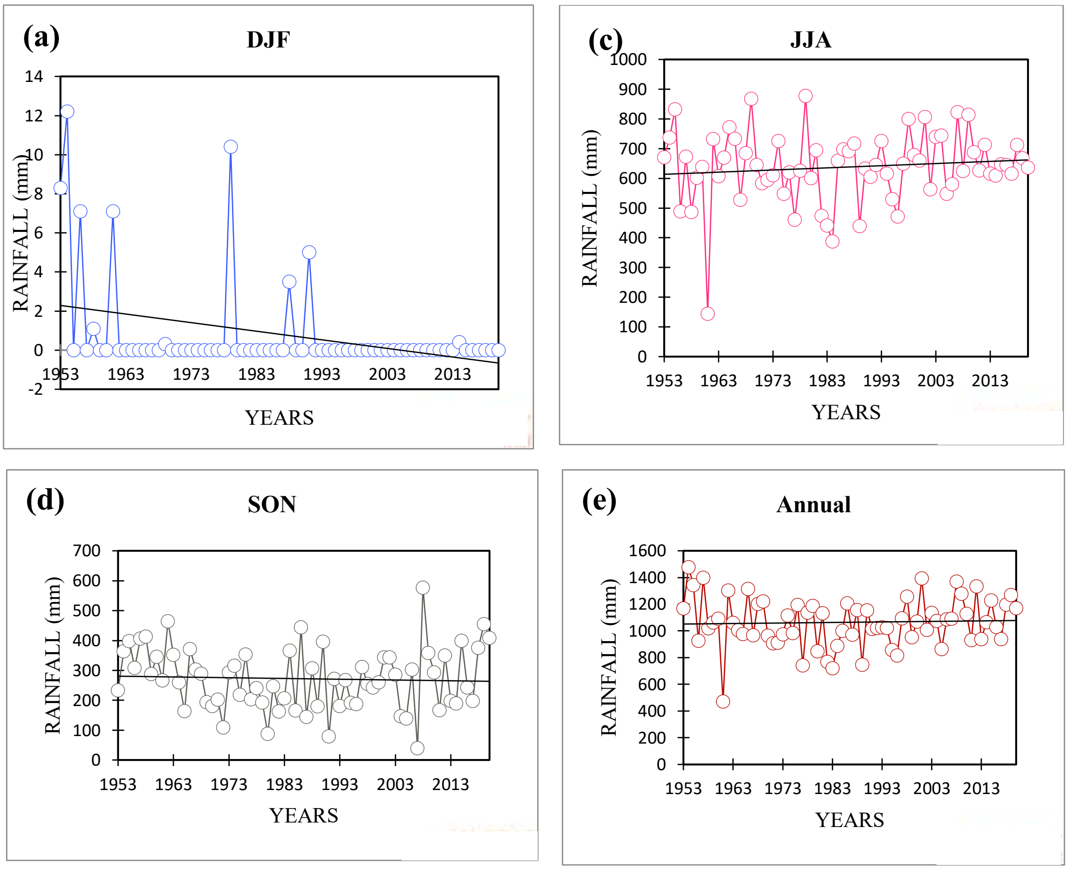

Figure 1: Rainfall trend charts in Samaru from 1953-2020 (a) DJF (b) MAM (c) JJA (d) SON (e) Annual

Implication of Climate Change on Livestock Production in Nigeria

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ABSTRACT

Livestock production is a contributing factor in species extinction, desertification, and habitat destruction which play very important role in economic, social and cultural or functions for rural households, also help on food supply, family nutrition, family income, asset savings, soil productivity, livelihoods, transport, agricultural traction, agricultural diversification and sustainable agricultural production, family and community employment, ritual purposes and social status. The triple whammy problems of rapid increase in population, climate change and pressure on resources are major constraints to adequate livestock production. Climate change is already having significant impacts in Nigeria due to the interplay of four main climate change - related hazards: increased temperature, change in amount, intensity, and pattern of rainfall, extreme weather events including sea surge and drought, and sea level rise. This paper examines the economic and social benefits of livestock production, environmental impact and climate change impacts on the livestock production which lead to increase existing risks of extinction of many threatened livestock or lead to reduction in productivity.
Keywords: Climate Change, Livestock, Species , Sustainable and Productivity

INTRODUCTION

Livestock production in Nigeria was dominated by nomadic pastoralism long before the advent of the British Colonial Administration. It accounts for one third of Nigeria's agricultural GDP, providing income, employment, food, farm energy, manure, fuel and transport and also a major source of government revenue (FAOSTAT, 2003). In South West Nigeria, a sizeable population of agro pastoralists in the hinterlands of the urban centres in the derived savanna of Oyo states of Nigeria were originally normadic cattle pastoralists (Johannesen, 2011). Its land use management is characterized by transhumant system due to vegetation variations, agricultural practices and tsetse fly infestation (Moyo and Swanepoel, 2010).

The derived savanna of the South-western zone of Nigeria is recently experiencing pressure on land and such pressure is as a result of increase in population, land development and expansion of cropping land (Olafadehan, 2007). With this new development, a new system of livestock production has been observed to be evolving in the zone since the 1990s. The herd size is not only declining in number but the pastoralists are also settling down and taking up crop production in conjunction with cattle husbandry. As a result of these changes, new opportunities for growth are opening up and also new challenges are being face. It has been argued that, livestock, especially ruminants, are the most efficient user of uncultivated land and contribute evidently to crop production.

Livestock production are environmentally friendly improving energy and nutrient cycling. Livestock is also used to transport agricultural inputs and outputs and people. Livestock production is an important mean of exchange between rural households and, when sold, contributes to boost and strengthen rural markets. Rural markets are an important piece in the operation mode of rural communities and a significant contribution for rural families' wellbeing and wealth (Moyo, and Swanepoel, 2010).

Economic and social benefits of livestock production

As in many other countries of sub-Saharan Africa, livestock account for as much as one third of Nigeria's agricultural gross domestic product (GDP), providing income, employment, food, farm energy and manure, fuel and transport. Livestock fulfill many roles for a substantial number of people in the country. The livestock industry is a major source of government revenue, for example through taxation and export earnings from hides and skins. Yet planners and economists often underestimate the contribution of livestock to GDP. Their role as a source of farm power in the northern savanna zone and as a source of organic manure to boost crop production, as well as their efficient utilization of otherwise unusable plants to produce meat, milk and other products, are often not considered. For example, manure outputs of 1368 kg DM/head/year and 248 kg DM/head/year have been estimated for cattle and sheep respectively (Platell *et al.,* 2011). These outputs are a major contribution to soil fertility.

The choice of ruminants and poultry was not accidental. Nigeria has about 40 million hectares of available grazing land yet to be fully exploited. Cattle, sheep and goats provide aver 70% of the national meat supply and all the locally produced milk in Nigeria, while the poultry sector, provided opportunities for rapid growth. National Animal Production Research Institute (NAPRI) scientists have shown that some of our indigenous cattle can gain an average weight of 0.9 to 1.2 kg per day on silage and concentrate rations. The potential of this finding can be assessed when it is realized that at present over 1 million herd of cattle are slaughtered annually in Nigeria, but that 75% of them are fit for further fattening and could yield an extra 25 000 to 45 000 tonnes of meat per year if this technology were employed (McSweeney, 2012). NAPRI's research on dairy cattle has shown that a linear increase in milk yield from crossbred cows takes place as the exotic gene is increased up to the 7/8 level. The F1 Friesian x Bunaji cow (50%) gives 1684 kg, the 3/4 (75%) gives 1850 kg and the 7/8 gives 2051 kg of milk in a lactation of about 260 days. However, the economic return is not justify increasing the exotic gene pool beyond 50% (Platell *et al.,* 2011). In the area of poultry production, work concentrated on achieving optimum energy and protein levels in the rations of laying chickens, and on broiler production. The protein and energy sources are quantitatively the most important and expensive aspect of economic ration formulation (Olomu, personal communication). Import substitution for fish meal, an expensive imported feed ingredient, has received special attention over the last few years.

In some cultures, animals can be considered sacred (cattle in India) and in others cultures (pigs in Muslim countries) animals are impure. For both of these cultures, those species are not consumed by the population. In other countries or cultures, animals play an important leisure role, being used for betting, like horse racing and cock fighting, for sports, like horses in polo and bullfighting and for hunting, like dogs, falcons and horses (Swanepoel *et al.,* 2010).

Environmental impact of livestock production

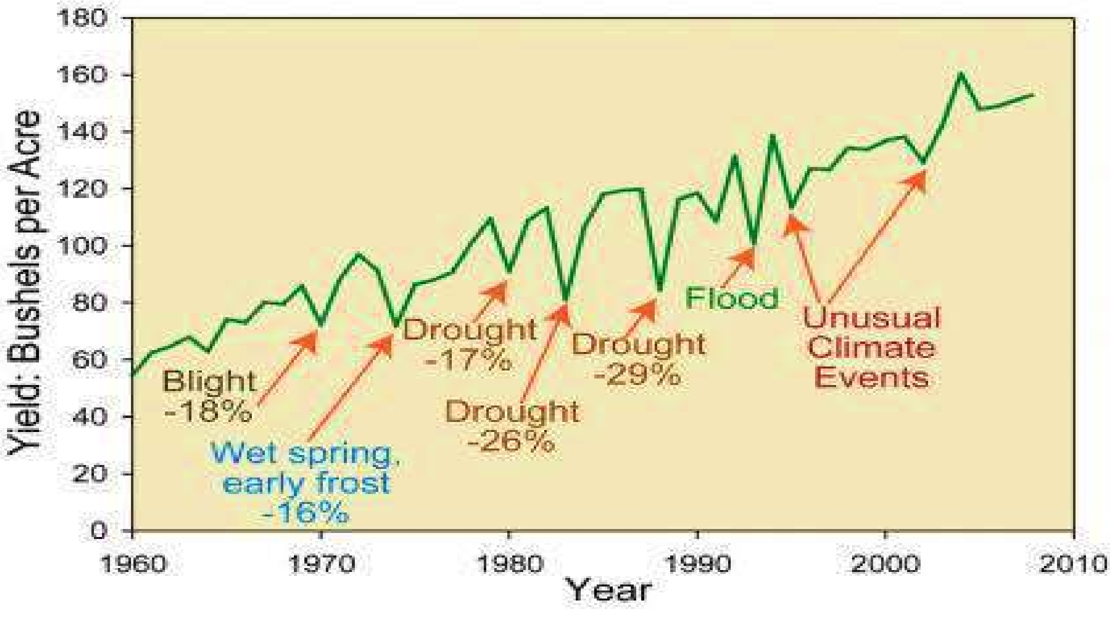
Animal husbandry has a significant impact on the world environment. It is responsible for somewhere between 20 and 33% of the fresh water usage in the world, (Mekonnen *et al.,* 2012) and the production of feed for them, occupy about a third of the earth's ice-free 12 land (FAOSTAT, 2003). Animal agriculture contributes to species extinction in various ways. Habitat is destroyed by clearing forests and converting land to grow feed crops and for animal grazing, while predators and herbivores are frequently targeted and hunted because of a perceived threat to livestock profits; for example, animal husbandry is responsible for up to 91% of the deforestation in the Amazon region (McSweeney and Raish*,* 2012). In addition, livestock produce greenhouse gases. Cows produce some 570 million cubic metres of methane per day, (Ross *et al.,* 2013) that accounts for 35 - 40% of the overall methane emissions of the planet (Steinfeld *et al.,* 2006). Livestock is responsible for 65% of all human-related emissions of the powerful and long-lived greenhouse gas nitrous oxide (Steinfeld *et al.,* 2006).

Climate Change Impacts

In general, Nigeria is strongly predisposed to severe negative impacts of climate change due to its fragile economy, weak resilience and low adaptive capacity. Much of the sensitive economic resources are dependent on climate. For example, the agriculture, forestry and fishing sectors employ up to 70% of the workforce (FAO, 2012). The heavy concentration of GDP generating industry in locations that are highly vulnerable to climate change - induced sea level rise, e.g. Lagos and the Niger Delta makes the country extremely vulnerable. The 2011 Climate Change Vulnerability Index (CCVI) published by the UK - based risk company, Maplecroft, classifies Nigeria as being of high risk (FGN, 2012).

Climate change is already having significant impacts in Nigeria due to the interplay of four main climate change - related hazards, viz and viz; increased temperature, change in amount, intensity, and pattern of rainfall, extreme weather events (including sea surge and drought), and sea level rise. These impacts are expected to increase in the future. Recent estimates suggest that, in the absence of adaptation, climate change could result in a loss of between 2% and 11% of Nigeria's GDP by 2020, rising to between 6% and 30% by the year 2050. This loss is equivalent to between ₦15 trillion (US$100 billion) and ₦69 trillion (US$460 billion). This large projected cost is the result of a wide range of climate change impacts affecting all sectors in Nigeria: agriculture, water resources (fresh, coastal and fisheries), forest, biodiversity, health and sanitation, human settlements and housing, energy, transportation and communication, industry and commerce, disaster, migration and security, livelihoods, and education (FAO,2012).

Impacts on livestock



Source: USGCRP (2009)

According to Obioha (2009), the sustainability of the environment to provide all life support systems and the materials for fulfilling all developmental aspirations of man and animal is dependent on the suitability of the climate which is undergoing constant changes. The impact of these changes is posing threat to livestock production in Nigeria such as:

- Higher CO_2 levels can affect crop yields. Some laboratory experiments suggest that elevated CO_2 levels can increase plant growth. However, other factors, such as changing temperatures, ozone, and water and nutrient constraints, may counteract these potential increases in yield. For example, if temperature exceeds a crop's optimal level, if sufficient water and nutrients are not available, yield increases may be reduced or reversed. Elevated CO_2 has been associated with reduced protein and nitrogen content in alfalfa and soybean plants, resulting in a loss of quality. Reduced grain and forage quality can reduce the ability of pasture and rangeland to support grazing livestock (Hatfield *et al.,* 2014).
- More extreme temperature and precipitation can prevent crops from growing. Extreme events, especially floods and droughts, can harm crops and reduce yields. For example, in 2010 and 2012, high nighttime temperatures affected corn yields across the U.S. Corn Belt, and premature budding due to a warm winter caused $220 million in losses of Michigan cherries in 2012 (Hatfield *et al.,*2014)
- Many weeds, pests, and fungi thrive under warmer temperatures, wetter climates, and increased CO_2 levels. Currently, U.S. farmers spend more than $11 billion per year to fight weeds, which compete with crops for light, water, and nutrients (Hatfield *et al.,* 2014). The ranges and distribution of weeds and pests are likely to increase with climate change. This could cause new problems for farmers' crops previously unexposed to these species. (Ziska *et al*., 2016).
- Heat waves, which are projected to increase under climate change, could directly threaten livestock. In 2011, exposure to high temperature events caused over $1 billion in heat-related losses to agricultural producers (Hatfield *et al.,* 2014). Heat stress affects animals both directly and indirectly. Over time, heat stress can increase vulnerability to disease, reduce fertility, and reduce milk production. (Doney *et al.,*2014)

CONCLUSION

Human activities are major anthropogenic contributors to climate change (IPCC, 2001). According to the World Bank (2008), they account for 30 percent of greenhouse emissions. Conversely, the livestock production is very susceptible to climate change, which threatens food security globally, especially with the projected population increase.

Various agencies report yield declines as one of the main foreseen consequences, which will result in decreased livestock availability and incremental prices (World Bank, 2010; Nelson *et al*., 2009). These trends are especially significant for basic animals. Hence, their consumption as well as of animal protein is thought to decline. The decreased consumption is projected to reduce caloric intake and thus increased childhood malnutrition by 2050 (Nelson et al., 2009).

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Cost of Adaptation to Climate Change among Poultry Farmers in Ondo State, Nigeria

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ABSTRACT
The study evaluates the cost of adaptation to climate change among poultry farmers in Ondo State, Nigeria. A multi-stage sampling procedure was used to select 120 respondents with the aids of a well-structured questionnaire. Descriptive Statistics and Multinomial Logit (MNL) were used for the analysis. The results of the costs and returns of the poultry farmers revealed that the average total cost incurred was ₦1,343,724.17 with adaptation cost, which takes 2.38% of the total cost and the total revenue was ₦2,717,508 with a net revenue of ₦1,373,783.83. The result showed that poultry farming is a profitable enterprise despite the additional cost incurred as a result of climate change. Also, the MNL regression showed that age, belonging to association, experience, and household size were the factors responsible for the farmer's choice of adaptation practices in the area. It is therefore recommended that enlightenment programs on how farmers could cope with the consequences of climate change using appropriate and cost minimized adaptation strategies should be encouraged in the area.
Keywords: Costs, Adaptation, Climate change, Returns, Nigeria

INTRODUCTION
Poultry plays a vital role in the livelihood of rural households in Africa, especially Nigeria (Ayo-Enwerem *et al*., 2017a). Poultry are birds which render economic services to humans as a primary supplier of meat, egg and raw materials to industries (feathers, waste products), source of income and employment to people compared to other domestic animals (Ayo-Enwerem *et al*., 2017b). Poultry convert feed to egg and meat within a short period of time (Ahaotu *et al*., 2019a). The poultry sub-sector is the most common of all the sub-sectors of Nigerian agriculture. It contributed approximately 6.2% of the total livestock contribution of 2.67% to Agricultural Gross Domestic Product in 2012 and about 25% to the GDP of Nigeria in 2015 (PAN, 2015).

Developing the poultry industry in Nigeria will be the fastest means of bridging the protein deficiency gap prevailing the country (Is-Haaq *et al*., 2018). Whenever ambient temperature is high, chickens tend to have higher energy needs than when in thermo-neutral environments. Major losses result from a less efficient conversion of feed to meat; this also affects poultry health and productivity (Okonkwo and Ahaotu, 2019). Poultry flocks are particularly endangered to climate change due to a range of thermal conditions which affects the animals' behavioural and physiological activities (Ayo-Enwerem *et al*., 2017a). Hence, birds can only tolerate lowly temperature ranges to sustain the peak of their production for human consumption. The environmental conditions affecting the performance of chicken include temperature, relative humidity and light at a given time. Ambient temperatures significantly influence the survivability and performance of the poultry production (Ayo-Enwerem *et al*., 2017b). Ahaotu *et al*., (2019b) stated that as the ambient temperature increased to 34ºC, the mortality due to heat will be higher in broilers by 8.4%. As the feed consumption of the chickens decreases from 108.3g/bird/day at 31.6ºC to 68.9g/bird/day at 37.9ºC, the egg production will be reduced by 6.4% (Okonkwo and Ahaotu, 2019). Specifically, high or low temperatures lead to diseases infection while wind may serve as an agent for the spread of air-borne diseases that affect poultry. In particular, poultry flocks are extremely vulnerable to climate change as they can only tolerate a narrow temperature range (Rajkumar, *et al.,* 2011). Understanding the appropriate adaptation options to cope with climate-related problems, costs implication is crucial to successful poultry production and welfare. Therefore, this study aims at examining the costs of adaptation strategies among poultry famers in Ondo State, Nigeria.

METHODOLOGY

The study was carried out in Ondo State. Primary data were collected with the aids of a well-structured questionnaire. Two Local Government Areas (LGAs) namely Akure South and Akure Northt LGAs were purposively selected because of the large population of poultry producers in the area. Secondly, random sampling technique was used to select six (6) communities from each LGA, making 12 communities. Lastly, simple random sampling procedure was also used to select ten (10) poultry farmers, making a total of 120 respondents. Data analysis was done using descriptive statistics, farm budgeting techniques, and multinomial logit regression. Net profit is the difference between the Gross Revenue and Total Cost of Production. Total Cost of production is the total expenses incurred during the production period. Multinomial logit (MNL) Regression Model was employed to analyze factors influencing poultry farmers' choice of adaptation strategies to climate change in the study area. The dependent variables were grouped into four (4). They are: (i) ventilation system (ii) feed consumption (iii) reduction in stock size, and (iv) prompt vaccination. The explanatory variables included in the model are as follows:

$$Ui = \beta o + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + ei$$

X_1 = Sex (male = 1; female = 0)
X_2= Age (years)
X_3 = Access to extension visits (if yes = 1; otherwise = 0)
X_4 = Poultry Farming Association (if yes = 1; otherwise = 0)
X_5 = Experience (Years)
X_6 = farm income (₦)
X_7= Household size (number)
ei= disturbance error where burial method was taken as baseline disposal method.

RESULTS AND DISCUSSION

Cost of Adaptation Practices

The result in Table 1 revealed that the average cost incurred on adaptation practices by the poultry farmers on ventilation was ₦36,535.35, ₦24,291.67 on feed consumption, ₦33,740.74 is spent to maintain reduction in stock size, ₦37,700.0 on prompt vaccination of birds while ₦27,680.56 is spend to maintain keeping of resistant strains.

Table 1: Cost Incurred on Adaptation by the Respondents

Adaptation Strategies	Ventilation cost (₦)	Feed Consumption (₦)	Reduction in stock size (₦)	Prompt vaccination of birds (₦)	Keeping of resistant strains (₦)
Cost incurred	36,535.35	24,291.67	33,740.74	37,700	27,680.56

Source: Field Survey, 2021

Profitability of Poultry Farming

The gross margin analysis from Table 2 showed that the variable cost accounted for about 62.1% of the total cost, with a total variable cost of ₦815,177.91. The farmer's average gross income from poultry production was found to be ₦2,717,51. The gross margin was calculated to find the profitability of the enterprise by subtracting the total variable cost from the gross income. It was found to be ₦1,902,330.09. This result shows that poultry farming in the study area was profitable, that is for ₦1,311,734.51 spent on the enterprise a return of ₦2,717,508.0 was realized.

Table 2: Gross margin analysis of poultry farming in the study area

Variables	Value in Naira (₦)	% of total cost
(A)Total Variable Cost	815,177.91	62.1
(B)Total Fixed cost	496,556.60	37.9
(C)Total Cost	1,311,734.51	100.0
(D)Total Return	2,717,508	
Gross margin (D-A)	1,902,330.09	
(E)Net farm income (D-C)	1,405,773.49	
ROI (E/C)	1.07	
% Profit	**107%**	

Source: Field Survey, 2021

Adaptation Cost and Return of Poultry farming in the Study Area

The result in Table 3 showed that adaptation cost accounted for about 2.38% of the total cost. The total cost accounted for 39.33% of the total fixed cost, while total variable cost accounted for about 60.67% of the total cost. The result showed a return of investment of 1.02, which implies that for every 1 naira invested on poultry production, there is a return of 2kobo.

Table 3: Adaptation Cost and Return of Poultry farming in the Study Area

Variables	Value in Naira (₦)	% of total cost
Variable cost		
(A)Total Variable Cost	815,177.91	60.67
Fixed Cost		
(B)Total Fixed cost	528,546.26	39.33
(C)Total Cost	1,343,724.17	100
(D)Total Return	2,717,508	
Gross margin (D-A)	1,902,330.09	
(E)Net farm income (D-C)	1,373,783.83	
ROI (E/C)	1.02	

Source: Field Survey, 2021

Preference for Poultry Adaptation Management in the Study Area

Multinomial logistic regression results in Table 4 showed that the model was statistically significant given the value of chi-square of 39.36 and significant at $P<0.01$, confirming the appropriateness of the specified model. According to the regression results, four variables were reported to be significantly affecting the preference to adaptation measures. They are age, farmers association, experience and household size.

Table 4: Maximum Likelihood Estimates of Multinomial Logistic Regression for Determinants of the Poultry Adaptation Management

Variable	Ventilation system		Feed consumption		Reduction in stock		Prompt vaccination		Resistant strains	
	Coeff	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
Sex	-0.573	0.59	0.246	0.754	17.377	0.99	.258	0.981	-.522	0.995
Age	-0.036	0.455	-0.016	0.639	-.406**	0.022	-0.056	-.455	-0.096	0.739
Extension	-0.239	0.487	-0.165	0.478	-5.398	0.318	.018	0.824	-.020	0.791
Association	-3.072**	0.02	-1.12925	0.349	-2.6550	0.215	0.037	0.744	0.012	0.777
Experience	-0.0003	0.232	-.00038**	0.045	-.0017**	0.048	.007	0.990	.0.003	0.126
Income	0.0004	0.199	0.0002	0.335	0.00213	0.13	0.048	0.148	-1.44	0.995
Household size	0.076	0.789	.364	0.098	1.872	0.085	0.011**	0.050	.138	0.995

Log likelihood = -65.01; LR chi2= 39.36; Prob>chi^2 0.0023***; Number of observations = 120, ** means significance at 5%. Source: Field Survey, 2021

CONCLUSION

From the study, it was concluded that the average rate of returns on investment (result per naira invested) was 1.07 on poultry business, but 1.02 with the adoption of adaptation strategies indicating that for every ₦1 invested in the study area, a gain of 7kobo and 2kobo were made, respectively. The study also showed that age of the farmers, member of association, experience and household size were responsible for the choice of adaptation management system used by the poultry farmers in the study area.

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Adaptation Strategies of Sheep Farmers to Climate Change in Ilorin South of Kwara State

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ABSTRACT
The study was conducted to examine the adaptation strategies of sheep farmers to climate *change in Ilorin South Local Government Area of Kwara State. Multi-stage sampling procedure was used to select respondents for the study. The results were analyzed with descriptive statistics such as frequency, percentages, mean and chi square weas used to analyze the hypotheses. The results of the study revealed that 87.5% of the respondents were male, 32.5% were within the age range of 30-39 years, 64.2% were married, 40.0% of the respondents had tertiary education as their highest level of education and 97.5% of the respondents had a household size of 1-10 members. It was also found that 30% of the respondents earned monthly income of ₦30,001-₦ 40,000 and 74.2% of the farmers sourced for information from personal experience while 70% sourced their information from television. Moreover, 96.7% of the respondents perceived high rainfall as evidence of climate change while 92.5% of the sheep farmers also perceived long period of harmattan as an evidence of climate change. Majority (95%) of the respondents perceived reduced farmer's income and increased mortality as effect of climate change while 93.3% of the respondents perceived reduced body weight and increased disease infection as effects of climate change. Furthermore, frequent vaccination and rearing of resistant breeds are the major adaptation strategies used by the respondents. It is therefore recommended that sheep farmers should be well informed on the best practices for adapting to climate change which can be harnessed through research and extension service as extension agents had a very low patronage for sourcing information on effects of climate change and suitable adaptation strategies to help adapt more to climate. Also, diversifying into other income generating activities by sheep farmers will help make up for the reduction in income they experienced as result of the adverse effect of climate change on sheep farming.*

Keywords: adaptation strategies, climate change, harmattan, high rainfall, sheep farming

INTRODUCTION
Climate change is a global threat and its effects across regions and continents differ. Climate change is any change in climate over time, whether due to natural variability or as a result of human activity (BNRCC, 2011). Evidence from the Intergovernmental Panel on Climate Change (IPCC, 2007) is now overwhelmingly convincing that climate change is real, that it will become worse, and that the poorest and most vulnerable people will be the worst affected. The IPCC predicts that by 2100 the increase in global average surface temperature may be between 1.8° C and 4.0° C. With increases of 1.5° C to 2.5° C, approximately 20 to 30 per cent of plant and animal species are expected to be at risk of extinction (FAO, 2007) with severe consequences for food security. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2007). Sheep farmers therefore

need to consider making adaptations now to help reduce cost, risk and concern in the future (Farming Features, 2009).

Sheep (*Ovis aries*) are quadrupedal ruminant animals typically kept as livestock. In Nigeria, sheep are mainly kept for meat (Williamson and Payne, 2016) and accounts for about 11 per cent of the total meat supplied from slaughter houses in Nigeria (Adu and Ngere,2003).
There are four major breeds of sheep in Nigeria. These four predominant breeds are the West African Dwarf (WAD), Balami, Yankassa and Ouda.

Studies show that small ruminant animal's farmers have various ways with which they adapt to climate change such as destocking, provision of sunshade, adequate ventilation, use of drought resistant breeds, extensive rearing of animal and improved nutritional management.
The economic importance of sheep cannot be over emphasized, with their body size, high productive capacities and rapid growth rates are ideally suited to production by resource poor small holders. Local breeds in Nigeria are more affordable to resource poor families and produces more milk in relation to body size than cattle (Nuru, 2012).

The perceived threats and weaknesses of sheep production due to climate change includes more heat stress in both housed and outdoor flocks, reduced production and growth rate at higher temperatures, higher mortality rates in outdoor flocks result from extreme weather events, more expensive housing to withstand storms and temperature fluctuations, more effective ventilation and cooling systems to counteract higher temperatures, higher energy cost in operating ventilation system more frequently, increased persistence of some endo-parasite and ecto-parasite with associated increase in medication are big challenges to consider. Given that the effects of climate variation can only be mitigated; it is pertinent to ascertain the perceived effect on the trends by the people most involved.

Therefore, from the aforementioned, the following objectives will proffer solution to this study. The main objective of this study was to determine the adaptation strategies adopted by sheep farmers to climate change in Ilorin south Local Government Area of Kwara State
Specific objectives of this study were to:

i. describe the socio-economic characteristics of the sheep farmers in the study area;
ii. identify the sources of information on climate change available to sheep farmers in the study area.
iii. determine the perceived evidence of climate change among sheep farmers in the study area;
iv. determine the effects of climate change on sheep farming in the study area;
v. ascertain the adaptation strategies adopted by sheep farmers in the study area.

METHODOLOGY

Ilorin South is a Local Government Area in Kwara State, Nigeria. Its headquarters is in the town of Fufu. It has an area of 174 km^2 and a population of 208,691 at the 2006 census. The postal code of the area is 240. The town which occupies an area of about 100km and the total population 532.088 people. It is situated at a strategic point between the densely populated South-Western and the sparsely populated Middle Belt area of Nigeria.

The population of the study consisted of sheep farmers in in Ilorin south Local Government area of Kwara state. Multi-stage sampling techniques was used for this study. In the first stage Ilorin south Local Government area of Kwara state was purposively selected due to the predominance of sheep farmer. In the second stage, 10 villages were randomly selected out of the 24 villages namely; Mogaji, Fufu, Ilota, Igbona, Omode, Akanbi, Ere-omo, Nasudo, Tangolo and Onikanga in Ilorin south Local Government area of Kwara state. In the third stage 12 sheep farmers were randomly chosen from the 10 villages to give a total number of 120 sheep farmers that were used for this study. Primary data was used in collecting data for this study through an interviewed schedule to gather information from the sheep farmers. Data analysis was done using descriptive statistics.

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

Sex

Table 1 showed the socio-economic characteristics of the respondents. The table revealed that most (87.5%) of the respondents were male, while (12.5%) of them were female. This implies that male was more involved in farming in the study area than female. This might be due to the fact that sheep farming require more strength in carrying the activities attached to it. This tally with the findings of Osotimehin *et al*. (2006) who reported that farmers age affects their efficiency in performing farm management decisions.

Age

The result on age from Table 1 indicated that (32.5%) of the respondents were within 30-39 years, (22.5%) were within 20-29 years, (20.0%) were 60 years and above, 17.5% were within 40-49 years while only (7.5%) were within 50-59 years. The mean age of the respondents was 41 years; this implies that farmers in the study area were mostly youth who are still active enough to carry out tedious activities associated with farming.

Marital status

Table 1 further revealed that most (64.2%) of the respondents were married, 25.8% were single, (2.5%) each were widowed and divorced; this implies that farmers in the study area were mostly married folks who tend to have extra hands assisting with farming activities. This finding agrees with the findings of Darkyong (2010) who noted that dominance of married people in any sheep production business have positive effect on the business by raising money to cater for their large family size.

Educational status

Result in Table 1 shows that (40.0%) of the respondents had tertiary education, 38.3% of them had secondary education, (13.5%) of them had primary education while 8.3% of them had no formal education; this implies that farmers in the study area were educated. Being educated will help the farmers to likely cope with effect of climate change and able to adopt some adaptation strategies to combat the effect. This against the finding is in line with that of Muhammad and Kwali (2005) who reported that more than 60% of livestock farmers in northern Nigeria were not literate in terms of western education.

Household size

The result in Table 1 shows that majority (97.5%) of the respondents had 1-10 household members, (8.3%) of them had 11-20 household members, only few (2.5%) of them more than 20 household members; this implies that respondents in the study area have medium family size who can be make use of on farming and making use of family member will reduce cost of labour. This finding is similar to (Deborah, 2011), who reported that majority of farmers (52.5%) in Kano state had 1-9 household size.

Income (monthly)

The result in Table 1 finally shows that (30.0%) of the respondents earned between 30,001-40,000 monthly, (23.3%) of them earned above 40,000, 20.0% of them earned between 20,001-30,000 monthly, 15.8% of them earned between 10,001-20,000 while 10.8% of them earned less than 10,000 monthly; this implies that respondents in the study area are low income earners and this might be due to the fact that majority of the respondents operate on a small scale

Table 1: Socio-economic characteristics of the respondents

Variables	Frequency	Percentage	Mean
Sex			
Male	105	87.5	
Female	15	12.5	
Age			
20 – 29	27	22.5	
30 -39	39	32.5	41
40-49	21	17.5	
50 -59	9	7.5	
60 and above	24	20.0	
Marital status			
Single	31	25.8	
Married	83	69.2	
Divorced	3	2.5	
Windowed	3	2.5	
Religion			
Christianity	23	19.2	
Islam	93	77.5	
Traditional	4	3.3	
Educational status			
Primary education	16	13.3	
Secondary education	46	38.3	
Tertiary education	48	40.0	
No formal education	10	8.3	
Secondary occupation			
Civil servant	26	21.7	
Tailoring	24	20.0	
Carpentry	6	5.0	
Catering	5	4.2	
Trading	59	49.2	
Household size			
1 – 10	117	97.5	6
11 – 20	10	8.3	
21 – 30	3	2.5	
Income (monthly)			
1 – 10000	13	10.8	
10001 – 20000	19	15.8	
20001 – 30000	24	20.0	
30001 – 40000	36	30.0	35000
40001 and above	28	23.3	

Source: Field survey, 2020

Sources of information on climate change

Table 2 revealed the sources of information on climate change in the study area. The table showed that majority (74.2%) got information from personal experiences, 70.0% of them sourced for information from television, 68.3% sourced for information from radio. This implies that the major sources of information on climate change for sheep farmers in the study area were personal experience, television and radio and this may be due to the fact that respondents in the study area have been in faming for a long while, which therefore make them to learn from their personal experiences. However, other sources of information available include internet, meteorological station and friends and families. This supports the findings of Yahaya and Badiru (2002) that personal experience, television, farmers' association and radio were the potent source of information to farmers and their families.

Table 2: Sources of information on climate change

Sources	Yes	No
Radio	82(68.3)	38(31.7)
Television	84(70.0)	36(30.0)
Fellow Farmers	42(35.0)	78(65.0)
Sheep farmers association	29(24.2)	91(75.8)
Newspaper	31(25.8)	89(74.2)
Friends and Family	37(30.8)	83(69.2)
Agricultural Extension agents	18(15.0)	102(85.0)
Magazine and journals	16(13.3)	104(86.7)
Conference and seminar	16(13.3)	104(86.7)
Internet	62(51.7)	58(48.3)
Meteorological station	43(35.8)	77(64.2)
Personal experience	89(74.2)	31(25.8)

Source: Field survey, 2020. *All figures in parentheses are in percentage*

Perceived evidence of climate change among farmers

The result in Table 3 revealed the perceived evidence of climate change among farmers. The table showed that majority (96.7%) of the respondents perceived high rainfall as an evidence of climate change, 92.5% also perceived long period of harmattan as an evidence of climate change, 82.5% of them perceived high temperature as an evidence of climate change, 69.2% of them perceived increase incident of pest and disease as an evidence of climate change. This implies that the major evidence of climate change identified in the study area were high rainfall, long period of harmattan and high temperature and this may be due to the fact that these conditions have one or more effect on the livestock reared. High sunshine, drought and increased incident of pest and disease were also identified evidence of climate change among farmers in the study area. Result of analysis is in concordance with Elijah and Adedapo (2006) and implies that variations in climate revolve around heat and rainfall intensities and deviations.

Table 3: Perceived evidence of climate change among farmers

Perceived evidence on sheep rearing	Yes	No
High temperature	99(82.5)	21(17.5)
High rainfall	116(96.7)	4(3.3)
Long period of harmattan	111(92.5)	9(7.5)
Short period of harmattan	19(15.8)	101(84.2)
Flood	24(20.0)	96(80.0)
Excessive wind	29(24.2)	91(75.8)
High heat waves	41(34.2)	79(65.8)
High sunshine drought	56(46.7)	64(53.3)
Increase incident of pest and diseases	83(69.2)	37(30.8)

Source: Field survey, 2020. *All figures in parentheses are in percentage*

Perceived effect of climate change on sheep farming rearing

The Table 4 showed that majority (95.0%) of the respondents perceived reduced farmer's income and increased mortality as effect of climate change on farming, 93.3% of them each perceived reduced body weight and increased disease infection as effect of climate change, 90.0% of them also perceived reduced fertility as effect of climate change. This implies that all the above listed effects are perceived effects of climate change by the farmers in the study area, and this may be due to the fact that a slight change in the climatic condition of the study area, leads to some (or all) these factors which in turn leads to the reduction in the farmers' income.

Table 4: Perceived effect of climate change on farming

Effect of climate change on sheep farming	Yes	No
Change in taste of meat	85(70.8	35(29.2)
Decreased activity	86(71.7)	34(28.3)
Increased disease infection	112(93.3)	8(6..7)
Increased mortality	114(95.0)	6(5.0)
Reduced body weight/stunted growth	112(93.3)	8(6.7)
Reduction farmers income	114(95.0)	6(5.0)
Reduced feed intake	102(85.0)	18(15.0)
Reduced fertility in sheep	108(90.0)	12(10.0)

Source: Field survey, 2020. *All figures in parentheses are in percentage*

Strategies used in adapting to the effect of climate change

The table 5 showed that majority (83.3%) of the respondents used frequent vaccination to adapt to effect of climate change, 61.7% of the respondents adapt to climate change by keeping different breeds of sheep, (47.5%) of them adapt to climate change by cross breeding with improved breed, (43.3%) of them adapt to climate change by keeping other livestock, 40.0% of them adapt to climate change by keeping improved breed of sheep.

This implies that the main strategy used by farmers in the study area in adapting to climate change was frequent vaccination and this may be due to the fact that frequent vaccination prevents any kind of disease outbreak, it may also reduce mortality rate, increase feed intake, and also increase fertility in the course of climate change.

Table 5: Strategies used in adapting to the effect of climate change

Strategies used in adapting to the effect of climate change	Yes	No
Frequent vaccination of sheep	100(83.3)	20(16.7)
Keeping of improved breed of sheep	48(40.0)	72(60.0)
Rearing of other livestock/mixed breeding	52(43.3)	68(56.7)
Extensive management system	42(35.0)	78(65.0)
Rearing on commercial scale	62(51.7)	58(48.3)
Cross breeding with improved breed	57(47.5)	63(52.5)
Keeping varieties of sheep	74(61.7)	46(38.3)
Rearing disease resistant strains	28(23.3)	92(76.7)

Source: Field survey, 2020. All figures in parentheses are in percentage

CONCLUSION

From the findings of this study it is concluded that majority of the respondents were male youth married, who had tertiary education and had 1-10 household member. From the findings of this study it is concluded that frequent vaccination of sheep, keeping varieties of sheep and cross breeding with improved breed were the adaption strategies to effect of climate change. Finally, it is also concluded that age (p=0.000), educational status (p=0.023) and secondary occupation (p=0.014) had significant effect on the adoption of strategies used in adapting to climate change.

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Influence of Flooding on Yields of an Indigenous Vegetable (*Corchorus olitorius* L) in Ekpoma: Implications for Climate Change in South – South Nigeria

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ABSTRACT

Experiments were conducted to study the response of Corchorus olitorius to flooded soils at the demonstration plot of Ambrose Ali University, Ekpoma. The study revealed that the negative response of the vegetable crop to flooding was significant (P<0.05). The general effects were low dry weights yields, wilting and yellowing of leaves leading to senescence and eventual death of the plants. At week eight, the control plants had significant (P<0.05) higher dry matter yields of 2.4 g/plant than the 0.2g/plant dry matter recorded for plants in flooded conditions as the flooding effects resulted in 91.7% yield decrease. Similarly, at 8 Weeks of the treatment, leaf area of flooded plants was 0.76cm^2/plant while that of control plants was 11.64cm^2/plant. Thus a 93.5% reduction was obtained due to flooding effects. The response of the plants to flooding confirmed that yield decrease significantly (P<0.05) as the flooding persisted. This thorough understanding of how flooding affect C. olitorius would aid in the development of strategies for the cultivation and availability of the leafy vegetable crop in the South – South region for enhanced livelihoods in the wake of climate change.

Keywords: Analysis, climate change, Corchorus olitorius, crop, flooding, food security, leaf area, livelihoods, poverty, randomly, sampling, vegetable, yield

INTRODUCTION

Corchorus olitorius L, which is also known as Sorrel, Jew's mallow, jute, is a leafy vegetable and a member of the family *Tiliacea*. The plant is herbaceous and it is grown and eaten mostly in Southern Nigeria. The planting season is March or a little later and harvesting season is July – September (Okigbo, 1978). It is also grown in the Northern Nigeria, particularly in the Savanna zone where a long wet season extending from June to November provides adequate rains and sufficient sunlight for the necessary vegetative growth and production of the crop. In Nigeria, *C. olitorius* is locally called "Ewedu" by the Yoruba in South West geopolitical zone, "Iyienlolo" in Ishan province (South – South geopolitical zone), "Ahihara" by the Igbo in South East geopolitical zone, and "Malafiya" by the Hausa. The leaf is used mainly as vegetable and it features prominently in local soups.

Medicinally, leaf of *C. olitorius* is used to cure cancer, diabetes, hypertension etc. The species is Vitamin K and Vitamin B6 rich vegetable and it is also rich in antioxidants (Shaker, 2021). It is used in traditional medicine to heal gonorrhea, restless leg syndrome, and to protect eye health. Additionally, it is used as a cure for internal bleeding. It is also used in traditional medicine to treat malaria, typhoid fever, heart disease (Habib Adebo *et al*., 2018), cold and tumours (Lawal *et al*., 2020). The species grows to a height of about 3 m and it tolerates different soil types ranging from loamy to clayey loam. The leaves of *Corchorus olitorius* contain 5 – 6 per cent protein and it is good source of iron, Calcium, and phosphorus.

Vegetable production in Nigeria is traditionally in small holdings and often in mixture with arable crops (Omidiji *et al*., 1986). This method of vegetable production does not meet the requirement of the populace in Nigeria especially during the dry season. A desire towards improving vegetable production calls for, among other factors, study on response of *Corchorus olitorius* to flooding and the development of improved cultivars (e.g. flood tolerant types), through breeding. The objective of this study, therefore, was to examine the response of *Corchorus olitorius* to flooding so as to develop means of boosting its production and making it available in the markets in the wake of climate change.

MATERIALS AND METHODS

Seeds of a local variety of *Corchorus olitorius* were obtained from farmer's garden in Ibadan and were sown in germination trays at the experimental farm of Ambrose Alli University, Ekpoma (06^0 42' N Latitude 06^0 08' E Longitude) in Edo State, Nigeria using garden soil. Samples of the soil were analyzed at the Nigerian Institute for Oil Palm Research (NIFOR) for some selected chemical soil properties (Table 1). The mean elevation at the experimental site was 509 m above sea level (a.s.l.). Ekpoma falls within the tropical rainfall belt, in the South – South geopolitical zone of Nigeria. Seedlings of *C. olitorius* were transplanted into individual polyethylene bags, each measuring 25cm x 15cm, and allowed to harden prior to transplanting out in the field.

Research on the vegetable crop was carried out during the dry season in controlled conditions to avoid rainfall interference with the treatments. The treatments were: (1) flooded treatment, where the soil was completely flooded with water throughout the experimental period; (2) control treatment, where regular watering was done daily. Seedlings for the treatment involving flooded condition were laid inside metal containers, each measuring 204cm x 160cm x 30cm, where they were flooded with water. The level of water above the soil surface was 2cm. This level was topped up daily when it was necessary to re-fill the containers to the flooded level.

The experiments were arranged in a Completely Randomized Design with four replicates using 30cm x 30cm spacing between and within rows respectively (i.e. 111,111 plants^{-ha}). Sampling for growth and development commenced two weeks after treatment application to enable the seedlings acclimatize to the weather. After the acclimatization, the sampling was done weekly over a period of 8 weeks. For every sampling week, five plants of the species per replicate were selected randomly and harvested from each treatment for growth analysis. The sampled plants in the polyethylene bags were soaked in a bucket of water for 15 minutes prior to harvesting and were carefully pulled out from the polyethylene bags without losing any of the roots. The sampled plants were separated into roots, stems and leaves and the fresh weights of the different parts were taken. The plant parts were dried in an oven at 65^0 C until constant weights were achieved and they were re-weighed to obtain dry weights.

The response of the species was studies using leaf area, and fresh and dry weights of the plants. Leaf area was determined using the predictive equation described by Hunt (1975), $Y = 1.26 + 0.85X$, where Y and X are predictive and calculated (leaf length X leaf width) leaf area respectively. All data were analyzed by analysis of variance (ANOVA) procedure with SAS Statistical software package (SAS, 1987). Means separations for the effects were obtained by Fisher's Least Significant Difference (LSD) test as described by Clark (1980). Effects were considered significant in all statistical calculations if P-values were less than 0.05 ($p<0.05$).

RESULTS AND DISCUSSION

The total dry matter yields of *C. olitorius* are shown in Fig 1. Seedlings of the species grown in control treatment had significantly ($P<0.05$) higher dry matter (2.3g/plant) than the 0.19g/plant of seedlings grown under flooded conditions. This was expected on the basis of the availability of optimum water for physiological processes in the control plants. As Boot *et al*., (1986) pointed out, the fact that the dry matter of waterlogged plants was reduced suggests strongly that flooding reduces growth rate of plants because cell division and enlargement on which growth depends are affected.

Fig 2 shows results of leaf area. The significant smaller leaf area in treatment involving flooding (less than 1cm^2/plant) is normal. Control treatment developed larger leaf area (11.6cm^2/plant) than the flooding treatment, indicating that plants in control treatment produced larger leaves to account for the regular water applied to them, which was probably optimum for plant growth. In general, flooded plants performed poorly as expressed by the dry weights and a reduced total leaf area compared to the control plants. Nevertheless, they weakly survived up to week 7, implying that prolonged flooding leads to plant death and thus, *C. olitorius* tolerate flooding up to 7 weeks.

As expected, plants grown in the control treatment developed extensive shoot and root and they produced large and green leaves, thus produced higher yields throughout the experimental period than the plants in flooded condition. This was probably due to adequate water application. Also, the application of too much water to plants, in the flooding treatment, resulted in a yield decrease of 93.5%. It is most probably that the growth rate of the species depended on the water treatments imposed on the plants. But other factors, such as temperature (Fawusi and Ormrod 1981), and soil fertility (Awodun and Ojeniyi 2002) have been known to contribute to plant growth.

Significant results from the study were consistent with lower yields and smaller leaf areas obtained from flooded soils than regular watered soils of the control treatment. Flooding effects also appeared in form of yellowing of the leaves. Based on these findings, it could be said that the yellowish of the leaves, together with senescence observed in *C. olitorius* under flooded condition, was probably due to a response to adverse effects, as also observed in other crops (Davies 1984; Trought and Drew 1980).

Generally, flooding effects were first observed during the third week of sampling. It is notable that yellow colour appeared on leaves during the third week of flooding, indicating reduced metabolic processes.

CONCLUSION

Results of the research showed poor performance of *C. olitorius* in flooded soils. These results are of particular interest in the wake of climate change since virtually all Nigerians depend on vegetable for improved health, nutrition and wellbeing. Clearly, the lower growth rate of *C. olitorius* in flooded condition is unsurprising, in view of the stressed conditions imposed on them. The vulnerability of *C. olitorius* to flooding seems to be a discouraging feature of the species. That the effects of flooding seem to be pronounced in the plants tested indicate that the capacity of *C. olitorius* to tolerate flooded conditions may be relative low - and this has some implications on food security, poverty and livelihoods – as it may be vulnerable to climate change.

It is obvious from dry matter production and leaf area development that production of *C. olitorius* in the South – South geopolitical zone of Nigeria, cannot be encouraged during the peak of rainy season since farmers would lose roughly 90% of vegetable yields if grown on flooded and poorly drained soils. We recommend that, with moderate rainfall, *C. olitorius* should be cultivated in the dry-land areas of South – South geopolitical zone. Furthermore, it could be cultivated near the riverbank especially during the off-season dry period when other vegetable crops are not available in the markets. Further experiments that will include growing *Corchorus olitorius* in different locations could help to confirm this assumption.

For practical purpose, off-season vegetable production has an advantage in that livelihoods of the people will be enhanced, since poverty can be reduced via food security. Investigation of climate change on other vegetable crops needs to be carried out to better understand water stresses and predictable impacts on vegetable crop production.

Table 1: Selected chemical properties of soil used for the experiment (0 – 15cm depth)

Chemical Properties	Values
pH (H_2O)	5.15
Organic Carbon (%)	1.32
N (%)	0.08
P ($mg.kg^{-1}$)	4.41
Ca (cmol (+) kg^{-1})	1.00
Mg (cmol (+) kg^{-1})	0.12
K (cmol (+) kg^{-1})	0.05
Na (cmol (+) kg^{-1})	0.29
ECEC (cmol (+) kg^{-1})	2.56
Total acidity (cmol (+) kg^{-1})	1.10

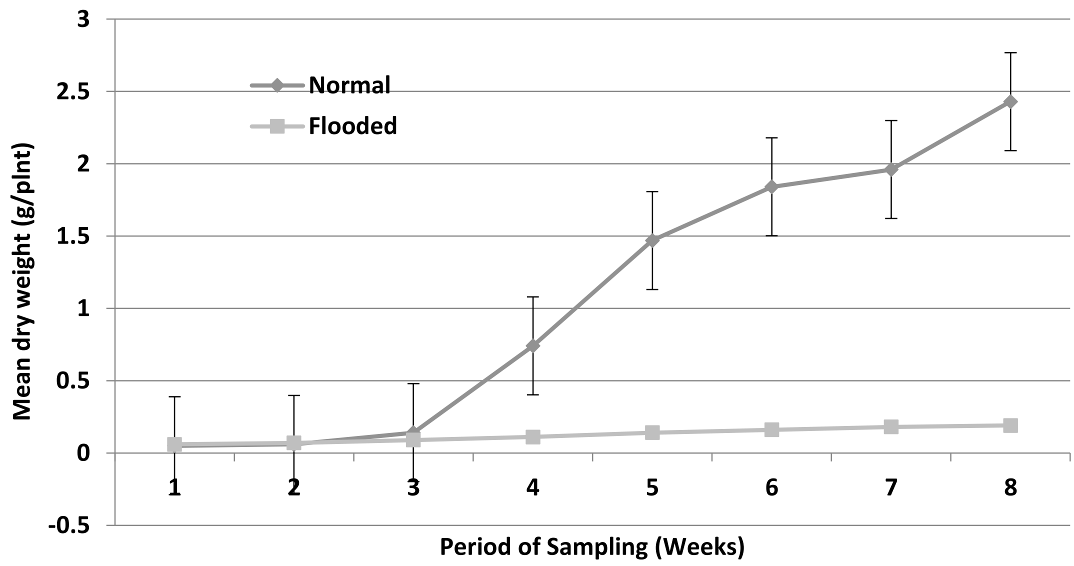

Fig. 1: Mean total dry weight of *Corcorus olitorius* as influenced by flooding

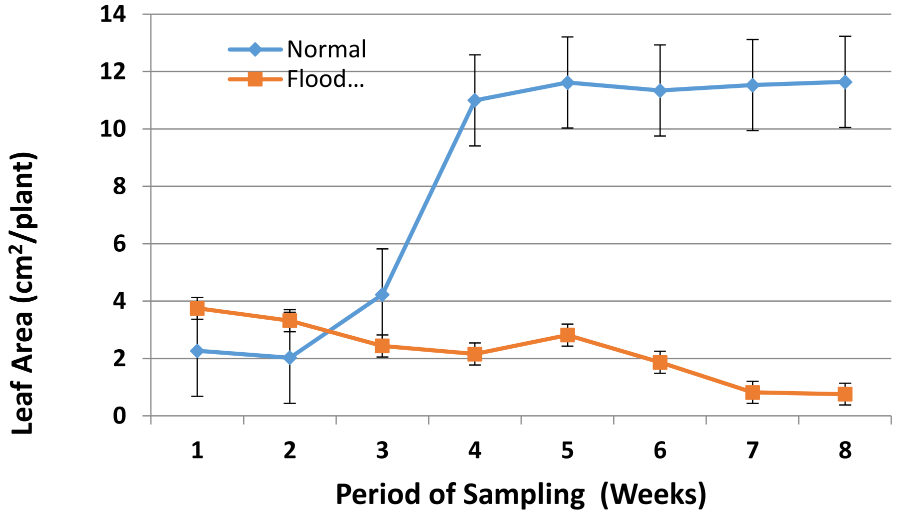

Fig. 2: Total leaf area of *Corcorus olitorius* as influenced by flooding

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PROCEEDINGS

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SUB-THEME 9

Post-Harvest Handling, Product Development, Quality Standards for Local and Export Markets

Effect of Different Processing Methods on Proximate Composition of UMUSPO 3 (*ipomoea batatas*) Variety

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ABSTRACT
Umuspo 3 (Ipomoea batatas) variety was harvested from the experimental field of the National Root Crops Research Institute, Umudike. It was washed and processed to determine the effect of different processing methods (boiling, frying, micro wave heating and baking) on the proximate composition. The experiment revealed that the moisture content was found to increase significantly from 71.30% in the control to 76.48% and 80.79% in the samples boiled for 10 and 20 minutes respectively. The ash content of the samples ranged from 0.35% in the samples boiled for 20 minutes to 2.71% in the sample baked for 45 minutes. It was observed that boiling caused the highest decrease in ash content from 1.43% in the control to 0.42% in the sample boiled for 10 minutes and 0.35% in sample boiled for 20 minutes. The fat content of the samples ranged from 2.43 to 4.46%. it was observed that baking resulted to the highest decrease from 3.20% in the control to 1.03% in the sample baked for 45 minutes. This represents a decrease of 68%. The crude fibre content of the control was found to be 4.00% this value was quite higher than the range (0.67 to 2.00) reported by Omodamiro et al., (2013) for fifteen sweet potato genotypes. Protein content of the control was recorded as 3.94% and this value was quite higher than 0.46% reported by Omodamiro et al., (2013) for sweet potato. It was observed that the crude protein content of the boiled sample decreased significantly. The carbohydrate content of the samples ranged from 16.13 to 17.55% as boiling caused significant increase (p≤0.05) in carbohydrate content from 16.13% in the control. However different processing treatments have helped in the consumption and utilization of Orange sweet potatoe in the area of harnessing the abundant nutrients.
Keywords: Boiled sample, Genotypes Orange sweet potato, Processing

INTRODUCTION
Sweet potato (*Ipomoea batatas* (L) Lam) is an important tuber crop grown in the tropics, sub-tropics and warm temperate regions of the world for its edible storage roots. It is a dicotyledonous plant that belongs to the *Convolvulaceae*. Its large, starchy, sweet-tasting, tuberous roots are a root vegetable (Purseglove, 1968; Woolfe, 1992). Of the approximately 50 genera and more than 1,000 species of *Convolvulaceae*, *I.batatas* is the only crop of major importance. Some others are used locally, but many are poisonous. Sweetpotatoe is widely grown in eastern, central and southern Africa (to a lesser extent in West Africa), where it is prized by the region's resource-poor farmers both as a reliable, low input, food security crop, and increasingly, for its commercial potentials (Minde *et al*., 1998). The bulk of sweet potato production in this region is still accounted for by a large number of farmers' varieties. Over the years these varieties have been selected by farmers, based on the ability to yield storage roots of acceptable consumer quality, and to produce planting material for continued propagation. Vitamin A deficiency is a major public health issue in developing countries. Children and pregnant/lactating women are the most vulnerable (FAO, 2002). Sub-Saharan

Africa is one of the most affected areas with 33 million pre-school children who are deficient, which accounts for a third of the world cases (West, 2002). There are different strategies to tackle vitamin A deficiency. Traditional interventions consist of administration of vitamin A capsules. Although a single dose can be given every six months or every year, these medical interventions are costly (Nestel *et al*., 2006). Food fortification is another approach used to reduce vitamin A deficiency that works by adding vitamin A to food commodities (for example sugar). An alternative approach is bio-fortification, which consists of breeding staple crops to increase their content of vitamins and minerals. Compared to the two other strategies, bio-fortification is considered the more sustainable approach because it has the potentials to provide vitamins or minerals throughout the year with a one-off intervention and in the longer term at lower cost (K'osambo *et al.*,1998). For the same level of impact on public health, the cost of bio-fortification is estimated to be half that of vitamin A supplementation (Nestel *et al*.,2006). Moreover, rural and low-income communities, which have been shown to be at more risk, can be reached by this approach and it also creates opportunities for income generation from production and marketing of these crops. Therefore, this work aimed at evaluating the effect of different processing methods on the proximate composition of sweet potato variety (UMUSPO 3).

MATERIALS AND METHODS

UMUSPO 3 (*ipomoea batatas*) variety was identified, cultivated and harvested at National Root Crops Research Institute umudike. It was cleaned, washed and sliced before taken to the laboratory for analysis. Standard analytical procedures were used to determine the proximate composition as were reported by Onwuka (2005). Statistical Analysis used was Analysis of variance version 16. Means were separated using Duncan multiple range Test.

RESULTS AND DISCUSSION

The results on effect of processing methods on proximate composition of Umuspo3variety are presented in Table 4.2. The result revealed significant differences ($p<0.05$) between the processing methods.

Moisture: The moisture content was found to increase significantly from 71.30% in the control to 76.48% and 80.79% in samples boiled for 10 and 20 minutes respectively. Boiling for longer time also caused additional increase ($p<0.05$) in moisture content. The increased moisture content might be due to the water absorption capacity of fibers and other natural chemical components in the sweet potato during heat treatment (Ekanayake *et al*., 2000). Microwave heating for 5 minutes (67.01%) and 10 minutes (64.51%), frying for 5 minutes (65.59%) and 10 minutes (62.60%) and baking for 25 minutes (12.91%) and 45 minutes (9.55%) resulted to significant decrease ($p<0.05$) in moisture content but baking for 45 minutes caused the highest decrease. The decrease was attributed to moisture losses from the sweet potato as a result of heat application.

Ash: The mean ash content of the samples ranged from 0.35% in sample boiled for 20 minutes to 2.71% in sample baked for 45 minutes. It was observed that boiling caused the highest decrease in ash content from 1.43% in the control to 0.42% in sample boiled for 10 minutes and 0.35% in sample boiled for 20 minutes. It was also seen that boiling for 20 minutes caused significant decrease in ash content when compared with boiling for 10 minutes. The decrease in total ash may be due to solubilization of the mineral compounds and water absorption during boiling (Frontela *et al*., 2009; Gibson, 1994). The mean ash content of samples given frying (1.46%; 1.45%)and microwave heating treatment (1.43%; 1.44%) treatments for 5 and 10 minutes respectively increased insignificantly ($p>0.05$). Baking however, resulted to the highest increase ($p<0.05$) in ash content with sample baked for 25 and 45 minutes having values of 2.28 and 2.71% respectively. In addition, baking for longer time in this study resulted to significantly higher ash content ($p<0.05$) compared to baking for 25 minutes. Hence, the samples with higher percentage ash contents are expected to have high concentrations of various mineral elements, which are advantageous to speed up metabolic processes and improve growth and development (Esenwah and Ikenebomeh, 2008).

Fat: The fat content of the samples ranged from 2.43 to 4.46%. It was observed that baking resulted to the highest decrease from 3.20% in the control to 1.03% in sample baked for 45 minutes. This represents a decrease of 68%. However, baking for longer times did not significantly affect the fat content of the samples compared to baking for shorter time. Boiling also caused a decrease in fat content by 13% in samples boiled for 10 minutes and 24% in samples boiled for 20 minutes. It was also evident that boiling for longer time in this study caused further reduction ($p<0.05$) in fat content of the samples. Microwave heating for 5 minutes (3.14%) insignificantly affected ($p>0.05$) the fat content. However, microwave heating for 10 minutes caused a significant decrease ($p<0.05$) in fat content by 6%. The decrease in fat content of the samples observed in this study after baking, boiling and microwave heating could be as a result of lipid oxidation. Lipid oxidation is known to be increased by many factors such as heat, light and radiation (Savage *et al*., 2002). The highest values of fat were found in the fried samples and they were significantly higher ($p<0.05$) than those obtained by other processing methods with samples fried for 5 and 10 minutes recording an increase by 20 and 39% respectively. Frying for longer time also resulted to significantly higher proportions of fat compared to frying for 5 minutes. The increase in fat content was due to absorption of oil by the sweet potato during frying. According to DRI (2004), the recommended daily energy allowance is between 2100 to 2550kcal for male and 1800 to 2000kcal for female. Thus, fat from the processed OFSP samples would provide energy between 77.95 to 342.71 kcal. On the minimum, fat from the processed OFSP samples would provide between 4 to 16% and 4 to 19% of the RDA of energy for male and female respectively. These values were below the standard of 20 to 35% of the daily calorific need as stated by Coleman (2013), suggesting that Umuspo 3 variety is a poor source of fat.

Table 4.2: Effect of Processing on Proximate Composition (%) of Umuspo 3 (*Ipomoea batatas*) Variety

Processing Method	Processing Time (minutes)	Moisture	Ash	Fat	Crude Fiber	Protein	Carbohydrate
Raw (control)	0	$71.30^{c}\pm1.55$	$1.43^{c}\pm0.32$	$3.20^{c}\pm0.28$	$4.00^{c}\pm0.00$	$3.94^{b}\pm0.62$	$16.13^{e}\pm1.54$
Boiling	10	$76.48^{b}\pm1.58$	$0.42^{d}\pm0.09$	$2.78^{e}\pm0.24$	$3.05^{d}\pm0.00$	$2.39^{c}\pm0.36$	$18.30^{de}\pm1.54$
Boiling	20	$80.79^{a}\pm1.60$	$0.35^{d}\pm0.14$	$2.43^{f}\pm0.21$	$2.40^{e}\pm0.00$	$1.43^{d}\pm0.31$	$18.76^{d}\pm1.74$
Frying	5	$65.59^{e}\pm1.42$	$1.46^{c}\pm0.31$	$3.84^{b}\pm0.34$	$3.82^{c}\pm0.14$	$2.58^{c}\pm0.46$	$22.79^{c}\pm1.64$
Frying	10	$62.60^{g}\pm1.32$	$1.45^{c}\pm0.31$	$4.46^{a}\pm0.41$	$3.69^{c}\pm0.14$	$2.74^{c}\pm0.43$	$27.08^{b}\pm1.63$
Microwave Heating	5	$67.01^{d}\pm1.46$	$1.43^{c}\pm0.31$	$3.14^{c}\pm0.27$	$4.02^{c}\pm0.00$	$3.98^{ab}\pm0.53$	$20.62^{cd}\pm1.51$
Microwave Heating	10	$64.51^{f}\pm1.35$	$1.44^{c}\pm0.32$	$3.01^{d}\pm0.26$	$4.06^{c}\pm0.14$	$4.11^{ab}\pm0.49$	$26.21^{b}\pm1.26$
Baking	25	$12.91^{h}\pm0.09$	$2.28^{b}\pm0.51$	$1.14^{g}\pm0.14$	$5.70^{b}\pm0.14$	$4.41^{ab}\pm0.18$	$73.59^{a}\pm0.57$
Baking	45	$9.55^{i}\pm0.18$	$2.71^{a}\pm0.61$	$1.03^{g}\pm0.02$	$6.65^{a}\pm0.02$	$4.70^{a}\pm0.09$	$75.55^{a}\pm0.71$

Values are means ± standard deviations of duplicate determinations. Two means along the same column with different superscripts are significantly different ($p<0.05$)

Crude fiber: The crude fiber content of the control was found to be 4.00%. This value was quite higher than the range (0.67 to 2.00%) reported by Omodamiro *et al*., (2013) for fifteen (15) sweet potato genotypes. The variation could be due to effect of variety resulting from differences in genetic composition The boiled samples had the least crude fiber content with samples boiled for 10 minutes recording a value of 3.05% and sample boiled for 20 minutes having a value of 2.40%. These values represent a significant decrease by 24 and 40% respectively. It was also evident that boiling for longer time of 20 minutes caused significant reductions ($p<0.05$) in fiber content compared to boiling for 10 minutes. The decrease in crude fiber with increased duration of cooking (boiling) agrees with the report of Akinmutimi (2007), who worked on *mucuna* species. The effect of microwave heating for 5minutes (4.02%) and 10minutes (4.06%) and frying for 5 minutes (3.82%) and 10 minutes (3.69%) caused insignificant ($p>0.05$) changes in crude fiber content. However, baking caused significant increase ($p<0.05$) in crude fiber content with samples baked for 25 minutes and 45 minutes recording values of 5.70 and 6.65% respectively. These values represent an increase of about 43 and 66% respectively. The increase could be due to removal of moisture from the sample. According to DRI (2004), the RDA for crude fiber is 38g and 25g for male and female respectively. Thus, 100g of the processed OFSP samples would provide between 6 to 18% and 10 to 27% of the RDA of crude fiber for male and female respectively. Fibers exhibit beneficial physiological effects to the human body, as they stimulate and accelerate intestinal contraction and transit, and increased feaces volume (Hassan *et al*., 2007). Therefore, the high levels of crude fiber observed for the processed samples could be an advantage as it might help in the treatment of diseases such as obesity, diabetes, cancer and gastrointestinal disorders (Hodgkinson, 1977) and indigestion and prevention of colon cancer (Hurrel *et al*., 1992).

Protein: The protein content of the control was recorded as 3.94% and this value was quite higher than 0.46% reported by Adepoju and Adejumo (2015) for sweet potato. It was observed that the crude protein content of the boiled samples decreased significantly by 39 and 64% in samples boiled for 10 and 20minutes respectively. The result also revealed that increase in boiling time caused further reductions ($p<0.05$) in protein content. Similar observations have been reported by Ezeocha and Ojimelukwe (2012) in their studies on water yam. This reduction may be as a result of the loss of free amino acids which took place through leaching (Ezeocha and Ojimelukwe, 2012). Frying also caused significant reductions ($p<0.05$) in protein content by 30 and 34% in samples fried for 5 and10 minutes respectively. However, microwave heating resulted to significant increase($p<0.05$) in protein content by 1.0 and 4.3% in samples given microwave heat treatment for 5 and 10 minutes respectively while baking caused the highest increase ($p<0.05$) by 12% in samples baked for 25 minutes and 19% in samples baked for 45 minutes. The observed increase in protein content of OFSP samples given microwave heating and baking treatments could be attributed to increased relative concentration due to moisture losses. According to DRI (2004), the RDA of protein for men and women are 56 and 46 g respectively and 23 to 36g for children (Aremu *et al*., 2006). Thus, 100g of the processed OFSP samples would provide on the minimum between 3 to 8% and 3 to 10% of the RDA of protein for men and women and adequately supply those of children.

Carbohydrate: The carbohydrate content of the samples ranged from 16.13 to 75.55%. Boiling caused significant increase ($p<0.05$) in carbohydrate content from 16.13% in the control to 18.30% (10 minutes) and 18.76% (20 minutes). This was not in agreement with the findings of Gemede (2014) who reported a decrease in carbohydrate content of boiled *Anchote* (*Cocciniaabyssinica*) tubers. Frying for 5 minutes (22.79%) significantly increased the carbohydrate content by 41%. Similarly, microwave heating for 5 minutes (20.62%) significantly increased the carbohydrate content by 28%. Frying (27.08%) and microwave heating (26.21%) for 10 minutes were insignificantly different ($p>0.05$) but resulted to significant increase in carbohydrate content by 68 and 62% respectively. The result also suggests that frying and microwave heating for longer time in this study resulted to further increase ($p<0.05$) in carbohydrate content. Furthermore, baking for 45 minutes caused the highest increase ($p<0.05$) in carbohydrate content by 368%. However, baking for longer time in this work did not result to any significant change in carbohydrate content compared to baking for shorter time. The increase observed in samples from boiling, microwave heat, frying and baking treatments could be attributed to increased relative concentration due to removal of moisture. According to DRI (2004), the recommended daily allowance for carbohydrate for adult men and women is 130g. With the total carbohydrate value of the processed OFSP samples ranging from 18.30to 75.55%, Umuspo3 variety is a good source of carbohydrate being able to provide only 14 to 58% of the RDA for carbohydrate per 100g.

CONCLUSION

Different processing treatments have been found to play a major role in ascertaining best method for nutrient retention, and utilization of UMUSPO 3(*ipomoea batatas*) variety. Hence its proper utilization will enhance adequate nutrient supply, cure to hidden hunger and ensure food security.

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Nutritional Compositions of Fermented and Extruded Rice – Sesame Blends

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ABSTRACT

The demand for processed cereal foods among school children and some office workers is increasing in Nigeria. Enrichment of cereal-based foods with other protein sources such as legumes will improve the food quality to produce high energy-protein foods. Fermentation and extrusion cooking experiment was adopted in this research to enhance the bioaccessibility and bioavailability of nutrients from brown rice (FARO52) and sesame (NCRIBEN04E) collected from National Cereals Research Institute (NCRI) Badeggi, Niger State. Samples $FR_{90}S_{10}$, $FR_{80}S_{20}$, $FR_{70}S_{30}$, $FR^{60}S_{40}$, $F_{50}RS_{50}$ and R_{100} (control) were subjected to proximate analysis and mineral determination in the extrudates. The protein content observed ranges from 7.26-17.46%, carbohydrate (65.59-84.75%), fat (2.04-6.30%) and energy value of (386.4-391.17%) within the blends. The macro and micronutrients were present in sufficient amounts, suggesting general nutritional improvement to common use of whole cereal. Products from such blends could be used to as breakfast cereal to combat nutritional problems among school children and improve food security in Nigeria.

Keywords: cereal-based foods, extrudates, nutritional, whole cereal

INTRODUCTION

Directly extruded snacks also referred to as second generation snacks are trendy in the market, but considered product of poor nutritional quality mainly due to the utilization of sole cereal in its production (Felix-Medina *et al*., 2020). It is a highly preferred food product by children, and therefore need to be nutrient dense to support growth and development of children (Danbaba *et al*., 2020). The world Health Organization (WHO) in 2016 reported poor access to nutritionally dense foods including snacks in developing countries of Africa and Asia is responsible for half of the death of children under the age of 5 years. In 2015 alone, it was observed that more than one-quarter of all children under 5 years with wasted muscles lives in Africa. Affordable nutrient dense, easily digestible products including snacks are thought to be ideal to overcome protein-energy-malnutrition among children in developing countries (Pathak and Kochhar, 2018).

Food processing operations such as fermentation, germination (sprouting), roasting etc has been shown to have significant impact on the nutritional composition of final products (Danbaba *et al*., 2020). The production of cereals-legume based products to supply additional protein and minerals to the daily diet of the vulnerable groups of the population has increased significantly over the years. Such products include nutritionally enhanced biscuits, breads, cakes, porridges and extruded snacks. Extrusion cooking technology has played a central role in modern cereal-based industries especially for the production of snacks from wheat, corn, oats and rice (Chaiyakul *et al*., 2009). Nevertheless, fewer rice-based extruded products are available in the market compared to those from corn and wheat. But, rice flour has become an attractive ingredient in the production of extruded products due to its bland taste, attractive white colour, hypoallergenicity, ease of digestion and the ability to expand well and make excellent extrudate (Guy, 2001). However, nutritionally, rice and rice-based products are deficient in lysine, an essential amino acid, which can be improved by blending rice with food materials rich in lysine. Food legumes have been proven to be comparatively rich in lysine and therefore combination of rice protein and legume protein provide an ideal source of dietary protein for humans. The utilization of locally grown crops for the production of high protein, shelf stable and affordable recipes in less developed countries has been stressed by international agencies as one of the most suitable channel for addressing the deepening global nutrition challenges (Iwe *et al*., 2001).

MATERIALS AND METHODS

Brown rice (FARO 52) and sesame (NCRIBEN 04E) were obtained from National Cereals Research Institute (NCRI) Badeggi, Niger State and manually cleaned to remove impurities.

Rice fermentation and Milling

The method of Jeygowri *et al*., (2015) was adopted for rice fermentation with slight modifications. Brown rice was soaked in warm water for 30 minutes to obtain uniform hydration. Fermentation was carried out by soaking in sterile distilled water overnight (12-16 hours) at an ambient temperature. The water in the container was drained after fermentation and the rice was air dried before transferring into an oven where the moisture content was reduced to12%. The fermented dried rice was milled into flour using locally fabricated attrition mill and sieved through a laboratory sieve of 80 mesh size and packaged in polyethylene bags until required.

Sesame fermentation and Milling

The sesame seeds were dehulled and fermented as described by Akindahunsi, (2004) with little modifications. The seeds were boiled in water for 6hrs and allowed to cool then placed in a plastic container with a tight lid to ferment for 7 days. The seeds were oven dried at 105°C for 12hrs to end fermentation and defatted using hydraulic press to obtain defatted sesame cake. The defatted sesame was dried to about 12% moisture in an oven then grinded into flour using a laboratory blender, sieved and stored in a glass container until when required.

Formulation of Composite

Five composite flours were formulated with the fermented seeds and coded as $FR_{90}S_{10}$, $FR_{80}S_{20}$, $FR_{70}S_{30}$, $FR_{60}S_{40}$ and $FR_{50}S_{50}$with varying proportions of sesame (10, 20, 30, 40 and 50) and R_{100}asthe control.

Extrusion cooking experiment

The extrusion cooking experimental was performed using a small scale laboratory single screw extruder (DUISBURG DCE-330 Model, Germany) with components such as feed moisture content (11-13%), cooking temperature (120%) and die zones kept constant for all samples. The samples were dried 6-7hrs after extrusion at 60°C in an oven and crushed using a small scale laboratory blender into powder forms then stored in a desiccator until required for analysis.

Analysis for Proximate and Mineral Composition

Proximate composition such as Moisture, Fat, Protein, Fibre, Ash using AOAC (2011), and Mineral contents (Na, K, Ca, Mg, P, Fe and Zn) were determined using AAS~~,~~ while Carbohydrates were calculated by difference (in complete). Gross energy value (Kcal/100 g) was calculated as described by FAO (2008).

RESULTS AND DISCUSSION

The results of mean values observed for proximate composition (moisture, protein, lipid, fibre, ash, carbohydrate and caloric value) for fermented rice-sesame extrudates is presented in Table 1. The highest moisture content of 6.56% was recorded in sample $FR_{50}S_{50}$ suggesting low moisture enough to have an extended shelf life. It has been observed by several authors that in a dry food system with moisture content between 6% and 10%, there is a prolong shelf stability, and above this range, the stability of the system could be impeded by both chemical and microbiological agents (Danbaba *et al*., 2016). The protein content increased from 7.26% to 17.46% with increase in sesame as compared to 2.28% recorded in extruded rice flour suggesting proportional increase in protein when rice is fortified with sesame.

The fat content ranged between 2.04 and 6.30% within the formulations. Danbaba *et al*., (2016) reported that for a food to be used as complementary formulations, the minimum fat content requirement should be 6%.Dietary fats are beneficial in the body because of their function as carriers of fat soluble vitamins in the diet and as mediators of some physiological processes associated with growth and development, inflammation and brain function (Gbenyi *et al*., 2016).The significantly low fat content implies that this quality parameter needs to be added from other sources into the diet of the consumers of this product especially if it is going to be used as weaning food. The ash content which is the indication of mineral availability increased from 0.99% of the extrude rice to 2.46% with increase in sesame addition. These results are in agreement with an earlier observation by El-Samahy *et al* (2007), who observed significant increase in ash content when cactus pear concentration was increased in a rice-cactus pear extruded samples.

Table 1: Proximate composition (%) of fermented rice-sesame extrudates

Sample	**Moisture**	**Ash**	**Fat**	**Protein**	**Crude Fibre**	**Carbohydrate**	**Energy Value** (Kcal/100 g)
$FR_{90}S_{10}$	4.01 ± 0.05^e	1.16 ± 0.06^e	2.04 ± 0.18^e	7.26 ± 0.26^e	0.76 ± 0.04^d	84.75 ± 0.04^b	386.4 ± 0.58^f
$FR_{80}S_{20}$	4.99 ± 0.01^d	1.36 ± 0.19^d	3.05 ± 0.07^d	10.42 ± 0.12^d	0.90 ± 0.13^c	79.26 ± 0.13^c	386.17 ± 0.26^e
$FR_{70}S_{30}$	5.14 ± 0.03^b	1.51 ± 0.01^c	3.62 ± 0.06^c	12.52 ± 0.25^c	0.99 ± 0.01^c	76.21 ± 0.23^d	387.5 ± 0.14^d
$FR_{60}S_{40}$	4.49 ± 0.03^c	2.02 ± 0.04^b	4.55 ± 0.63^b	15.75 ± 0.18^b	1.33 ± 0.03^b	71.85 ± 0.91^e	391.35 ± 0.29^b
$FR_{50}S_{50}$	6.56 ± 0.08^a	2.46 ± 0.03^a	6.30 ± 0.85^a	17.46 ± 0.06^a	1.62 ± 0.02^a	65.59 ± 0.75^f	388.9 ± 0.23^c
R_{100}	1.72 ± 0.35^f	0.99±0.01f	0.99±0.00f	2.28 ± 0.00^f	0.65±0.01e	93.37 ± 0.36^a	392 ± 1.47^a

Values are expressed as mean± Standard Deviation. Values with different superscripts on the same column are statistically different at p<0.05. Key: $FR_{90}S_{10}$ *=Fermented Rice (90%) Sesame (10%),* $FR_{80}S_{20}$ *= (Fermented Rice (80%) Sesame(20%),* $FR_{70}S_{30}$ *=Fermented Rice(70%)/Sesame(30%),* $FR_{60}S_{40}$*= Fermented Rice(60)/Sesame(40%),* $FR_{50}S_{50}$ *= (=Fermented Rice(50%)/Sesame(50%),* R_{100}*= Extruded Rice(100%).*

Table 2 shows the result of dietary mineral composition of extruded rice sample and extruded blends. The result shows that the mineral elements (Na, K, Ca, Mg, P, Fe and Zn) varied significantly (P<0.05) among the extrudates. The extrudates had higher values for mineral composition than individual extruded rice sample which show that fermentation and fortification with sesame had improved the nutritional value of extrudates when compared to the extruded rice (R_{100}). The reason may be due to heat sensitivity and oxidation tendency of this class of nutrients (Anuonye et al).

Table 2: Mineral composition of fermented rice-sesame extrudates (g/100g)

Sample	Na	K	Ca	Mg	P	Fe (mg/100g)	Zn (mg/100g)
$FR_{90}S_{10}$	0.49 ± 0.01^{cd}	0.50 ± 0.03^{c}	0.56 ± 0.02^{b}	0.51 ± 0.02^{a}	1.20 ± 0.85^{e}	2.83 ± 0.01^{e}	0.37 ± 0.01^{e}
$FR_{80}S_{20}$	0.48 ± 0.01^{d}	0.62 ± 0.01^{b}	0.50 ± 0.03^{b}	0.33 ± 0.01^{b}	1.28 ± 1.43^{d}	4.12 ± 0.01^{d}	0.55 ± 0.01^{d}
$FR_{70}S_{30}$	0.50 ± 0.02^{c}	0.94 ± 0.03^{a}	0.37 ± 0.04^{c}	0.29 ± 0.74^{b}	1.70 ± 0.86^{c}	7.21 ± 0.01^{c}	0.80 ± 0.00^{b}
$FR_{60}S_{40}$	0.67 ± 0.02^{a}	0.31 ± 0.04^{d}	0.13 ± 0.01^{d}	0.51 ± 0.02^{a}	2.26 ± 2.19^{b}	7.89 ± 0.13^{b}	0.67 ± 0.01^{c}
$FR_{50}S_{50}$	0.53 ± 0.03^{b}	0.07 ± 0.00^{e}	0.68 ± 0.03^{a}	0.58 ± 0.03^{a}	2.30 ± 1.56^{a}	9.37 ± 0.06^{a}	0.94 ± 0.01^{a}
R_{100}	0.08 ± 0.00^{e}	0.05 ± 0.00^{e}	0.21 ± 0.01^{e}	0.22 ± 0.01^{e}	0.14 ± 0.00^{b}	0.8^{f}	0.11^{f}

Values are expressed as mean± Standard Deviation. Values with different superscripts on the same column are statistically different at $p<0.05$. Key: $FR_{90}S_{10}$=Fermented Rice (90%) Sesame (10%), $FR_{80}S_{20}$= (Fermented Rice (80%) Sesame (20%), $FR_{70}S_{30}$=Fermented Rice (70%)/Sesame(30%), $FR_{60}S_{40}$=Fermented, Rice(60)/Sesame(40%), $FR_{50}S_{50}$=(=Fermented Rice(50%)/Sesame(50%), R_{100}=Extruded Rice(100%).

CONCLUSION

Evidence is overwhelming indicating sesame as a good protein source for the production of rice complementary foods. The results from this work showed that blended rice and sesame extrudates contained macro and micronutrients in sufficient amounts. Extrusion did not deleteriously affect these nutrients when compared with the individual extruded rice. It is thus concluded that extrusion of blends of fermented rice and sesame would produce high energy-protein meals adequate in macro- and micronutrients to combat nutritional problems in challenged populations.

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Proximate Composition of Selected *Rotundata* and *Alata* Yam Varieties on Different Drying Methods

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ABSTRACT
A study was conducted to investigate the effect of sun-drying and oven-drying methods on the proximate composition of alata and rotundata varieties. Oven-drying was done at 60°C for 72 hrs while sun drying was done at 33°C for 120 hrs to obtain a constant weight. The proximate composition, mineral contents and pH were determined to investigate the effect of drying methods on the nutritional value of the yam flour. It was observed that all parameter examined were affected by the drying methods as they varied in composition with two different processed samples (sun and oven dried). The results of the experiment show, that sun dried yam flour retained the highest value in protein, ash, fiber and CHO and also in minerals Ca, Mg and P. than oven dried method except moisture content which have low value than the sample. Sun dried yam flour had the highest value, thereby retaining the most nutritional composition of the samples.

Keywords: Sun drying, Oven drying, Alata. Rotundata

INTRODUCTION
Yams are widely grown and consumed amongst various communities in the tropics, among them is *D. rotundata* and *D. alata* which are very important tubers in West Africa. These tropical food crops are abundant at a particular period, when they are in season and are scarce, during the off season (when they are out of season). Since these food crops are highly perishable after harvest; drying is a common practice for preserving them, in order to make them available throughout the year (Habou *et al*., 2003; Eklou *et al*., 2006).

Sun and oven drying are the popular drying methods used in drying these food crops; sun drying being the most common practice (Matazu and Haroun, 2004). These food crops, when dried are processed to produce flour which can be reconstituted to form paste or dough (Emperatriz *et al*., 2008; Bricas *et al*., 1997). In Nigeria, West Africa, yam flour is used to produce a paste known as amala that is eaten with soup by the consumers (Akingbala *et al*., 1995; Akissoe *et al*., 2001; Hounhouigan *et al*., 2003).

These two drying methods (sun and oven) utilize heat to remove water from food by evaporation. The removal of water by heat has been reported to affect the nutrient contents of food in various ways. It can either increase the concentration of some nutrients by making them more available or decrease the concentration of some nutrients (Hassan *et al*., 2007; Morris *et al*., 2004; Ladan *et al*., 1997). This study was therefore carried out to establish the effects of these two drying methods on the nutrients of these important food crops, in order to determine the most suitable method that will not only increase their shelf life but also retain their nutrients adequately, since, good nutritional value of food is important to the well-being of the consumers.

MATERIALS AND METHODS

Two varieties each of white yam (*Dioscorea rotundata*) and water yam (*Dioscorea alata*) were collected from National Root Crops Research Institute (NRCRI) Umudike yam barn.

Sample preparation

They were washed with clean water, peeled using stainless kitchen knife and sliced into smaller pieces of about 3 mm thickness. The slices were divided into two sets, one set was sun-dried for two weeks and the other set was oven dried until constant weight was obtained. The dried slices were milled with a hammer mill and then sieved under laboratory sieve of 600 mm aperture size and stored in air tight container for further laboratory analysis.

Determination of proximate compositions

Moisture, protein, crude fat, crude fibre and ash contents of the four yam flour samples were determined according to standard methods as described by AOAC 1995 while carbohydrate was determined by difference.

Determination of minerals (calcium, magnesium and potassium)

The mineral content of each sample was determined by the method of James*, et al* (1995). Exactly 2g of the sample was burnt to ashes in a muffle furnace at 500ºC. After complete ashing, the ash was diluted with 1% Hydrochloric (Hcl) acid, then filtered into a 100ml standard flask, and made up to the mark with deionized water. The solution was read with AAS machine (model No: Analysis 400, Serial No 201510114102) for the determination of the mineral content. All values were expressed in mg/100g.

Statistical analysis

One-way analysis of variance (ANOVA) was used to compare means of variables and results were expressed as means of variables.

RESULTS AND DISCUSSION

The proximate composition is shown in Table 1. The moisture content of processed sample range from 5.01% sun dried white yam to 7.82% sun dried white yam. Protein range from 0.79% oven dried water yam to 5.56% sun dried white yam. The ash ranged from 1.86 oven dried water yam to 3.23% sun dried white yam. Fiber ranges from 1.11% oven dry water yam to 1.93% sun dry white yam. Fat range from 0.18% oven dry water yam to 0.75%sun dry white yam. CHO range from 80.74% oven dry water yam to 88.74% sun dry white yam.

The minerals in the processed yam tuber, calcium range from 1.12% oven dry water yam to 3.82% sundry of white yam. Magnesium ranges from 1.23% oven dry water yam to 2.74% sundry white yam. Potassium range from 2.44% oven dry water yam to 4.63% sundry white yam. Tannins range from 0.21% oven dry water yam to 1.14% sundry white yam.

Table 1: Proximate composition of yam flour

Methods	Samples	Moisture%	Protein%	Ash %	Fiber %	Fat %	CHO %
Sun	TDr160	5.01^{h}	3.45^{c}	3.23^{a}	1.93^{a}	0.65^{a}	85.63^{d}
Oven	TDr160	6.49^{f}	1.23^{g}	2.76^{c}	1.60^{c}	0.77^{c}	87.35^{b}
Sun	TDa194	6.54^{e}	2.87^{e}	2.67^{c}	1.75^{b}	0.68^{b}	85.49^{e}
Oven	TDa194	6.73^{d}	0.79^{h}	1.89^{f}	1.42^{d}	0.43^{d}	80.74^{a}
Sun	TDr206	7.55^{a}	5.56^{a}	3.06^{b}	1.66^{c}	0.71^{a}	88.46^{g}
Oven	TDr206	7.67^{c}	3.37^{d}	2.65^{d}	1.23^{e}	0.23^{e}	84.85^{f}
Sun	TDa247	6.05^{g}	4.55^{b}	2.34^{e}	1.04^{f}	0.49^{d}	85.53^{e}
Oven	TDa247	7.82^{b}	2.49^{f}	1.86^{f}	1.11^{f}	0.18^{f}	86.54^{c}

Means with the same letters in a column are not significantly (p _ 0.05) different.

Table 2: Mineral composition of yam flour

Methods	Samples	Ca %	Mg %	P %	Tan %	pH %
Sun	TDr160	3.82^{a}	2.62^{b}	3.12^{e}	1.14^{a}	6.10^{a}
Oven	TDr160	2.67^{c}	1.42^{f}	2.59^{f}	0.23^{f}	5.70^{b}
Sun	TDa194	2.69^{c}	2.74^{a}	3.26^{d}	0.67^{c}	5.04^{e}
Oven	TDa194	2.19^{e}	1.23^{g}	2.44^{g}	0.14^{g}	5.37^{c}
Sun	TDr206	3.76^{b}	2.52^{c}	4.63^{a}	1.02^{b}	6.09^{a}
Oven	TDr206	1.93^{f}	1.87^{e}	3.76^{c}	1.34^{e}	5.34^{c}
Sun	TDa247	2.45^{d}	2.44^{d}	3.98^{b}	0.88^{d}	5.68^{b}
Oven	TDa247	1.12^{g}	1.26^{g}	2.48^{g}	0.21^{f}	5.21^{d}

Means with the same letters in a column are not significantly (p _ 0.05) different.

The moisture content of the yam tuber is usually high hence the water yam and white yam have low value of moisture content. Our results support the report of Riley et al. (2006). It is believed that materials such as flour range of crude protein content from 0.79% - 5.56%. There is significant difference among the samples Dugler *et al*. (2002). Intake of staple foods with low protein content may lead to several impaired biological processes in the body. This shows that *D. alata* is rich in protein and can provide this nutrient to the consumers. The high gelatinization temperature of sample might be attributed to the high starch content. High protein solubility is always necessary for gelation as observed by Farquer, *et al.* (1996). Minerals are biological components of diets which perform biochemical and physiological functions in living cells through synergistic interactions or independent modulation of biological reactions, Dugler *et al* (2000).

CONCLUSION

Acceptable yam flour can be produced through different drying methods depending on intend usage. The results of the experiment carried out on the yam flour indicated that some dry methods affect the nutritional component of the dried yam flour by not only altering the biochemical composition. The results of this study revealed that the processing sun drying, on yam tubers has significant effect on the nutrient content as well as protein, ash, and minerals contents. Sun drying method has been found to be a good method to produce yam flour with better retention of nutritional contents.

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Effect of Drying Methods on the Nutritional Composition of *Dioscorea alata* and *D. Rotundata* yam varieties in Umudike

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ABSTRACT
A study was conducted to investigate the effect of sun-drying and oven-drying methods on the nutritional composition of water yam and white yam varieties. Oven-drying was done at 60°C for 72 hrs while sun drying was done at 33°C for 120 hrs to obtain a constant weight. The functional properties proximate composition, mineral contents and pH were determined to investigate the effect of dry methods on the nutritional value of the yam flour. It was observed that all parameter examined were affected by the drying methods as they varied in composition with two different processed samples (sun and oven dried). The results of the experiment show that sun dried yam flour retained the highest value in protein, ash, fiber and CHO and also in minerals Ca, Mg and P. than oven dried method except moisture content which have low value than the sample. Sun dried yam flour had the highest value, thereby retaining the most nutritional composition of the samples.
Keyword: *sun dry, oven dry, alata. rotundata*

INTRODUCTION
Yams are widely grown and consumed amongst various communities in the tropics, among them is *Dioscorea rotundata* and *D. alata* which are very important tubers in West Africa. These tropical food crops are abundant at a particular period, when they are in season and are scarce, during the off season (when they are out of season). Since these food crops are highly perishable after harvest; drying is a common practice for preserving them, in order to make them available throughout the year (Habou *et al*., 2003; Eklou *et al*., 2006).

Sun and oven drying are the popular drying methods used in drying these food crops; sun drying being the most common practice (Matazu and Haroun, 2004). These food crops, when dried are processed to produce flour which can be reconstituted to form paste or dough (Emperatriz *et al*., 2008; Bricas *et al*., 1997). In Nigeria, West Africa, yam flour is used to produce a paste known as amala that is eaten with soup by the consumers (Akingbala *et al*., 1995; Akissoe *et al*., 2001; Hounhouigan *et al*., 2003).

These two drying methods (sun and oven) utilize heat to remove water from food by evaporation. The removal of water by heat has been reported to affect the nutrient contents of food in various ways. It can either increase the concentration of some nutrients by making them more available or decrease the concentration of some nutrients (Hassan *et al*., 2007; Morris *et al*., 2004; Ladan *et al*., 1997). This study was therefore carried out to establish the effects of these various drying methods on the nutrients of these important food crops, in order to determine the most suitable method that will not only increase their shelf life but also retain their nutrients adequately; since good nutritional value of food is important to the well-being of the consumers. Therefore, this study was conceived to evaluate the effect of drying methods on the nutritional composition of *D. rotundata* (white yam) and *D. alata* (water yam) varieties.

MATERIALS AND METHODS

Two varieties each of white yam (*D. rotundata*) and water yam (*D. alata*) yam two varieties each were collected from National Root Crops Research Institute (NRCRI) Umudike yam barn.

Sample preparation

They were washed with clean water, peeled using stainless kitchen knife and sliced into smaller pieces of about 3 mm thickness. the slices were divided into two sets, one set was sun-dried for two weeks and the other set was oven dried until constant weight was obtained. The dried slices were milled with a hammer mill and then sieved under laboratory sieve of 600 mm aperture size and stored in air tight container for further laboratory analysis.

Determination of proximate compositions

Moisture, protein, crude fat, crude fibre and ash contents of the four yam flour samples were determined according to standard methods described by AOAC (1995) which carbohydrate was determined by difference.

Statistical analysis

One-way analysis of variance (ANOVA) was used to compare means of variables and results were expressed as means of variables.

RESULTS AND DISCUSSION

The proximate composition are shown in table 1. The moisture content of processed sample range from 5.01% sun dried white yam to 8.25% sun dried white yam. Protein range from 0.79% oven dried water yam to 5.56% sun dried white yam. The ash range from 1.89 oven dried water yam to 3.25% sun dried white yam. Fiber ranges from 1.11% oven dry water yam to 1.93% sun dry white yam. Fat range from 0.18% oven dry water yam to 0.75%sun dry white yam. CHO range from 80.74% oven dry water yam to 88.74% sun dry white yam.

The minerals in the processed yam tuber, calcium range from 1.12% oven dry water yam to 3.82% sundry of white yam. Magnesium ranges from 1.23% oven dry water yam to 2.74% sundry white yam. Potassium range from 2.44% oven dry water yam to 4.63% sundry white yam. Tannins range from 0.21% oven dry water yam to 1.14% sundry white yam. pH range from 5.21% oven dry water yam to 6.10% sundry white yam (Table 2).

Table 1: Proximate composition of yam flour

Methods	Samples	Moisture%	Protein%	Ash %	Fiber %	Fat %	CHO %
Sun	TDr160	5.01^{h}	3.45^{c}	3.23^{a}	1.93^{a}	0.65^{a}	85.63^{d}
Oven	TDr160	6.49^{f}	1.23^{g}	2.76^{c}	1.60^{c}	0.77^{c}	87.35^{b}
Sun	TDa194	6.54^{e}	2.87^{e}	2.67^{c}	1.75^{b}	0.68^{b}	85.49^{e}
Oven	TDa194	6.73^{d}	0.79^{h}	1.89^{f}	1.42^{d}	0.43^{d}	80.74^{a}
Sun	TDr206	7.55^{a}	5.56^{a}	3.06^{b}	1.66^{c}	0.71^{a}	88.46^{g}
Oven	TDr206	7.67^{c}	3.37^{d}	2.65^{d}	1.23^{e}	0.23^{e}	84.85^{f}
Sun	TDa247	6.05^{g}	4.55^{b}	2.34^{e}	1.04^{f}	0.49^{d}	85.53^{e}
Oven	TDa247	7.82^{b}	2.49^{f}	1.86^{f}	1.11^{f}	0.18^{f}	86.54^{c}

Means with the same letters in a column are not significantly (p _ 0.05) different

Table 2: Mineral composition of yam flour

Methods	Samples	Ca %	Mg %	P %	Tan %	pH %
Sun	TDr160	3.82[a]	2.62[b]	3.12[e]	1.14[a]	6.10[a]
Oven	TDr160	2.67[c]	1.42[f]	2.59[f]	0.23[f]	5.70[b]
Sun	TDa194	2.69[c]	2.74[a]	3.26[d]	0.67[c]	5.04[e]
Oven	TDa194	2.19[e]	1.23[g]	2.44[g]	0.14[g]	5.37[c]
Sun	TDr206	3.76[b]	2.52[c]	4.63[a]	1.02[b]	6.09[a]
Oven	TDr206	1.93[f]	1.87[e]	3.76[c]	1.34[e]	5.34[c]
Sun	TDa247	2.45[d]	2.44[d]	3.98[b]	0.88[d]	5.68[b]
Oven	TDa247	1.12[g]	1.26[g]	2.48[g]	0.21[f]	5.21[d]

Means with the same letters in a column are not significantly (p _ 0.05) different

The moisture content of the yam tuber is usually high hence the water yam and white yam have low value of moisture content. Our results support the report of Riley et al. (2006). It is believed that materials such as flour range of crude protein content from 0.79% - 5.56%. There is significant difference among the samples Dugler, *et al*. (2002). Intake of staple foods with low protein content may lead to several impaired biological processes in the body. This shows that *D. alata* is rich in protein and can provide this nutrient to the consumers.

The high gelatinization temperature of sample might be attributed to the high starch content. High protein solubility is always necessary for gelation as observed by Farquer*, et al.* (1996). Minerals are biological components of diets which perform biochemical and physiological functions in living cells through synergistic interactions or independent modulation of biological reactions, Dugler, H *et al* (2000).

CONCLUSION

Acceptable yam flour can be produced through different drying methods depending on intend usage. The results of the experiment carried out on the yam flour indicated that some dry methods affect the nutritional component of the dried yam flour by not only altering the biochemical composition. The results of this study revealed that the processing (Sun drying, and oven-drying) yam tubers has significant effect on the nutrient content as well as gelation temperature, protein, ash, and minerals elements. Sun drying method has been found to be a good method to produce yam flour with better retention of nutritional contents.

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Proximate and Mineral Composition of Plantain (*Musa paradisiaca*) Flour Obtained Through Different Processing Methods

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ABSTRACT
The study was conducted to determine the proximate and mineral composition of plantain (Musa paradisiaca) flour produced using different processing methods. The experimental design was 2x2 factorial fitted into Randomized Complete Block Design (RCBD). In investigating the proximate and mineral composition of plantain flour, 4 samples of plantain flour were prepared using direct and blanching methods of processing. The plantain chips gotten from the blanched plantain fingers and those that were not blanched (direct) were subjected to sun drying and oven drying. The four samples were coded as SDD (Sun Dry Direct), ODD (Oven Dry Direct), SDB (Sun Dry Blanching) and ODB (Oven Dry Blanching). The results showed that moisture content was low in all the samples which ranged between 9.6% - 10.24%, crude fat content was within the range of 0.45% - 0.84%, ash content was between 1.89% - 2.32%, crude protein was between 1.78% - 2.15%. Carbohydrates, dry matter, phosphorus, magnesium, calcium and potassium contents were high ranging from 83.82% - 88.45%, 89.68% - 90.37%, 125.62mg/100g – 153.40 mg/100g, 56.75mg/100g – 74.92mg/100g and 73.60mg/100g – 87.30mg/100g respectively. The apparent increase in these nutrients is as a result of the removal of moisture which tends to increase the concentration of food nutrients. Though, all the processing methods gave rise to flour with similar proximate and mineral composition, there was significant difference ($p<0.05$) in proximate analysis among different methods of processing. However, to achieve a fast drying and conserve more nutrients, the direct method of processing for both sun drying and oven drying is recommended.

Keywords: Plantain flour, proximate and mineral composition and processing methods

INTRODUCTION
Plantain is a tree-like perennial crop with an underground rhizome and fibrous roots. It belongs to the family Musaceae and the genus Musa. Records have shown that plantain originated from Southeast Asia (IITA, 2009). Investigation results of scientists recorded sixty-eight species of plantain in the world with two hybrids (FAO, 1990). The most important parts of the plant are the fruits which are 3-10inches or more in length depending on the cultivar. Plantain is a major starchy staple food in the Sub-Saharan Africa both for rural and urban populace, producing more than 25% of the carbohydrates and 10% of the daily calorie intake for more than 70 million people in the continent (Kayode *et al.*, 2011). About 63 million tonnes of the crop are produced annually in the producing countries, allowing only a meager 10% for foreign financial earning through exportation (Awodoyin, 2003; Baiyeri *et al.*, 2011). Nigeria is one of the largest plantain producing countries in Sub-Sahara Africa but does not feature among plantain exporting nations because it produces more for local consumption than for exportation (FAO, 2010). This may be attributed to the perishability nature of the fruits and inadequate storage facilities as well as poor processing technology.

Plantain, though available all year round has its season of peak production. At the peak period of production there is more availability of the crop at affordable prices. Its abundance at the peak of harvest season is hardly contained (Yarkwan and Uvir, 2015). This leads to inadequate supply of plantain and plantain products during the off season of the crop. Since the storage life span of plantain is very short, plantain products can only be made available in sufficient amount during the off season if the fruits are processed within the shortest period of time after harvest. In Nigeria, plantain is commonly processed into flour traditionally, sun drying is the method used for plantain processing. The area where plantain is produced in large quantities is the rainforest belt where there is short period of dry season in a year. Depending on the sun as the source of heat for drying plantain during the raining season may expose the product to microbial infestation that can reduce the quality of the flour. Thus the need for another method of drying other than sun-drying to make plantain flour available at all seasons. The consumption of plantain flour has risen tremendously in Nigeria in recent years because of rapidly increasing urbanization and the great demand for easy and convenient food by the non-farming urban population (Akinyemi *et al.,* 2010).

Plantain flour producers have always applied the direct methods of drying plantain chips whether it is sun-drying or oven drying. Little or nothing has been done about blanching plantain with its peels before drying. Plantain peels have been shown to contain considerable amount of nutrients. According to Happi-Emaga *et al* (2007) peel from unripe fruit presents (on dry basis) 6 – 10% protein, 6 – 12% ash, 2 – 6% lipids, 11 – 39% is soluble dietary fibre (SDF) and 7 – 30% insoluble dietary fibre (IDF). Therefore, some of the fingers were blanched with the peels before they were subjected to oven or sun drying while others were oven dried and sun dried directly. Consumers may also want to know which method of drying plantain produces plantain flour of high nutritional value. There is paucity of information on the proximate and mineral composition of plantain flour produced using different drying methods. Hence, this study is designed to make such information available to both consumers and producers.

MATERIALS AND METHODS

The processing of the plantain flour was carried out during the dry season at Federal College of Education (Technical), Omoku, Ogba/Egbema/Ndoni Local Government Area of Rivers State. A big bunch of unripe plantain was shared into two parts. One part representing 'Direct' was washed, peeled and cut into chips. The chips were divided into two (2) parts and one part was oven dried at 60^{o}c while the other was sun-dried. Again, the second part representing 'Blanching' was washed, blanched for five minutes, peeled and cut into chips. The chips were again divided into two (2) parts which were subjected to oven drying at 60^{o}c and sun drying respectively. The four samples were dried until they became crispy and were milled into flour. The milled samples were sieved to produce very fine flour using a mesh size of 0.2mm.

The above samples were used for proximate and mineral composition determination. Parameters used for proximate composition were percentage moisture content, dry matter, ash, crude protein, crude fibre, fat and carbohydrate while parameters used for determination of mineral composition were nitrogen (%) phosphorus (mg/100g) calcium (mg/100g), potassium (mg/100g), carbon:nitrogen ratio (mg/kg) and minerals salt (mg/100g). data were subjected to statistical analysis using analysis of variance, means were separated using fishers Least Significant Difference (LSD) and treatment effects and response trend were presented graphically using bar chart.

RESULTS AND DISCUSSION

The results of proximate analysis and mineral composition of plantain flour produced using oven dry direct method, sun dry direct method, oven dry blanching method and sun-dry blanching method are presented in figures 1 – 4. The moisture content ranged from 9.65% in direct method – 10.32% in blanching while dry matter content ranged from 89.68% in blanching method – 90.37% in direct method as shown in figure 3. The range of percentage ash was from 1.89% in blanching method – 2.32% in direct method, crude protein was slightly higher in direct method (2.15%) than in blanching method (1. 78%), the range of crude fibre was 0.98% in blanching method – 1. 12% in direct method while fat content for all the samples were very low ranging from 0.45% in sundried, blanching method - 0. 34% in oven dried direct method as indicated in figure 4. Carbohydrate level was highest in the sample from oven dried direct method (88.45%) and it was lowest in the sample obtained from sun-dried direct (88.82%) (figure 3).

The result of the mineral composition indicated that the content of mineral considered were lowest in samples obtained through oven dry blanching method (Nitrogen - 0.28%, Phosphorus - 125.60mg/100g, Potassium - 73.60mg/100g, Calcium - 56.75mg/100g, Carbon:Nitrogen ratio – 10.60mg/100g and Magnesium - 24.92mg/100g) while they were highest in sample produced from sun direct method (Nitrogen - 0.37%, Phosphorus - 153.40mg/100g, Potassium - 87.30mg/100g, Calcium – 74.92mg/100g,) except in Carbon:Nitrogen ratio and Magnesium contents in which sample from oven dry direct method were highest (Carbon:Nitrogen ratio – 16.45mg/100g and Magnesium - 29.62mg/100g) as shown in figures 1 and 2.

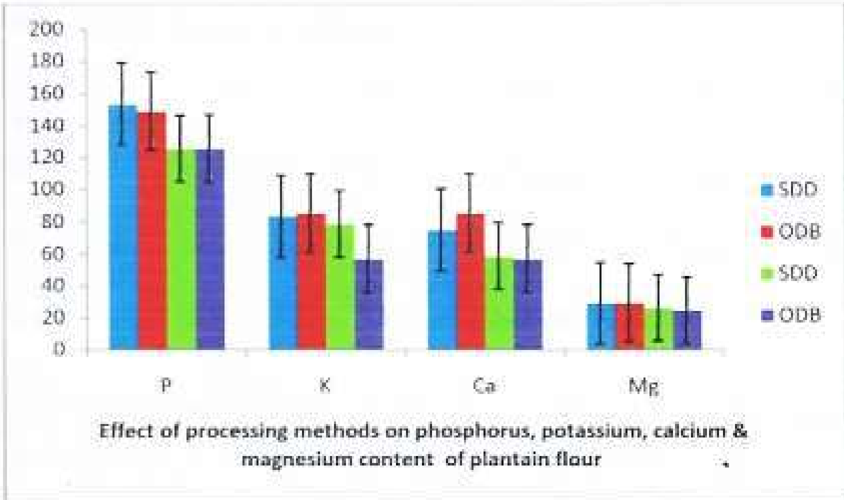
Moisture and crude protein contents of plantain produced through the four processing methods were low compared to those of fresh plantain (Moisture Content - 59.77% and 7.65%) as reported by Yarkwan and Uvir, 2015. Carbohydrates, dry matter, phosphorus, calcium, carbon:nitrogen ratio, magnesium and potassium contents were higher than those of fresh plantain. The low and high nutrient values could be as a result of heat application during drying process. Heat application can improve or reduce nutrient value of food material. Heat improves the digestibility of food, promotes palatability and extends the shelf life of food. Application of heat also enhances food preservation by removing the moisture in the food in order to prevent the growth of microorganisms that can cause deterioration. Drying processes can lead to nutrients losses by inducing biochemical nutritional variation.

The increase in carbohydrates, dry matter, crude fibre, carbon:nitrogen ratio, phosphorus and potassium contents could be due to the removal of moisture which tends to increase the concentration of nutrients (Moris and Barnett, 2004). Processing has been reported to increase carbohydrates availability in a more digestible form (Emperatriz, Ronald, Elvina and Mily, 2008). This could be explained by the results obtained from the four drying methods ranging from 83.82% - 88.45% compared to that of fresh plantain (28.23%) as reported by Yarkwan and Uvir, 2015.

The moisture contents of plantain flour obtained from oven dry direct method (9.69%), sun dry direct method (9.85%), oven dry blanching method (10.32%) and sundry blanching method (10.24%) fell within the range of 9.09% (oven dried) and 13.00% (sun dried) as reported by Agoreyo *et al.*, 2011. The flour from the blanched plantain had higher moisture content (10.24% and 10.32%) than the flour obtained through direct drying (9.63% and 9.85%). The moisture content of processed food gives an indication of its anticipated shelf life. Food with low moisture contents remains in good condition for a longer time than the one with high moisture content. During storage, food with high moisture content is prone to microbial growth which could affect the colour, taste and aroma of the food. A well dried food withstands microbial infestation better during storage, therefore, direct drying method should be preferred to blanching.

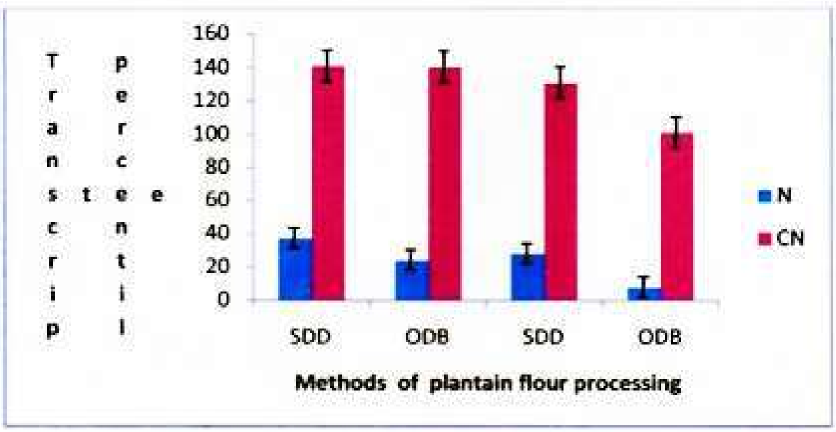
Fat contents of plantain flour obtained from the four processing methods, oven dry direct (0.84%), oven dry blanching (0.63%), sun dry direct (0.45%) and sundry blanching (0.78%) are lower than the fat content of fresh plantain (2.75%) as reported by Agoyero *et al* (2011). Fat contents of blanched samples (0.45% and 0.63%) were lower than fat contents of direct samples (0.78% and 0.84%) as shown in figure 4. The fat contents of plantain flour from sun drying method for both blanching and direct (0.45% and 0.78%) respectively are lower than those obtained from oven dried flour for both blanching and direct (0.63% and 0.84%) respectively (figure 4). The difference observed between oven dried and sun dried samples could be as a result of solar radiations mediated oxidation of the composite lipids especially the unsaturated fatty acids thereby decreasing the overall crude lipids content and quality (Yarkwan and Uvir, 2015). Lipid oxidation is known to be increased by many factors such as heat, sunlight and radiation (Savage, Dutta, Rodriguez-Estrada, 2002).

Ash is the inorganic residue after the water and organic matter have been removed by burning a food sample. The ash contents of plantain flour obtained from the four processing methods, oven dry direct (2.16%), sun dry direct (2.32%), oven dry blanching (1.89%) and sundry blanching (1.94%) were higher than the fresh fruit ash content as reported by Okareh, Adeolu and Adepoju (2015). The ash contents of blanched samples for both sun dry and oven dry methods (1.94% and 1.89%) respectively were lower than those of the direct samples for both sun dry and oven dry methods (2.32% and 2.16%)respectively as shown in figure 4.



SDD; OD;SDB & ODB means sun dried direct, oven dried direct, sun dried blanching, oven dried blanching, P,K, Ca, Mg means phosphorus, potassium, Calcium& Magnesium respectively

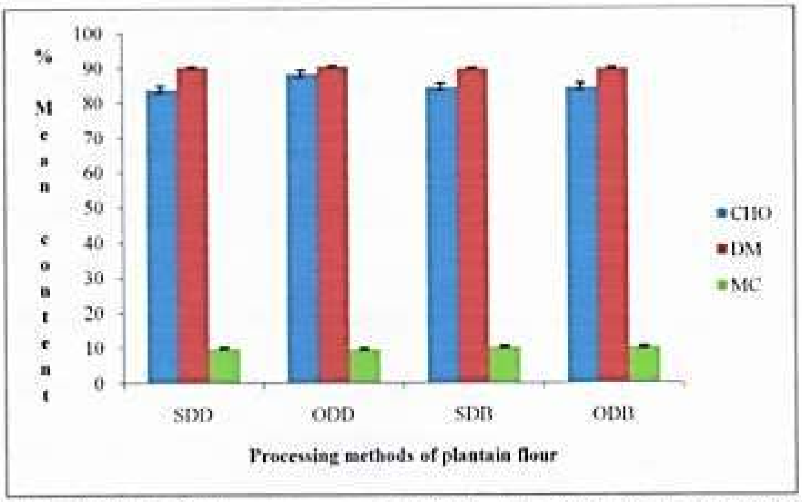
Figure 1 Effect of processing methods on some minerals content of plantain flour



SDD; OD;SDB & ODB means sun dried direct, oven dried direct, sun dried blanching, oven dried blanching;N means nitrogen, CN carbon- nitrogen ratio,

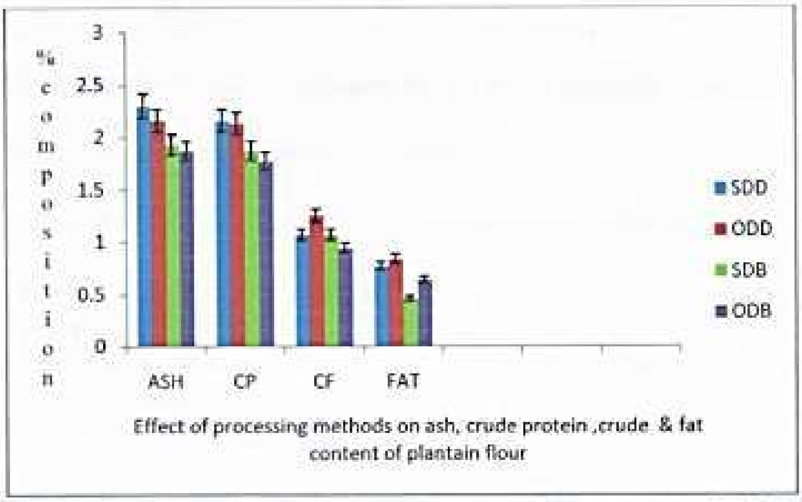
Figure 2.Effect of processing methods on nitrogen and carbon- nitrogen ratio of plantain flour

The crude protein contents of the four samples which range from 1.78% - 2.15% is lower than that of fresh plantain (7.65%) as reported by Yarkwan and Uvir (2015). The protein contents of flour produced through direct method for both oven dry and sundry (2.12% and 2.15%) respectively were higher than those obtained from blanching method for both sun dry and oven dry (1.86% and 1.78%) respectively as seen in figure 4. The direct method conserved protein than the blanching method. Decrease in protein content of plantain flour probably occurred as a result of Millard reaction which result between carbohydrates and protein (Wiriya *et al.*, 2004). Since plantain is eaten mainly for its carbohydrates content, the decrease in protein due to processing method does not render the product unfit for consumption rather it has appreciably increased the value of carbohydrates for which the food is needed.



SDD; OD;SDB & ODB means sun dried direct, oven dried direct, sun dried blanching, oven dried blanching CHO means carbohydrate, dry matter & moisture contents respectively

Figure3. Effect of processing methods on carbohydrate, dry matter and moisture content of plantain flour



SDD; OD; SDB & ODB means sun dried direct, oven dried direct, sun dried blanching & oven dried blanching;ash ,CP, CF,FAT means ash crude protein, crude fibre, & fat content respectively

Figure 4.Effect of processing methods on ash, crude protein, crude fibre and fat content of plantain flour.

CONCLUSION

The results obtained from the study showed that the four drying methods were good as they yielded nutritional constituents with minimal differences. However, to achieve fast drying and conserve more nutrients, the direct method of processing for both sun drying and oven drying is recommended. This is because there was significant difference ($P<0.05$) in proximate analysis among the different methods of processing. The result is in agreement with report of Savage *et al* (2002) which stated that the values for proximate composition of plantain flour processed with different drying methods differ significantly ($P<0.05$) from each other. Comparing the oven drying and sun drying, oven drying though more expensive is recommended because it allows for quick drying, neat product and could be used during the raining season while sun drying method though cheap, takes a long time and product may be prone to contamination from dust and micro-organisms.

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Comparison of Tomato Storage Characteristics under Two Different Evaporative Pad Materials

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ABSTRACT
Tomatoes are important in the agricultural sector as they serve as raw materials for the production of value added products. The general objective of this study was to compare tomato storage characteristics using two evaporative pad materials (charcoal and river sand). River sand and charcoal were used as cooling pads with storage under ambient conditions being the third treatment (control). Each treatment had two replicates. Temperature, Relative humidity, Cooling efficiency, Weight, Firmness and Colour assessment were determined throughout the test period and the results were subjected to Analysis of Variance [ANOVA]. Means were separated using DMRT at 5 percent level of significance. Result from storing fresh tomatoes under both media showed that a cooling chamber filled with charcoal as absorbent material with uninterrupted water supply performed best in the storing of tomato fruit when compared to tomatoes stored under ambient conditions or with river sand as evaporative media. It is therefore recommended that further studies should vary the use of different absorbent materials with respect to availability, cost, and durability among others. Comparison can also be further made between tomato storage under bagged and unbagged conditions.
Keywords: evaporative cooling, tomato storage, low cost storage structure, fruits and vegetable preservation

INTRODUCTION
Evaporative cooling is the process by which the temperature of a substance is reduced due to the cooling effect from the evaporation of water. The conversion of sensible heat to latent heat causes a decrease in the ambient temperature as the evaporated water provides useful cooling. This cooling effect has been used on various scales from small scale cooling to large industrial applications (Liberty *et al.,* 2013). Evaporative cooling occurs when air that is not too humid, passes over a wet surface. Hence, the faster the rate of evaporation, the greater the cooling. The efficiency of an evaporative cooler depends on the humidity of the surrounding air (Nobel, 2003), and the type of evaporative pads used. Evaporative systems take advantage of the reduction in temperature resulting from the evaporation of mostly water to air (Kinchi, 2016). Consequently, in developing countries there is an interest in simple, low-cost alternatives, many of which depend on evaporative cooling which is simple and does not require any power supply (FAO, 2003). To alleviate environmental degradation, the need for energy-efficient and eco-friendly systems for building cooling becomes essential. Hence, the importance of devices for controlling indoor temperatures is increasing (Jungchul et al., 2022). Evaporative cooling, a typical passive cooling technique, could meet the energy demand and global climatic issues (Sujatha et al., 2020). Deterioration of fresh tomatoes during storage depends partly on temperature (Ajayi, 2011). One way to slow down deterioration and thus increase the length of time tomatoes can be stored, is by lowering the temperature to an appropriate level. It is essential that tomatoes are not damaged during harvest and that they are kept clean. This is

because damaged and bruised tomatoes have much shorter storage lives and very poor appearance after storage. Fabiyi (2010) stated that keeping products at their lowest safe temperature (0^0C for temperate crops or 10-12^0C for chilling-sensitive crops) will increase storage life by lowering respiration rate, decreasing sensitivity to ethylene gas and reducing water loss. Refrigerated cold stores are the best method of preserving vegetables but they are expensive.

Evaporative pads can be made from locally available materials such as river sand, saw dust, charcoal and so on, and help to keep products fresh for a while in an environmentally friendly way with no pollution. However, it requires constant water supply to wet the pads, for optimum performance.

Fruits and vegetable farmers do not get enough value for their labour due to weak storage infrastructure, poor transportation, and the perishable nature of these crops often results in substantial economic losses. Local fruit and vegetable farmers often sell as much as they can when the produce is still fresh. Once produce loses its freshness, they are forced to sell it at lower prices or give away for free. During this post-harvest glut, the loss is considerable and often some of the produce will have to be fed to animals or allowed to rot. According to Olunloyo *et al.,* (2017), the damage that occurs in fruits and vegetables is primarily due to loss of moisture, change in physical composition and pathological attack. There is therefore a need to store tomatoes under optimum conditions to reduce perishability, increase shelf life and maintain market value. Evaporative cooling has been used to store tomatoes successfully using various evaporative pad materials, with varying results. With all year round demand for tomatoes, a cost effective evaporative pad material is essential for tomato storage. Hence, this study aimed at evaluating and comparing the performance of two evaporative pad materials (river sand, charcoal) on stored fresh tomatoes.

METHODOLOGY

The project was carried out at Crop Production Technology's Experimental plot, Federal College of Forestry, Ibadan. The college is situated at Jericho Hill, Ibadan North West Local Government Area of Oyo state. The area lies between latitude 7˚54′N and longitude 3˚34′E. The annual rainfall range is from 1400mm-1500mm.The average temperature is about 32˚C with average humidity of 80-85%, with two distinct seasons of wet (April to October) and dry (November-March) (FRIN, 2019).

The following steps were carried out in the course of the work:

1. The existing evaporative cooler (Olunloyo *et al*., 2017a) was refurbished and fit with a source of constant water supply.
2. The cooling pads/ evaporative media (River sand and Charcoal): River sand was collected from a flowing stream and Charcoal was procured from the market. Both pad materials were filled into the designated evaporative cooling chamber cavities designed for the pad materials. Each storage chamber in the evaporative cooler has dimensions of 74cm× 24cm and a depth of 40cm. The total volume of the evaporative cooler is $1.72m^3$ and the structure can store 206.83kg of tomatoes (Olunloyo *et al.,* 2017b).
3. Performance evaluation: Both cooling pads were evaluated using tomatoes as a test crop. The following parameters were assessed; Chamber temperatures and humidity values were taken five times daily (7am, 10am, 1pm, 4pm, 7pm) with the aid of a thermometer and hygrometer respectively; Tomato weight was taken every two days to determine weight loss with the use of sensitive scale; Firmness was assessed at two day intervals to determine the loss in firmness (three different weights: 30g, 60g, and 100g, were placed on randomly selected tomatoes and the level of depression/ distortion in the circumference was measured in cm with a rope and ruler).

Other calculations included those for: Cooling efficiency and Physiological weight loss as adopted by Olunloyo *et al*. (2017a). Statistical analysis**:** Data obtained was subjected to analysis of variance [ANOVA]. Significant means were separated using DMRT at 5% level of significance.

RESULTS AND DISCUSSION

Table 1: Effect of absorbent material on mean daily temperature of the storage chamber

Trt	DAYS											
	1	2	3	4	5	6	7	8	9	10	11	12
R	22.90	27.00	26.40	26.80	26.60	26.10	26.50	25.40	26.20	27.00	26.10	25.50
S	a	a	a	a	a	a	a	a	a	a	a	a
C	22.20	26.80	26.50	27.00	26.10	25.10	26.50	25.30	26.20	26.90	26.00	25.40
H	a	a	a	a	a	a	a	a	a	a	a	a
C	23.10	28.40	27.40	27.80	27.00	28.00	27.60	27.20	27.20	28.00	27.20	26.20
O	a	b	b	b	a	b	b	b	b	b	b	a

Note: Means with the same alphabet in the same column are not significantly different at 5% level of significance; RS: River sand, CH: Charcoal, and CO: Ambient conditions.

The effect of temperature on tomato storage using different absorbent materials is presented in table 1. There was significant difference among the treatments in all the days except on days 1, 5 and 12. The highest mean temperature was recorded under ambient conditions in all the days. The least mean was recorded in Charcoal storage in all the days except on days 3 and 4 with values of 26.50°C and 27.00°C.

This corresponds with Sushmita et al., (2008), who stated that keeping fruit and vegetables at their lowest safe temperature will increase storage life. Hence, tomatoes stored using charcoal as absorbent material reached the lowest temperature in almost all the days.

Table 2: Effect of absorbent material on mean daily humidity of the storage chamber

Trt	DAYS											
	1	2	3	4	5	6	7	8	9	10	11	12
R	67.00	87.40	87.20	88.30	87.70	89.70	88.10	87.70	87.90	85.80	89.40	89.30
S	a	a	b	a	a	b	a	a	a	a	a	a
C	71.10	88.10	89.50	90.60	87.80	90.30	88.90	90.10	87.80	87.40	89.20	89.30
H	a	a	b	b	a	b	a	a	a	a	a	a
C	64.00	83.00	82.60	91.00	87.40	83.70	87.60	89.20	89.20	86.20	91.00	87.00
O	a	a	a	b	a	a	a	a	a	a	a	a

Note: Means with the same alphabet in the same column are not significantly different at 5% level of significance; RS: River sand, CH: Charcoal, and CO: Ambient conditions.

The effect of relative humidity on tomato storage using different absorbent materials is presented in table 2. There was no significant difference among the treatments in all the days except on days 3, 4 and 6. The highest mean humidity was recorded in Charcoal on all the days except on days 4 and 9 and is with 90.60%, 87.80% and 89.20% while the least mean was recorded under ambient conditions on all the days except on days 4, 8,9, 10 and 11 with the highest mean value of 91.00% and 91.00%. ASHRAE (1982) reported that high relative humidity increases the shelf life of fresh fruit and vegetables. This implies that charcoal as an absorbent materials performed better in tomatoes storage in term of humidity.

Table 3: Effect of absorbent materials on mean daily cooling efficiency of the storage chamber

Trt	DAYS											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
RS	26.66a	40.20a	40.84a	57.01b	56.66b	73.94a	49.46a	67.53b	66.25a	69.11ab	35.01a	71.84b
CH	56.66a	35.45a	53.34a	58.34b	56.66b	105.64a	67.22a	67.53b	60.00a	74.28b	36.67a	61.84b
CO	50.01a	43.00a	45.32a	33.34a	34.28a	74.08a	49.12a	36.66a	52.22a	59.62a	40.00a	40.00a

Note: Means with the same alphabet in the same column are not significantly different at 5% level of significance; RS: River sand, CH: Charcoal, and CO: Ambient conditions.

Table 3 shows that there was no significant difference among the treatments in all the days except on days 4, 5, 8, 10 and 12. The highest mean cooling efficiency was recorded in Charcoal in all the days except days 2, 9 and 11 with values of 35.45%, 60.60% and 36.67% while the least mean was recorded under ambient conditions on all days except on days 1, 2, 3, 6 and11 with value of 50.01%, 43.00%, 45.32%, 74.08% and 40.00%. Therefore Charcoal as an absorbent material performed better in cooling efficiency on the stored tomatoes.

Table 4: Effect of absorbent materials on the weight of stored tomato

			DAYS				
TRT	**Initial**	**2**	**4**	**6**	**8**	**10**	**12**
RS	716.50a	656.00a	641.00b	597.00a	560.00b	493.50a	452.60a
CH	724.50a	639.50a	600.00a	564.60b	512.00a	489.00a	478.00a
CO	727.00a	692.00a	612.00ab	525.50a	516.00a	442.00a	421.08a

Note: means with the same alphabet in the same column are not significantly different at 5% level of significance; RS: River sand, CH: Charcoal, and CO: Ambient conditions.

The effect of different absorbent materials on weight of stored tomato is presented in table 4. There was no significant difference in all the days except on days 4, 6, and 8. It reveals that tomatoes under Charcoal evaporative storage had the highest mean weight of 478.00g followed by those under river sand evaporative storage (452.60g) after 12 days of storage. Tomatoes stored under ambient conditions had the least readings with mean weight of 421.08g. This corresponds with the work of Chandy (2016) who stated that fruits generally lose weight during storage. Charcoal therefore, performed favorably in terms of tomato weight loss during storage.

Table 5: Effect of absorbent materials on the firmness of stored tomato

		DAYS									
		2		4		6		8		10	
Treatments	Compression Weights	I.R	F.R	I.R	F.R	I.R	F.R	I.R	F.R	I.R	F.R
River sand	30g	13.50a	13.50a	12.00a	12.00a	11.00b	11.00b	11.00b	9.50b	15.00c	11.75b
	60g	13.50a	13.00a	12.00a	12.00a	11.00b	11.00b	9.50b	7.00b	11.75c	9.50b
	100g	13.00a	12.75a	12.00a	10.00a	11.00b	9.50b	7.00b	7.00b	9.50b	5.50b
Charcoal	30g	13.00a	13.00a	15.00a	15.00a	15.50c	15.50c	16.00c	15.50c	14.25c	12.50b
	60g	13.00a	13.00a	15.00a	15.00a	15.50c	15.50c	15.50c	15.00c	12.50c	11.25c
	100g	13.50a	12.85a	15.00a	12.50a	15.50c	15.00c	15.00c	13.00c	11.25c	8.75c
Control	30g	16.00a	16.00a	15.00a	13.00a	0.00a	0.00a	0.00a	0.00a	0.00a	0.00a
	60g	16.00a	15.50a	13.00a	10.00a	0.00a	0.00a	0.00a	0.00a	0.00a	0.00a
	100g	15.50a	15.00a	10.00a	8.00a	0.00a	0.00a	0.00a	0.00a	0.00a	0.00a

Note: I.R =Initial Reading (cm), F.R. = Final Reading (cm); means with the same alphabet in the same column are not significantly different at 5% level of significance.

Table 5 shows the compression test results of tomatoes for all three treatments, under three different weights, over the course of 10 days. At day 10, under compression by 100g weights, it was recorded that charcoal stored tomatoes showed the least compression range (8.75cm), followed by river sand tomatoes (5.50cm). Tomatoes stored under ambient conditions had no readings as they were flattened from day 3 of storage. This implies that tomatoes stored under charcoal evaporative cooling kept firm for a longer period than the other two treatments.

Colour assessment
Tomatoes stored under ambient conditions showed the most drastic color changes. On the 3rd day, the tomatoes changed from a bright reddish color, to pale red, and later turned black. The tomatoes stored in the cooling chamber still retained their colour with little significant changes within the test period, but spoilage of samples in the cooling chamber were noticed on the 10th day of the test period. The color change observed was based on the physical appearance of the tomatoes and supports the work of Fabiyi (2010).

Table 6: Absorption rate of river sand and charcoal as evaporative media

	River Sand	**Charcoal**
Weight	400g	400g
Amount of water absorbed (Ltr/hr)	11.7ltr/hr	16.7ltr/hr

Charcoal absorbed more water than river sand. This implies that charcoal is a better evaporative media than river sand.

CONCLUSION

From the results, it was concluded that a cooling chamber filled with charcoal as absorbent material with uninterrupted water supply performed best in the storage of tomato fruit which helps in extending the fruit's shelf life when compared to tomatoes stored under ambient conditions or with river sand as evaporative media. Using charcoal as an evaporative pad promotes low temperatures and high humidity for stored tomatoes, resulting in higher cooling efficiencies, lower weight loss, and firmer stored tomatoes during the storage period. Based on the results from this experiment it is therefore recommended that further studies should also vary the use of different absorbent materials with respect to availability, cost, and durability among others. Comparison can also be made between tomato storage under bagged and unbagged conditions.

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Effect of Charcoal Evaporative Pad on Bagged Tomato Storage Characteristics

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ABSTRACT
Tomatoes are important in the agricultural sector as they serve as raw materials for the production of value added products. The general objective of this study was to evaluate bagged tomato storage characteristics using charcoal as an evaporative pad material. Bagged fresh tomatoes were stored in a charcoal evaporative cooling structure and under ambient conditions as a control. Each treatment had two replicates. Temperature, Relative humidity, cooling efficiency, Weight, Firmness and Colour assessment were determined throughout the test period and the results were subjected to Analysis of Variance [ANOVA]. Means were separated using DMRT at 5 percent level of significance. Result showed that a cooling chamber filled with charcoal as absorbent material with uninterrupted water supply performed better in the storing of bagged tomatoes when compared to the ones stored under ambient conditions. It is therefore recommended that further studies should vary the use of different absorbent materials with respect to availability, cost, and durability among others.
Keywords: evaporative cooling, tomato storage, low cost storage structure, fruits and vegetable preservation, charcoal.

INTRODUCTION
Evaporative cooling occurs when the temperature of a substance is reduced due to the cooling effect from the evaporation of water. This cooling effect has been used on various scales from small scale cooling to large industrial applications (Liberty *et al.,* 2013). The efficiency of an evaporative cooler depends on the humidity of the surrounding air (Nobel, 2003), and the type of evaporative pads used.

Deterioration of fresh tomatoes during storage depends partly on temperature (Ajayi, 2011). One way to slow down deterioration and thus increase the length of time tomatoes can be stored, is by lowering the temperature to an appropriate level. Fabiyi (2010) stated that keeping products at their lowest safe temperature (0^0C for temperate crops or 10-12^{0}C for chilling-sensitive crops) will increase storage life by lowering respiration rate, decreasing sensitivity to ethylene gas and reducing water loss. Respiration and metabolic rates are related to room/air temperatures within a given range. Hence, the higher the rate of respiration, the faster the produce deteriorates (Marilou *et al.,* 2021).

Evaporative pads can be made from locally available materials such as river sand, saw dust, charcoal etc., and help to keep products fresh for a while in a pollution free and safe way. However, it requires constant water supply to wet the pads, for optimum performance. Fruits and vegetable farmers do not get enough value for their labor due to weak storage infrastructure, poor transportation, and the perishable nature of these crops. This often results in substantial economic losses. According to Olunloyo *et al.,* (2017a), the damage that occurs in fruits and vegetables is primarily due to loss of moisture, change in physical composition and pathological attack. There is therefore a need to store tomatoes under optimum conditions to reduce perishability, increase shelf life and maintain market value. using a cost effective evaporative pad material is essential for tomato storage. Hence, this study aimed at evaluating bagged tomato storage characteristics using charcoal as an evaporative pad material.

METHODOLOGY

The project was carried out at Crop Production Technology's Experimental plot, Federal College of Forestry, Ibadan. The college is situated at Jericho Hill, Ibadan North West Local Government Area of Oyo state. The area lies between latitude 7˚54´N and longitude 3˚34´E. The annual rainfall range is from 1400mm-1500mm.The average temperature is about 32˚C with average humidity of 80-85%, with two distinct seasons of wet (April to October) and dry (November-March).

The following steps were carried out in the course of the work:

4. The existing evaporative cooler (Olunloyo et al., 2017b) was refurbished and fit with a source of constant water supply. The cooling pad/ evaporative media (Charcoal): Charcoal was procured from the market and filled into the designated evaporative cooling chamber cavities designed for the pad materials. Each storage chamber in the evaporative cooler has dimensions of 74cm× 24cm and a depth of 40cm. The total volume of the evaporative cooler is 1.72m^3 and the structure can store 206.83kg of tomatoes (Olunloyo *et al.,* 2017a).
5. Performance evaluation: Storage characteristics of bagged tomatoes were evaluated using charcoal as a test evaporative pad material. The following parameters were assessed; Chamber temperatures and humidity values were taken five times daily (7am, 10am, 1pm, 4pm, 7pm) with the aid of a thermometer and hygrometer respectively; Tomato weight was taken every two days to determine weight loss with the use of sensitive scale; Firmness was assessed at two day intervals to determine the loss in firmness (three different weights: 30g, 60g, and 100g, were placed on randomly selected tomatoes and the level of depression/ distortion in the circumference was measured in cm with a rope and ruler).
6. Parameters calculated included cooling efficiency and physiological weight loss as used by Olunloyo *et al*. (2017b).
7. Statistical analysis: Data obtained was subjected to analysis of variance [ANOVA]. Significant means were separated using DMRT at 5% level of significance.

RESULTS AND DISCUSSION

Table 1: Effect of charcoal evaporative pad on mean daily temperature of bagged tomatoes in the storage chamber

DAY	CH	CO
1	25.90a	27.00a
2	25.50a	27.30b
3	26.00a	27.20b
4	26.40a	27.60a
5	27.10ab	28.00b
6	26.80a	28.00a
7	27.20a	28.60a
8	27.00a	28.20b
9	26.80a	28.40b
10	26.90a	28.00b
11	26.00a	27.20b
12	25.40a	26.20a
13	27.00a	28.40b
14	26.10a	28.00b

Note: Means with the same alphabet in the same column are not significantly different at 5% level of significance; CH: Charcoal, CO: Ambient

There was significant difference among the treatments in all the days except on days 1, 4, 6 and 12. Higher mean temperatures were recorded under ambient conditions on all days, with consecutively low temperatures in the charcoal evaporative storage structure. This corresponds with Sushmita *et al.,* (2008), who stated that keeping fruit and vegetables at their lowest safe temperature will increase storage life. Hence, bagged tomatoes stored using charcoal as absorbent material had lower temperatures in all the days.

Table 2: Effect of charcoal evaporative pad on mean daily humidity values of bagged tomatoes in the storage chamber

DAY	CH	CO
1	88.70a	87.40a
2	88.40a	80.40a
3	89.60a	87.60a
4	89.00a	89.00a
5	89.00a	84.60a
6	90.70b	87.60a
7	87.30a	89.40a
8	87.20a	88.40a
9	87.40a	83.00a
10	87.40a	86.20a
11	89.20a	91.00a
12	89.30a	87.00a
13	88.10a	83.0a
14	90.30b	83.70a

Note: Means with the same alphabet in the same column are not significantly different at 5% level of significance; CH: Charcoal, CO: Ambient

There was no significant difference among the treatments in all the days except days 6 and 14. Charcoal storage reported higher humidity values for bagged tomatoes on all days except days 4, 7, 8, and 11. ASHRAE (1982) reported that high relative humidity increases the shelf life of fresh fruit and vegetables. This implies that charcoal as an absorbent material performed better in bagged tomato storage in terms of humidity.

Table 3: Effect of absorbent materials on the weight of stored tomato

	DAYS							
	Initial	**2**	**4**	**6**	**8**	**10**	**12**	**14**
CH	488.00a	478.00b	422.50b	330.50a	260.20a	240.10a	228.20a	220.00b
CO	465.00a	364.00a	282.50a	240.50a	190.01a	160.00a	142.08a	130.09a

Note: Means with the same alphabet in the same column are not significantly different at 5% level of significance; CH: Charcoal, CO: Ambient

There was no significant difference in the treatments in all the days except on days 2, 4, and 14. Charcoal stored bagged tomatoes had the higher mean weight of 220.00g by day 14, compared to bagged tomatoes stored under ambient conditions with mean weight of 130.09g. This corresponds with the work of Chandy (2016) who stated that fruit generally loses weight during storage. Charcoal therefore performed favorably in terms of tomato weight loss during storage.

Table 4: Comparison of cooling efficiency of charcoal storage and ambient conditions on bagged tomatoes

DAY	CH	CO
1	70.26a	63.32a
2	55.17a	63.32a
3	58.34a	70.00a
4	62.62a	46.68a
5	67.38b	40.76a
6	52.58a	47.62a
7	66.34a	49.50a
8	65.01a	58.74a
9	72.06a	58.74a
10	43.00a	35.45a
11	53.32a	40.84a
12	40.00a	35.01a
13	67.22a	49.46a
14	67.38b	40.76a

Note: Means with the same alphabet in the same column are not significantly different at 5% level of significance; CH: Charcoal, CO: Ambient

There was no significant difference in the treatment in all the days except on days 5 and 14. Higher mean cooling efficiency (67.38%) was recorded in Charcoal storage of bagged tomatoes when compared with the ones stored under ambient conditions 40.76%. Therefore, charcoal as an evaporative absorbent material performed better than storage under ambient conditions in cooling tomatoes.

Table 5: Effect of storage type on the firmness of stored bagged tomatoes

		DAYS							
		2		4		6		8	
Treatment	Weight	I.R	F.R	I.R	F.R	I.R	F.R	I.R	F.R
Charcoal	30g	11.50a	11.50a	13.00a	13.00a	16.50b	16.50b	13.50b	13.50b
	60g	11.50a	11.50a	13.00a	13.00a	16.50b	16.50b	13.50b	13.00c
	100g	11.50a	11.50a	13.00a	13.00b	16.50b	16.50b	13.00c	11.00c
Control	30g	8.00a	8.00a	6.00a	6.00a	0.00a	0.00a	0.00a	0.00a
	60g	8.00a	8.00a	6.00a	5.00a	0.00a	0.00a	0.00a	0.00a
	100g	8.00a	8.00a	5.00a	4.00a	0.00a	0.00a	0.00a	0.00a

Note: Means with the same alphabet in the same column are not significantly different at 5% level of significance; CH: Charcoal, CO: Ambient

It was recorded that tomatoes stored under charcoal absorbent pad showed higher values for firmness, i.e., the least compression with 100g weights (11.00cm) by day 8 compared to those stored under ambient conditions (0.00cm). Ambient stored bagged tomatoes had lost all firmness and could not be measured by day 6. This shows that bagged tomatoes stayed firmer longer under charcoal evaporative storage than those stored under ambient conditions.

Table 6: Absorption rate of charcoal as evaporative media

	Charcoal
Weight	400g
Amount of water absorbed (Ltr/hr)	16.7ltr/hr

Charcoal absorbed 16.7 litres of water in an hour.

CONCLUSION

From the results, it was concluded that a cooling chamber filled with charcoal as absorbent material with uninterrupted water supply performed better in the storage of tomatoes stored in Ziploc bags which helps in extending the shelf life of tomato when compared to tomatoes stored under ambient conditions. The results also showed that tomatoes stored using charcoal as absorbent material reached the lowest temperature and performed better in terms of humidity, cooling efficiency in terms of tomato weight loss during storage. From the results, it was also concluded that Charcoal also performed better as an evaporative material for the tomatoes stored in ziploc bags. Based on the results from this experiment it is therefore recommended that further studies should also vary the use of different absorbent materials with respect to availability, cost, and durability among others.

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Effect of River Sand Evaporative Pad on Bagged Tomato Storage Characteristics

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ABSTRACT
Tomatoes are important in the agricultural sector as they serve as raw materials for the production of value added products. The general objective of this study was to evaluate bagged tomato storage characteristics using river sand as an evaporative pad material. Bagged fresh tomatoes were stored in a river sand evaporative cooling structure and under ambient conditions as a control. Each treatment had two replicates. Temperature, Relative humidity, Cooling efficiency, Weight, Firmness and Colour assessment were determined throughout the test period and the results were subjected to Analysis of Variance [ANOVA]. Means were separated using DMRT at 5 percent level of significance. Result showed that a cooling chamber filled with river sand as absorbent material with uninterrupted water supply performed better in the storing of bagged tomatoes when compared to the ones stored under ambient conditions. It is therefore recommended that further studies should vary the use of different absorbent materials with respect to availability, cost, and durability among others.
Keywords: evaporative cooling, tomato storage, low cost storage structure, fruits and vegetable preservation, river sand, ziploc bags

INTRODUCTION
Evaporative cooling occurs when the temperature of a substance is reduced due to the cooling effect from the evaporation of water. This cooling effect has been used on various scales from small scale cooling to large industrial applications (Liberty *et al.,* 2013). The efficiency of an evaporative cooler depends on the humidity of the surrounding air (Nobel, 2003), and the type of evaporative pads used.

Deterioration of fresh tomatoes during storage depends partly on temperature (Ajayi, 2011). One way to slow down deterioration and thus increase the length of time tomatoes can be stored, is by lowering the temperature to an appropriate level. Fabiyi (2010) stated that keeping products at their lowest safe temperature (0^0C for temperate crops or 10-12^0C for chilling-sensitive crops) will increase storage life by lowering respiration rate, decreasing sensitivity to ethylene gas and reducing water loss. Respiration and metabolic rates are related to room/air temperatures within a given range. Hence, the higher the rate of respiration, the faster the produce deteriorates (Marilou *et al.,* 2021).

Evaporative pads can be made from locally available materials such as river sand, saw dust, charcoal etc., and help to keep products fresh for a while in a pollution free and safe way. However, it requires constant water supply to wet the pads, for optimum performance. Fruits and vegetable farmers do not get enough value for their labor due to weak storage infrastructure, poor transportation, and the perishable nature of these crops. This often results in substantial economic losses. According to Olunloyo *et al.,* (2017a), the damage that occurs in fruits and vegetables is primarily due to loss of moisture, change in physical composition and pathological attack. There is therefore a need to store tomatoes under optimum conditions to reduce perishability, increase shelf life and maintain market value. using a cost effective evaporative pad material is essential for tomato storage. Hence, this study aimed at evaluating bagged tomato storage characteristics using charcoal as an evaporative pad material.

METHODOLOGY

The project was carried out at Crop Production Technology's Experimental plot, Federal College of Forestry, Ibadan. The college is situated at Jericho Hill, Ibadan North West Local Government Area of Oyo state. The area lies between latitude 7°54′N and longitude 3°34′E. The annual rainfall range is from 1400mm-1500mm.The average temperature is about 32°C with average humidity of 80-85%, with two distinct seasons of wet (April to October) and dry (November-March).

The following steps were carried out in the course of the work:

8. The existing evaporative cooler (Olunloyo et al., 2017b) was refurbished and fit with a source of constant water supply.
9. The cooling pad/ evaporative media (River sand): River sand was collected from the flowing stream between Federal College of Forestry Ibadan and the Forestry Research Institute of Nigeria Ibadan. Each storage chamber in the evaporative cooler has dimensions of 74cm× 24cm and a depth of 40cm. The total volume of the evaporative cooler is 1.72m^3 and the structure can store 206.83kg of tomatoes (Olunloyo *et al.,* 2017).
10. Performance evaluation: Storage characteristics of bagged tomatoes were evaluated using river sand as a test evaporative pad material. The following parameters were assessed; Chamber temperatures and humidity values were taken five times daily (7am, 10am, 1pm, 4pm, 7pm) with the aid of a thermometer and hygrometer respectively; Tomato weight was taken every two days to determine weight loss with the use of sensitive scale; Firmness was assessed at two day intervals to determine the loss in firmness (three different weights: 30g, 60g, and 100g, were placed on randomly selected tomatoes and the level of depression/ distortion in the circumference was measured in cm with a rope and ruler).
11. Parameters calculated included cooling efficiency and physiological weight loss as used by Olunloyo *et al*. (2017).
12. Statistical analysis: Data obtained was subjected to analysis of variance [ANOVA]. Significant means were separated using DMRT at 5% level of significance.

RESULTS AND DISCUSSION

Table 1: Effect of charcoal evaporative pad on mean daily temperature of bagged tomatoes in the storage chamber

DAY	RS	CO
1	26.00a	27.00a
2	26.00a	27.30b
3	26.10a	27.20b
4	26.40a	27.60a
5	26.60a	28.00b
6	26.70a	28.00a
7	27.30a	28.60a
8	27.00a	28.20b
9	27.00a	28.40b
10	27.00a	28.00b
11	26.10a	27.20b
12	25.50a	26.20a
13	26.80a	28.40b
14	25.50a	28.00b

Note: means with the same alphabet in the same column are not significantly different at 5% level of significance; RS: River sand, CO: Ambient

There was significant difference among the treatments in all the days except on days 1, 4, 6, 7, and 12. Higher mean temperatures were recorded under ambient conditions on all days, with consecutively low temperatures in the river sand evaporative storage structure. This corresponds with Sushmita *et al*. (2008), who stated that keeping fruit and vegetables at their lowest safe temperature will increase storage life. Hence, bagged tomatoes stored using river sand as absorbent material had lower temperatures in all the days.

Table 2: Effect of river sand evaporative pad on mean daily humidity values of bagged tomatoes in the storage chamber

DAY	RS	CO
1	86.20a	87.40a
2	87.80a	80.40a
3	87.80a	87.60a
4	89.00a	89.00a
5	88.10a	84.60a
6	90.60b	87.60a
7	88.20a	89.40a
8	88.10a	88.40a
9	88.01a	83.00a
10	85.80a	86.20a
11	89.40a	91.00a
12	89.30a	87.00a
13	87.40a	83.0a
14	89.70b	83.70a

Note: Means with the same alphabet in the same column are not significantly different at 5% level of significance; RS: River sand, CO: Ambient

There was no significant difference among the treatments in all the days except days 6 and 14. River sand storage reported higher humidity values for bagged tomatoes on all days except days 1, 4, 7, 8, and 11. ASHRAE (1982) reported that high relative humidity increases the shelf life of fresh fruit and vegetables. This implies that river sand as an absorbent material performed better in bagged tomato storage in terms of humidity, when compared to ambient storage.

Table 3: Effect of absorbent materials on the weight of stored bagged tomato

	DAYS							
	Initial	**2**	**4**	**6**	**8**	**10**	**12**	**14**
RS	473.50a	463.00a	414.00b	337.50a	230.10a	220.00a	205.10a	190.01b
CO	465.00a	364.00a	282.50a	240.50a	190.01a	160.00a	142.08a	130.09a

Note: Means with the same alphabet in the same column are not significantly different at 5% level of significance; RS: River sand, CO: Ambient

There was no significant difference in the treatments in all the days except on days 4 and 14. River sand stored bagged tomatoes had the higher mean weight of 190.00g by day 14, compared to bagged tomatoes stored under ambient conditions with mean weight of 130.09g. This corresponds with the work of Chandy (2016) who stated that fruit generally loses weight during storage. River sand therefore performed favorably in terms of bagged tomato weight loss during storage.

Table 4: Comparison of cooling efficiency of river sand storage and ambient conditions on bagged tomatoes

DAY	RS	CO
1	64.33a	63.32a
2	43.83a	63.32a
3	51.67a	70.00a
4	62.62a	46.68a
5	65.95b	40.76a
6	55.92a	47.62a
7	64.12a	49.50a
8	72.06a	58.74a
9	65.01a	58.74a
10	40.20a	35.45a
11	48.34a	40.84a
12	36.67a	35.01a
13	49.46a	49.46a
14	65.95b	40.76a

Note: Means with the same alphabet in the same column are not significantly different at 5% level of significance; RS: River sand, CO: Ambient

There was no significant difference in the treatment in all the days except on days 5 and 14. Higher mean cooling efficiencies were recorded in River sand storage of bagged tomatoes on all days except days 2 and 3. Over the storage period, bagged tomatoes stored under river sand storage had the highest mean cooling efficiency of 72.06, while storage under ambient conditions had the lowest mean cooling efficiency of 35.01. Therefore, river sand as an evaporative absorbent material performed better than storage under ambient conditions in cooling bagged tomatoes.

Table 5: Effect of storage type on the firmness of stored bagged tomatoes

		DAYS							
		2		4		6		8	
Treatment	Weight	I.R	F.R	I.R	F.R	I.R	F.R	I.R	F.R
River sand	30g	11.00a	11.00a	12.00a	11.75a	11.00a	11.00a	8.00b	8.00b
	60g	11.00a	11.00a	12.00a	12.00a	11.00a	10.50b	8.00b	7.00b
	100g	11.00a	11.00a	12.00a	11.95b	10.50a	8.50b	7.00b	4.00b
Control	30g	8.00a	8.00a	6.00a	6.00a	0.00a	0.00a	0.00a	0.00a
	60g	8.00a	8.00a	6.00a	5.00a	0.00a	0.00a	0.00a	0.00a
	100g	8.00a	8.00a	5.00a	4.00a	0.00a	0.00a	0.00a	0.00a

Note: Means with the same alphabet in the same column are not significantly different at 5% level of significance; RS: River sand, CO: Ambient

It was recorded that bagged tomatoes stored under river sand evaporative pad showed higher values for firmness, i.e., the least compression with 100g weights (4.00cm) by day 8 compared to those stored ambient conditions (0.00cm). Ambient stored bagged tomatoes had lost all firmness and could not be measured by day 6. This shows that bagged tomatoes stayed firmer longer under river sand evaporative storage than those stored under ambient conditions.

Table 6: Absorption rate of river sand as evaporative media

	River sand
Weight	400g
Amount of water absorbed (Ltr/hr)	11.7ltr/hr

River sand absorbed 16.7 litres of water in an hour. While impressive, this is lower than some other evaporative pad materials such as Charcoal (Olunloyo et al., 201b7).

CONCLUSION

From the results, it was concluded that a cooling chamber filled with river sand as absorbent material with uninterrupted water supply performed better in the storage of tomatoes stored in Ziploc bags which helps in extending the shelf life of tomato when compared to tomatoes stored under ambient conditions. The results also showed that tomatoes stored using river sand as absorbent material reached the lowest temperature and performed better in terms of humidity, cooling efficiency in terms of tomato weight loss during storage.

It was also concluded that River sand also performed better as an evaporative material for the tomatoes stored in ziploc bags. Based on the results from this experiment, it is therefore recommended that further studies should vary the use of different absorbent materials with respect to availability, cost, durability, and test crop among others.

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Comparative Evaluation of the Vitamin Composition of Three Varieties of Cassava Roots and Dried Chips

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ABSTRACT
Comparative evaluation of the vitamin composition of the fresh pulp, dried chips, fresh and dried peels of three varieties of cassava roots (TMS 30572, TMS 98/0505, and TMS 01/1368) shows that the fresh pulp had thiamin ranging from (0.04-0.06 mg/100g), riboflavin (0.02-0.04 mg/100g), niacin (0.39-0.44 mg/100g), vitamin C (8.44-9.54mg/100g), Carotenoid (2.17-5.86 µg/g), vitamin E (0.18-0.22 mg/100g) while the dried chips had thiamin ranging from (0.03-0.04 mg/100g), riboflavin (0.02-0.03 mg/100g), niacin (0.24-0.28 mg/100g), vitamin c (6.57-7.84 mg/100g), carotenoid (1.83-4.31 µg/g), vitamin E (0.14-0.18 mg/100g). The fresh peels had thiamin ranging from (0.05-0.07 mg/100g), riboflavin (0.03-0.04 mg/100g), niacin (0.38-0.48 mg/100g), vitamin C (9.66-10.48 mg/100g), carotenoid (2.76-6.31 µg/g), vitamin E (0.23-0.26 mg/100g) while the dried peels had thiamin ranging from (0.04-0.05 mg/100g), riboflavin (0.03-0.04 mg/100g), niacin (0.24-0.28 mg/100g), vitamin C (7.34-8.39 mg/100g), carotenoid (2.62-4.62 µg/g), vitamin E (0.18-0.20 mg/100g). The Carotenoid and the B-Complex vitamin content of the samples were determined using the spectrophotometric method by Onwuka, (2005). The vitamin C content of the samples was determined by the method described by Osborne and Vogt. (1978). Vitamin E content of the samples was determined by the method of Pearson D (1976). The result shows that [soaking + sun drying] and sun drying methods only has led to a significant loss of some part of the vitamin composition of the dried chips and the dried peels across the varieties except riboflavin in TMS 01/1368. The vitamin losses incurred by the dried chips and the dried peels were significant ($p<0.05$) when compared with the fresh pulp and the fresh peels across the varieties.
Keywords: Vitamin composition, fresh pulp, fresh peels, dried chips, dried peels, and evaluation

INTRODUCTION
Cassava (*Manihot esculenta* Crantz) is a woody shrub of the *Euphorbiaceae* family grown mainly for its tuberous roots (Lebot, 2009). It is originally the fourth most important source of calories in the developing world after wheat, maize, and rice. Worldwide, it feeds an estimated 700 million people directly or indirectly. Cassava production has increased steadily for the least 50 years, with 242 metric tons harvested in 2012. The increase is likely to continue as farmers in more than 105 countries have come to recognize the importance of the crop. There is much variation in the nutrient quality of the cassava root. In the tropical region, cassava is the most important root crop as a source of energy. The calorific value of cassava is high when compared to starchiest crops. The starch content of fresh cassava root is about 30% and gives the highest yield of starch per unit area of any crop known. The protein content is extremely low and ranges between 1-3%. The cassava root contains a number of mineral elements in an appreciable amount that are useful in the human diet. The root contains significant amount of iron, phosphorus and calcium, and is relatively rich in vitamin C (Kenneth and Richarson, 2013). A newly bred variety of cassava known as 'yellow root'

contains β-carotene which is a precursor of vitamin A. This source of vitamin A from carotenoids (*β-carotene*) in vegetables and fruits is the main source for most people in developing countries. It makes up 70-90% of their entire dietary vitamin A intake (Eleazu and Eleazu, 2012). The nutritional value of cassava root is important because they are the main part of the plant consumed in developing countries (Tewe, 1992). Cassava root can be processed into dried chips. Dried cassava chips is a shelf stable intermediate product of cassava made from the fresh roots which can be converted to other cassava based products as the need arises. The cassava root, as the most economically important part of the crop, can be processed into several products for human consumption which include gari, 'farhina de mandioca' cassava flour, and 'abacha' (Okaka, 2007). Industrially, dried cassava chips are used as an animal feeds and can also be used to produce other useful products. The cassava chips may have different sizes and shapes which could be rectangular, cubic, and thick sliced depending on the slicing and drying method. Cassava chips can be sold directly, ground into cassava meal, or pelletized (Hahn *et al*., 1992). Thailand remains the major exporter of dried cassava about 80% far ahead of Vietnam 14% (FAO, 2011).

MATERIALS AND METHODS

During processing of cassava roots into dried chips it should be expected that there may be some losses in the nutritional quality of the roots. This research therefore was intended to compare the vitamin composition of three varieties of cassava roots (TMS 30572, TMS 98/0505 and TMS 01/1368) with their dried chips in order to assess the losses made due to handling. Three varieties of cassava roots (TMS 30572, TMS 98/0505, and TMS 01/1368) were obtained from the experimental farm of National Root Crops Research Institute, Umudike. The samples were washed and peeled. The pulps as well as the peels for each of the samples were divided into two separate portions such that the fresh pulp and the dried chips on one hand, and the fresh peels and the dried peels on the other were obtained each. The fresh sample (fresh pulp and fresh peels) were cut into smaller sizes, and oven dried at 70 ^{O}C for 4 hours. Each of the samples were ground to its powder form using mortar and pestle and used for the vitamin composition analysis. The dried sample (dried chips and dried peels) were produced by first cutting the pulp into chunks and soaking in water for 24 hours, then cut into smaller sizes and sundried into chips. The peels were directly cut into smaller sizes and sun dried into chips without undergoing steeping. The chips were irregular pieces of about 1.5cm thick and 2-3 cm long and were produced within 2-3 days. The chips were ground and use for the vitamin composition analysis. Data were subjected to analysis of variance using the Statistical Package for Social Sciences (SPSS), version 20.0. Results were presented as Mean ± standard deviations. One-way analysis of variance (ANOVA) was used for comparison of the means. Differences between means were considered to be significant at p<0.05 using the Duncan Multiple Range Test.

CASSAVA ROOTS
⇩
WASHING
⇩
PEELING
⇩
CUT INTO CHUNKS
⇩
SOAKING (24hrs)
⇩
CHIPPING
⇩
SUN DRYING
⇩
DRIED CASSAVA CHIPS

Fig. 1(a)

CASSAVA ROOTS
⇩
WASHING
⇩
PEELING
⇩
CHIPPING
⇩
SUN DRYING
⇩
DRIED CASSAVA PEELS

Fig. 1(b)

Fig. 1(a): Flow chart for production of dried cassava chips.
Fig. 1 (b): Flow chart for production of dried cassava peels

RESULTS AND DISCUSSION

Figure 1(a) and (b) is showing the flow chart for the production of dried cassava chips and the dried peels. The vitamin composition of the fresh pulp, dried chips, fresh and dried peels of the three varieties of harvested cassava roots (TMS 30572, TMS 98/0505 and TMS 01/1368) are shown in Table 1. The result shows that there is a significant reduction ($p<0.05$) in the vitamin composition of the dried chips and the dried peels when compared with the fresh pulp and the fresh peels across the varieties with the exception of riboflavin in TMS 01/1368. This could be attributed to the effect of the processing methods applied in the study. This tends to suggest that [soaking + sun drying] has led to the reduction of the vitamin composition of the dried chips across the varieties except riboflavin in TMS 01/1368 while sun drying only has led to the reduction of the vitamin composition of the dried peels across the varieties except riboflavin in TMS 01/1368. The losses incurred by the dried chips in the vitamins analyzed are thiamine (25% to 40%), riboflavin (25% to 33.3%), niacin (30% to 45.5%), vitamin C (10% to 25.1%), β-carotene (15.7% to 26%), vitamin E (16.7% to 26.3%) while that incurred by the dried peels are thiamine (33.3% to 42.9%), niacin (26.3% to 44.2%), vitamin C (13.1% to 24%), β-carotene (5.1% to 26.8%), vitamin E (20.8% to 23.1%) respectively across the varieties. The losses incurred by the dried chips and dried peels across the varieties are significant at ($p<0.05$) when compared with the fresh pulp and the dried peels respectively across the varieties.

CONCLUSION

The results of this study has shown that processing cassava roots of the varieties (TMS 30572, TMS 98/0505, and TMS 01/1368) into dried chips using the traditional methods of [soaking + sun drying] and the fresh peels into dried peels using [sun drying] method had revealed a significant ($P<0.05$) percentage loss of some parts of the vitamin composition of the dried chips and the dried peels respectively except riboflavin in TMS 01/1368.

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Table 1: Vitamin composition of the fresh pulp, dried chips, fresh and dried peels of the three varieties of cassava roots (TMS 30572, TMS 98/0505, and TMS 01/1368)

Variety	Treatments	B1 (mg/100 g)	B2 (mg/100 g)	B3 (mg/100 g)	C (mg/100 g)	β-carotene (μg/g)	E (mg/100 g)
TMS 30572	Fresh Pulp	$0.06^{b}\pm0.00$	$0.04^{a}\pm0.00$	$0.44^{b}\pm0.01$	$8.77^{c}\pm0.01$	$2.53^{g}\pm0.11$	$0.19^{cd}\pm0.01$
	Dried Chips	$0.04^{d}\pm0.00$	$0.03^{b}\pm0.00$	$0.24^{f}\pm0.03$	$6.57^{g}\pm0.33$	$1.94^{i}\pm0.02$	$0.14^{f}\pm0.01$
	Fresh Peels	$0.07^{a}\pm0.00$	$0.04^{a}\pm0.00$	$0.48^{a}\pm0.00$	$9.66^{b}\pm0.06$	$3.17^{e}\pm0.01$	$0.23^{ab}\pm0.01$
	Dried Peels	$0.04^{d}\pm0.00$	$0.03^{b}\pm0.00$	$0.28^{e}\pm0.02$	$7.34^{f}\pm0.08$	$2.76^{f}\pm0.03$	$0.18^{de}\pm0.00$
TMS 98/0505	Fresh Pulp	$0.05^{c}\pm0.00$	$0.03^{b}\pm0.00$	$0.40^{cd}\pm0.00$	$9.54^{b}\pm0.08$	$2.17^{h}\pm0.01$	$0.22^{abc}\pm0.03$
	Dried Chips	$0.03^{e}\pm0.00$	$0.02^{c}\pm0.00$	$0.28^{e}\pm0.00$	$7.84^{e}\pm0.02$	$1.83^{i}\pm0.01$	$0.18^{de}\pm0.01$
	Fresh Peels	$0.06^{b}\pm0.00$	$0.03^{b}\pm0.00$	$0.43^{bc}\pm0.00$	$10.48^{a}\pm0.02$	$2.76^{f}\pm0.03$	$0.26^{a}\pm0.02$
	Dried Peels	$0.04^{d}\pm0.00$	$0.03^{b}\pm0.00$	$0.24^{f}\pm0.00$	$8.21^{d}\pm0.13$	$2.62^{g}\pm0.03$	$0.20^{bcd}\pm0.00$
TMS 01/1368	Fresh Pulp	$0.04^{d}\pm0.00$	$0.02^{c}\pm0.00$	$0.39^{d}\pm0.00$	$8.44^{d}\pm0.02$	$5.86^{b}\pm0.06$	$0.18^{de}\pm0.02$
	Dried Chips	$0.03^{e}\pm0.00$	$0.03^{b}\pm0.00$	$0.25^{ef}\pm0.00$	$7.60^{e}\pm0.00$	$4.31^{d}\pm0.01$	$0.15^{ef}\pm0.00$
	Fresh Peels	$0.05^{c}\pm0.00$	$0.03^{b}\pm0.00$	$0.38^{d}\pm0.03$	$9.66^{b}\pm0.03$	$6.31^{a}\pm0.01$	$0.24^{a}\pm0.01$
	Dried Peels	$0.05^{c}\pm0.00$	$0.04^{a}\pm0.00$	$0.28^{e}\pm0.01$	$8.39^{d}\pm0.13$	$4.62^{c}\pm0.12$	$0.19^{cd}\pm0.00$

Values are mean ± SD of duplicate determinations. Mean values with the same superscript within the same column are not significantly different (P > 0.05)

PROCEEDINGS

55th Annual Conference

Agricultural Society of Nigeria

25-29 Oct., 2021

Rufus Giwa Polytechnic, Owo Ondo State

SUB-THEME 10

Gender Mainstreaming and Strategies

Participation of Rural Women in Cassava Flakes (*Abacha*) Processing in Umunneochi LGA, Abia State, Nigeria

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ABSTRACT

The study was conducted among rural women in Umunneochi Local Government Area (LGA) of Abia State to assess the participation in Abacha processing. Multi stage sampling technique was used in the study. Out of the 3 communities: Isuochi, Nneato and Umuchieze, Isuochi in Umunneochi LGA was purposively selected and 54 women were randomly selected and interviewed to assess their level of participation in the production of Abacha popularly known as Ighu in the study area and Abacha in South Eastern Nigeria. Structured questionnaire was used to elicit information from the women. Data collected were analyzed by means of descriptive statistics. A three point Likert-type scale of high participation, low participation and no participation was used to present the levels of participation of the respondents in Abacha processing. The result shows a high level of participation of respondents at different levels of abacha processing. The result revealed that majority (3.9) of the women had high level of participation in Abacha storage activity, followed by activities with grating (3.8), packaging (3.8), soaking/washing (3.7) as shown by the mean scores. The major constraints in Abacha production were pests attack (100%), lack of water (96.2%) and weather variability (94%), lack of and high cost of modern processing technologies/ facilities (77.7% and 77.7%). It was recommended that modern processing facilities should be made available at an affordable cost to the farmers for processing of their produce for food security and income generation.

Keywords: Participation, Rural Women, Abacha, 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 Ojewale 2005). Cassava has a great processing value it can be processed and eaten as fufu, garri, flour, *abacha (flakes)* and many other food products. Although, cassava is the third most important food source in the tropical world after rice and maize and provides calories for over 160 million people of Africa its food value is greatly compromised by the endogenous presence of cyanogenic glucosides. However, drying and ensiling have been found to be effective ways of reducing the toxicity of cassava products.

Abacha is a flake like product from cassava tubers, indigenous, popular and highly consumed by people in southeastern and South South geopolitical zones of Nigeria. Its local salad are cassava products that are popular and relished by the Eastern and Southern Nigerians. *Abacha* is white and crunchy and can be eaten dry or wet as snack and eaten with or without coconut, peanuts/groundnuts or palm kernel, while the local salad known as African salad is softened *Abacha* cooked with vegetable, palm oil, fish and other additives (Adepoju and Nwangwu, 2010). Diversification of the uses of cassava promised high capacity for fighting hunger, alleviating poverty, as well as enhancing the livelihood of many rural farm households.

(Amamgbo *et al*., 2006). It is this value addition through processing, storage and utilization in order to come out with a wide range of products that is often described as value added products (Nwakor *et al.*, 2007). Solving the problem of agricultural productivity and rural development through processing and utilization will go a long way in poverty reduction and elimination of hunger. Value addition technology in cassava involves processing or conversion of edible cassava into more convenient or more acceptable from to the consumer (Onoja and Audu, 2005). *Abacha* is prepared with simple implements like knife for peeling and cutting the cassava tubers, bowls for washing the sliced cassava, pot for boiling, cassava slicer/shredder for slicing the cassava tubers into *abacha*, big flat baskets/mats for drying them under the sun. Abacha which can be prepared as an African salad is the major food used by 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, hotels or even mama put business are making a good living from the business. It is the major source of income among the people of Umunneochi LGA because every household produces cassava flakes to prevent hunger and poverty. This work was designed to assess: (i) the socio economic characteristics of women involved in *Abacha* processing (ii) ascertain level of women participation in *Abacha* processing activities and (iii) identify the constraints encounter in the processing of *Abacha* in Umunneochi L.G.A, Abia State.

METHODOLOGY

The study was conducted among rural women in Umunneochi L.G.A of Abia state. Multi stage sampling technique was used in this study. Out of the three communities in Umunnneochi LGA one community, Isuochi was purposively selected for this study. This is because the community is well known for *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 questionnaire and interview schedule were used to get information from the women about their participation in *Abacha* processing activities. Data collected were analyzed by simple descriptive statistics such as frequency distribution tables, percentage and mean scores. A three point likert type scale of no participation, low participation and high participation was used to measure the level of participation. The mean of participation was computed by multiplying the frequency of each response pattern with its appropriate nominal value and dividing the sum with the number of respondents as follows $3+2+1 = 6/3 = 2.0$. Mean of 2.0 and above were regarded as having high participation for each of the activities evaluated. A mean score of 2.0 was the bench mark for making decision on participation level. Scores below 2.0 is low participation.

RESULTS AND DISCUSSION

The results of this study were presented with tables as shown below. The result in Table 1 shows that about 38.9% of the women were above 60 years whereas many were between the age of 40-60 years (33.3%). Seventy-seven (77%) of the respondents are married. The largest proportion (55.5%) of the women had secondary education and 27.8% have primary education only about 11.16% of the women are illiterate. Majority of the women (83.3%) have large house hold size of 5-7 and above and this large size is good for the processing of cassava flakes. While 61.1% of these women (have large farm size for cassava production for *Abacha* processing. Greater percentage (89.9%) of the respondent have more than 10 years farming experience, in *abacha* processing.

Table 1: Distribution of Respondents based on Socioeconomic Characteristics

Age	Frequency	Percentage
<30	03	5.6
31-40	12	22.2
41-50	06	11.1
51-60	12	22.2
Above 60	21	38.9
Total	**54**	**100**
Marital Status		
Single	0	0
Married	42	77.8
Widow	12	22.2
Total	**54**	**100**
Gender		
Male	0	0
Female	54	100
Total	**54**	**100**
Educational Status		
No formal education	06	11.1
Primary	15	27.8
Secondary	30	55.5
Tertiary	03	5.6
Total	**54**	**100**
Household size		
<2	0	0
2-4	09	16.7
5-7	12	22.2
Above 7	33	61.1
Total	**54**	**100**
Farming experience		
<10	06	11.1
10-20	21	38.9
21-30	06	11.1
31-40	06	11.1
Above 40	15	27.8
Total	**54**	**100**

Source: Field survey 2019

Table 2 shows the levels of participation of the women in *abacha* processing activities which include cassava peeling, washing, slicing/grating, sun drying before washing, soaking /washing, spreading on mat/basket, sun drying after washing, routine turning of the *abacha* under the sun, packing of the dry slice, storage and marketing of the product. The result shows that majority of the women had the highest level of participation in the following activities with the following mean(x) scores; storage (3.9), grating (3.8), packaging (3.8), soaking/washing of *abacha* (3.7), drying of cassava flakes (3.6) respectively. The implication is that rural women in Umunneochi especially Isuochi take *abacha* processing as a very important occupation for alleviation of hunger and poverty There was high Participation of the women in *Abacha* processing in the twelve activities considered. This finding is in agreement with Onyemauwa (2012) who stated that majority of cassava processing activities were done by women in Oyo state.

Table 2: Level of Participation of the Respondents in *abacha* Production

Activities	High participation	Low participation	No 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 into *abacha*	54	22	02	208	3.8
Sun drying of abacha before washing	54	16	05	199	3.6
Soaking /washing of *abacha*	52	23	02	204	3.7
Spreading abacha on mat	45	15	01	166	3.0
Sun drying after washing	54	17	03	199	3.6
Routine turning of *abacha* under the sun	51	22	00	197	3.6
Packaging of the dry *abacha*	53	23	04	209	3.3
Storage of the product	49	31	05	214	3.9
Marketing of *abacha*	28	22	21	149	2.7

Source: Field survey 2019 Decision; ≥ 2.0 = High, < 2.0 = Low

Table 3: Distribution of Respondents According to the Constraints in *abacha* Processing

Constraints	Frequency	Percentage
Unavailability of Land	09	16.6
Local processing implements	48	88.8
Unavailability of finance	48	88.8
Lack of pesticides	27	50
Poor yield	21	38.8
Lack of modern processing technologies.	42	77.7
Labour cost	48	88.8
High cost of processing equipment	42	77.7
Pests incidence	54	100
Climate variability	51	94.4
Storage problems	18	33.3
Marketing	06	11.1
Theft	0	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 2019

The result in Table 4; shows that the major constraints in processing of cassava into *abacha* were pests attack (100%), unavailability of water (96.2%) and climate change (94%). animals like birds, fowls and goats constitute problems to *abacha* processors especially when spread outside under the sun for drying. Others were cost of labour (88.8%), lack of money (88.8%), poor access to credit (77.7%) and lack of modern processing implements (77.7%). The findings agreed with Adeoya et. al (2018) who observed that high cost of processing materials and high cost of labour were the major constraints in cassava processing in Imo state. Many problems constrained *abacha* processing in Umunneochi LGA. But due to improvement in technological development some of these problems are becoming reduced, like provision of public bore holes is reducing the stress of trekking many kilometers in search of water needed for the processing of *abacha*.

CONCLUSION

The level of participation of rural women in *abacha* production was very high. In all the activities involved in the processing of cassava tubers into *abacha*, the women were highly involved. These women used the occupation to fight against food in security, hunger and poverty among the people. Both the young, middle aged and elderly women in this area were involved in the production of *Abacha* not minding the cost of processing implements and other challenges involved in the exercise. Consumers of this product enjoy it in different forms thereby diversifying the utilization of our indigenous technologies. It was assumed that enlarged industrial/ commercial production of this product can attract International market and export to the producing areas. The major constraints in the production/processing of cassava tubers into *abacha* include pests attack, climate change, lack of money, high cost of labour and lack of water for washing of *abacha*. If these constraints are handled, *Abacha*, as a food security product can attract external markets for income generation in Nigeria.

Modern processing facilities are needed to encourage more women participation in *abacha* production. Government should encourage indigenous knowledge by establishing *abacha* processing plants in the study area and adequate pests control measures should be introduced to the rural women for increased production and processing of cassava into *abacha*

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Gender Preferences in the Utilization of Cassava Food Forms in Imo State Nigeria

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ABSTRACT

The utilization of cassava food forms in Imo State was analysed in this study in order to determine underlying preferences based on gender and the challenges thereof with a view to advising on areas of future research efforts and policy. A purposive and multi-stage sampling technique was used in selecting of agricultural zones, Local Government Areas, communities and respondents. A sample size of One hundred and twenty (120) cassava farmers consisting of 60 males and 60 females was used for the study. Data were obtained from respondents using a semi-structured questionnaire. The primary data gathered included socio-economic characteristics of respondents like age, education, marital status, household size, whether they produced or bought the cassava they processed, farm size, farming experience, membership of cooperative societies and number of times they were visited by Extension agents. They were asked to rank their preferences for the utilization (consumption) and constraints to their utilization of the following cassava value added products namely garri, fufu, wet-fufu, tapioca, flakes and flour. Means, frequencies and percentages were the statistical tools applied in data analysis. Both men and women in the study area preferred to consume fufu, followed by garri, tapioca, flakes and flour. Youths and children prefer garri first, then fufu, flakes tapioca and flour. All gender group in the study area ranked flour as their least preferred cassava value added product. The odour of some of the products and their poor colour constituted the most important constraints to utilization followed by lack consistency of the products especially when poorly prepared. To address the odour issue especially with fufu, the National Root Crops Research Institute had developed the technology for the production of odourless fufu. This technology appears not to have been assimilated by the rural dwellers in the study area and therefore should be popularized as a way of boasting utilization of cassava fufu.

Keywords: Cassava, value added product, food forms, utilization, gender

INTRODUCTION

Cassava is a staple of choice across cultures and social divides in Nigerian households. Locally adapted cassava landraces constitute an important part of the traditional diet of more than 600 million people in sub-Saharan Africa, Asia, and Latin America (FAO, 2017). It contributes about 15% of the daily dietary energy intake, and about 70% of the total calories for about 60 million people in Nigeria (Ezulike *et al*., 2006). Freshly harvested cassava roots are notorious for their short shelf lives due to post-harvest physiological deterioration (Amadi *et al*., 2017a) and must be stable forms such as garri, fufu, wet-fufu, tapioca, flakes and flour (Njoku *et al*., 2014). The utilization and possibly constraints to the utilization of these food forms may vary depending on certain innate preferences that are gender based (Amadi *et al*., 2017b; Amadi, 2018). Gendered power relations permeate social institutions so 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) and perhaps their consumption.

The objectives of this project are to determine preferences for utilization of cassava food forms based on gender in Imo State, and challenges to utilization with a view to advising on areas of future research efforts and policy.

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 5,100sq km. (NPC, 2006). A purposive and multi-stage sampling technique was used in selection of agricultural zones, Local Government Areas, communities and respondents. A sample size of One hundred and twenty (120) cassava farmers consisting of 60 males and 60 females was used for the study. Data were obtained from respondents using a semi-structured questionnaire. The primary data gathered included socio-economic characteristics of respondents like age, education, marital status, household size, whether they produced or bought the cassava they processed, farm size, farming experience, membership of cooperative societies and number of times they were visited by Extension Agents. They were asked to rank their preferences for the utilization (consumption) of the following cassava food forms namely garri, fufu, wet-fufu, tapioca, flakes and flour. They were also asked to list their constraints in utilizing these products. Means, frequencies and percentages were the statistical tools applied in data analysis.

RESULTS AND DISCUSSION

Socioeconomic Characteristics

The socioeconomic characteristics of the respondents in the study area are presented in Table 1. Men were slightly older than the women (52 and 48 years respectively). Most of the respondents were educated up secondary school level, were married, and have similar household size of around 9 persons. The decision to utilize a food form may be affected by the level of education. Pingali *et al*., (2005) found that the time taken to process and act on information decreases with education. Most of the respondents produced and sometimes bought the cassava they processed. Men had 4 years more experience in cassava farming than women perhaps because they were older. Khanna (2001) also noted that higher farming experience attainable through increased years of farming leads to higher rates of adoption of new agricultural innovation. Men had about twice more farm land (1.5 ha) than women (0.7ha). Considering the patriarchal system of land inheritance prevalent in the study area, this finding is in agreement with a prior expectation. Most of the respondents did not belong to cooperative societies that would have given them the leverage to better access improved technologies on cassava value addition. 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. Visits by extension agents to the respondents were almost non-existent and may lead to lack of awareness and adoption of technologies.

Table 1: Socioeconomic Characteristics

	Females		Males		Pooled	
Variable	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Age	48.05	10.35	51.86	8.87	49.89	9.81
*Educational level	3.13	0.82	2.95	0.78	3.04	0.80
*Marital Status	1.21	0.60	1.14	0.43	1.17	0.53
Household Size	9.29	3.27	8.80	3.33	9.05	3.29
*Do you buy or produce?	2.74	0.54	2.66	0.63	2.70	0.59
Years of Cassava Farming Experience	19.27	8.09	22.78	11.51	20.98	10.02
Farm Size (Ha)	0.67	3.31	1.49	3.61	1.07	3.00
*Membership of Cooperative	1.89	0.32	1.86	0.35	1.88	0.33
Number of Extension Contact Visits	0.08	0.27	0.05	0.29	0.07	0.28

** Dummy variable. Educational level: 1) No formal education 2) Primary 3) Secondary 4) Tertiary. Marital Status: 1) Married 2) Single 3) Widowed. Do you buy or produce cassava roots for processing 1) I buy 2) I produce 3) Both. Membership of Cooperative Societies 1) yes 2) no.*

Gender Preferences for Utilization of Cassava Food Forms

Gender preferences for the utilization of cassava value added products based ranking by the respondents are presented in Table 2. Both men and women in the study area preferred to consume fufu, followed by garri, tapioca, flakes and flour. Youths and children prefer garri first, then fufu, flakes tapioca and flour. All gender group in the study area ranked flour as their least preferred cassava value added product. Men and women preferred food form like fufu that will satisfy their hunger for a longer time while youths and children preferred food forms that are in ready to consume state like garri.

Table 2: Ranked Gender Preferences for Utilization of Cassava Food Forms

	Cassava food forms				
Gender	**Garri**	**Fufu**	**Tapioca**	**Flakes**	**Flour**
Women	2	1	3	4	5
Men	2	1	3	4	5
Youths	1	2	4	3	5
Children	1	2	4	3	5

Constraints to Utilization of Cassava food forms

The constraints to the utilization of cassava in the study area are presented in Table 3. According to the respondents, the odour of some of the products and their poor colour constitute the most important constraints followed by lack consistency of the products especially when poorly prepared. To address the odour issue especially with fufu, the National Root Crops Research Institute has developed the technology for the production of odourless fufu. This technology appears not to be assimilated by the rural dwellers in the study area and therefore should be popularized as a way of boasting utilization of cassava value added products.

Table3: Distribution of Respondents According to Constraints to Utilization

Constraints	Frequency	Percentage	Rank
Odour	67	43.23	1
Difficulty in swallowing	4	2.58	4
Poor colour	63	40.65	2
Consistency	17	10.97	3
Other	4	2.58	4
Total	155	100.00	

CONCLUSION

Men and women preferred to consume fufu most while youths and children preferred garri. Odour and poor colour were the major constraints to the utilization of cassava value added products in the study area. The technology of odourless fufu which removes the odour in fufu should be disseminated in the study area in order to remove or minimize the constraint and boast utilization of cassava value added products.

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Role of Women in Agricultural Development in Ohaukwu Local Government Area of Ebonyi State, Nigeria

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ABSTRACT

The study examined the role of women in agricultural development in Ohaukwu Local Government Area of Ebonyi State, Nigeria. The specific objectives were to; describe the socio-economic characteristics of women; identify role played by the women in agricultural development and examine factors influencing women contribution/participation to Agricultural development. A multistage random sampling technique was adopted for the study. Primary data was collected with the use of a well-structured questionnaire. Descriptive statistics and multiple regression estimates were used to analyze the data collected. Results on socio-economic characteristics showed that the mean age of the women was 46.7 years as a fairly good proportion (63.89%) of the respondents were married and 86.1% of them were literate possessing divers formal educational levels ranging from primary school education to tertiary school education. The mean household size of the respondents was 5.6 persons while a fairly good proportion (59.7%) of the rural women were farmers. The result further showed that the mean annual income of the women was N138,816.81 while a good proportion (62.5%) of the respondents belonged to farmers/ social network. The study further revealed that Agricultural development roles played by the effort of the women included agricultural financing which ranked the highest (73.6%), post-harvest/ processing activities (68.06%), sourcing of training on the use improved farm inputs (55.56%) and participation in Agricultural Development Programme (45.83%). Result on the determinant of factors influencing level of women contribution to agricultural development showed that the R^2 value (0.9065) of the lead equation indicates that, about 90.65 percent of variability in the dependent variable is attributed to the specified explanatory variables in the model. The F- statistic value of 36.56 is statistically significant at 1.0% probability level. Specifically, age was negatively significant while educational level, occupation and indigene status were positively significant. The study therefore recommended that government should initiate different agricultural development programs for the betterment of women especially in rural areas, agricultural women should be facilitated with financial help to seek new skills related with agricultural activities among others.

***Keywords*: Role, Women, Agricultural Development, Ohaukwu L.G.A**

INTRODUCTION

A significant proportion of the population of most African Nations lives in rural areas. They are predominantly peasant farmers by occupation (Nwaneri, Chukwu, Aroh, Nwafor, Uka, and Chukwu., 2018). Given the low level of their output, they are basically poor and suffer from low standard of living (Iheke, Achu and Nwaneri.,2019). Agricultural development according to Adegboye (2002) can be defined as the system of transforming poverty ridden, over populated and technologically backward sector of an economy into a modern going concern. Modern agriculture is fully integrated into the monetary or exchange market, which is technologically dynamic. Rural women play a vital role in food production and agricultural development at large. In rural areas, women participate fully in food production, processing and distribution which they combine with their functional role of procreation and home management. Ezeh (2007) in his study reported higher labour force participation in rural areas, which is contrary in the urban areas. They account for 70.0% of agricultural workers, 80.0% of food producers, 100.0% of those who process basic food stuff and they undertake 60.0% to 90.0% of the marketing (Nwaneri, Chukwu, Okoroafor, Orji and Aroh, 2017).

Similarly, Yahaya (2002) recorded that 76% of women in Nigeria are actively involved in farming activities and women supply most of the labour needed for agricultural activities and this (labour) is the most important factor of production to farmers as it is needed at all the stages of agricultural production. Women constitute more or less half of any country's population. In most countries however, women contribute much less than men towards the value of recorded production both quantitatively in labour force participation and qualitatively in educational achievement and skilled manpower (Lawanson, 2008). According to Lawanson, (2008), the under-utilization of females in agriculture has obvious implications for economic welfare and growth. Several factors, both economic and non-economic are responsible for this. Traditionally, women are regarded as homemakers, who oversee and coordinate the affairs and activities at home. Previously in Africa, women remained at home while their husbands and sons went out to the farm to work. But at home, however, they were not idle as they engaged in manual processing of food crops and other farm produce in addition to their housekeeping duties. With the advent of western education, industrialization and paid employment, men as well as women are drifted into the modern sector of the economy. This study, therefore, examines the Role of Women in Agricultural Development in Ohaukwu Local Government Area of Ebonyi State, Nigeria. The specific objectives of the study were to: describe socio-economic characteristics of women in the study area; identify role played by women in agricultural development and examine factors influencing women participation/contribution to agricultural development.

METHODOLOGY

The study was conducted in Ohaukwu Local Government Area of Ebonyi State. It is located between Latitude $6^0 7'$ and $6^0 58'$ North of the equator and Longitude $8^0 10''$ and $8^0 0''$ East of the Greenwich meridian. Ohaukwu LGA is bounded in the North by Benue State, to the East by Ebonyi LGA, in the South by Ezza North LGA and to the West by Ishielu LGA. It has an area of 517km^2 and a population of 195,555 with 94,479 males and 101,076 females (NPC, 2006). Ohaukwu LGA of Ebonyi State is characterized by minimum precipitation of about 2500mm per annum with annual mean temperature of between 27^0-30^0C and a relative humidity of 65% to 75%. The vegetation is typically rainforest made up of thick and varied combination of different plant groups ranging from shrubs to bigger trees. Majority of the population are subsistence farmers with farming inputs, equipment and tools used in the area remain traditional. Some important crops cultivated include; Okro, maize, cassava, oil palm, yam and cocoyam. The Local Government Area is made up of three autonomous communities namely; Ezza mgbo, Mgbo and Effiom and comprises of 18 villages. This study adopted purposive and multistage random sampling technique. First: Three autonomous communities that make up Ohaukwu LGA were selected. Second: Three villages were randomly selected from each of the selected autonomous communities making a total of nine villages. The third stage involved random selection of eight (8) rural women farmers from the selected villages making a total sample size of seventy-two (72) respondents. The data used for the research were obtained by means of a structured questionnaire administered as interview schedule. Data were analyzed using descriptive statistics such as frequency distribution, mean scores and tables and inferential statistics such as multiple regression analysis. Objectives i and ii were analyzed using descriptive statistics while objective iii was analyzed using multiple regression analysis. Multiple regression analysis is explicitly expressed below:

$$Y= f(X_1, X_2, X_3, X_4, X_5 + ei)$$

Y- Agricultural Development Programme Participated by Women

X_1 = Marital Status
X_2 = Household size (Number)
X_3 = Level of education (years)
X_4 = Annual farm income (N)
X_5 = Age of farmer (years)
X_6 = Occupation
X_7 = Membership of social network
X_8 = Indigene status
e = Error term

The four functional forms (Linear, Double log, Exponential and semi log forms) were fitted to the data. The lead equation was selected based on statistical and econometric reasons such as number of significant coefficients, magnitude of the f-ratio and R^2, and the conformity of the variables to *a priori*-expectation.

The four functional forms are specified as follows:
Linear form:
$$Y=b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + ei$$

Cobb-Douglas (Double Log):
$$LogY= b_0 + b_1logx_1 + b_2logx_2 + b_3logx_3 + b_4logx_4 + b_5logx_5 + b_6logx_6 + b_7logx_7 + b_8logx_8 + ei$$

Semi – Log:
$$Y = b_0 + b_1logx_1 + b_2log\ x_2 + b_3log\ x_3 + b_4logx_4 + b_5logx_5 + b_6logx_6 + b_7log\ x_7 + b_8logx_8 + ei$$

Exponential:
$$Log\ Y = b_0 + b_1\ x_1 + b_2\ x_2 + b_3\ x_3 + b_4\ x_4 + b_5\ x_5 + b_6\ x_6 + b_7\ x_7 + b_8\ x_8 + ei$$

RESULTS AND DISCUSSION

Table 1 shows the socio-economic characteristics of the respondents. The table revealed that 86.1% of the respondents were literate possessing divers formal educational levels that ranged from primary school education to tertiary school education. Akpabio (2005) reported that education is a major determinant of effective participation in agricultural development ideals. Also, Patrick and Edna (2002) reported that the problem of widespread of illiteracy among farmers who cannot read would hinder the understanding of information at their disposal. The marital status of respondents revealed that fairly good proportion (63.9%) of the respondents were married. This indicates that the married class were more involved in agricultural development. Akpabio (2005) opined that married persons with older children may be relieved of some filial responsibilities and may therefore be able to devote more time to the obligations of agricultural development while their mean age was 46.7 years. This is an indication that the respondents were mostly middle aged and would be actively involved in agricultural development activities. The findings conform to those of Nwaneri *et al.*, (2018) that most farmers in Nigeria are above 40 years. Age of respondents affect their attitude towards participating in developmental projects. Since a great proportion of the respondents were young and in their active stage of life, they would have the physical strength to be part of physical developmental work. (Nwaneri *et al.*, 2018). The mean household size was 5.6 persons. This result implies that the respondents had moderate family sizes and indicate availability of family labour as an input for agricultural activities. The table further revealed that 59.72% of the women were farmers. The predominance and preponderance of farmers in the rural areas explains why over 90% of food produced in the country comes from the rural sector of which women are the major contributors (Oluwepo, 2010). The mean annual income of the women was N138,816.81. The relatively low income status of the rural women has implication for household welfare and their cash contribution to community development activities. A good proportion (62.50%)of the respondents belonged to farmers/social network. This implies high innovativeness among the respondents due to influence of group dynamic effects. The involvement of women in associations enable them share ideas and work as a unifying force (Ume *et al*., 2016).

Table 1: Characteristics of Respondents in Ohaukwu LGA of Ebonyi State (N= 72)

Characteristics	Frequency	Percentage (%)
Educational level		
No formal Education	10	13.9
Primary Education	22	30.6
Secondary Education	31	43.0
Tertiary Education	9	12.5
Marital Status		
Married	46	63.9
Single	17	23.6
Widow	9	12.5
Age (Years)		
20-30	5	6.9
31-40	18	25.0
41-50	28	38.9
51- 60	16	22.2
61 and above	5	6.9
Mean	46.7	
Household size		
1-4	25	34.7
5-9	33	45.8
10 and above	14	19.4
Mean	5.6	
Primary Occupation		
Farming	43	59.7
Trading	13	18.1
Civil servant	13	18.1
Artisan	3	4.1
Annual Income		
Below N200,000	20	27.8
N200,000 – N400,000	42	58.3
Above N400,000	10	13.9
Mean	N138,816.81	
Membership of social		
network	45	62.5
Yes	27	37.5
No	**72**	**100.0**
Total		

Source: Field survey 2019

Table 2 shows the various kinds of agricultural development roles played by women. The table revealed that result with respect to agricultural financing (73.61%) which ranked first is in agreement with Anyiro, Ajuka and Udah (2015) that most women in rural areas take initiatives to improve their own standard of living. They do these by engaging most in self-help group led micro financing of farms. This is because although women farmers contribute significantly to agricultural production in Nigeria, they are least likely to benefit from agricultural credit schemes and technologies that would improve their productivity. This has been as a result of barriers exerted by cultural, social, biological and religious factors (Nwaru, 2003; Ijere, 1991). In fact, there is a strong case for arguing that without credit, it is difficult to see how women smallholders could generate incomes that can sustain an adequate livelihood (Anyiro *et al*., 2015). Postharvest/processing activities (68.06%) ranked second. The role of women in postharvest/ processing activities has been documented. Anyiro *et al.,* (2015) had shown some farm operations (such as processing) to be associated with women. Meanwhile, Anyiro and Onyemachi,(2014) reported a high participation level of women Fadama II beneficiaries in postharvest services in Nigeria. Sourcing of training on the use of improved farm input (55.56%) ranked third, while Participation in Agricultural Development Programme (45.83%) and Women In Agriculture (36.11) ranked fourth and fifth respectively.

Table 2: Agricultural Development Roles Played by Women

Project	Frequency*	Percentage	Rank
Post harvest/ processing activities	49	68.06	2
Agricultural financing	53	73.61	1
Construction of farm roads	23	31.94	6
Sourcing of training on the use of improved farm	40	55.56	3
input	33	45.83	4
Participation in ADP	26	36.11	5
Participation in WIA	21	29.17	7
Group farming and marketing			

Source: Field Survey Data, 2019. * Multiple responses recorded

Table 3 shows the multiple regression analysis result to the factors influencing the level of women's contribution to agricultural development. Exponential functional form was chosen as the lead equation based on statistical and econometric reasons such as the number of coefficients that are significant and in accordance with *a priori* expectation. The R^2 value (0.9065) of the lead equation indicates that, about 90.65 percent of variability in the dependent variable is attributed to the specified explanatory variables in the model. The F- statistic value of 36.56 is statistically significant at 1.0% probability level, suggesting that the results provided reasonably good estimates of the underlying factors that affect the level of women contribution to agricultural development.

The results showed that four out of the eight explanatory variables were significant at given levels. They include age, educational level, occupation and indigene status of the women. Specifically, the coefficient (-1.289909) of age of the women was negative and significant at 1.0% alpha level. The negative sign of this coefficient shows that as the women advance in age, the lower their level of contribution in the operations and activities of agricultural development projects. This implies that it is more likely for younger women to contribute more to developmental activities than older women. This finding is in line with Nwaneri (2015) and Ekong (2003). The coefficient (0.0482555) of educational level made positive contribution to the equation and is statistically significant at 1.0% probability level. The implication of this finding is that the higher the educational level of the rural women, the higher their level of contribution to agricultural development. Nwaru (2003) in his study found that education was positively linked to attitude towards participation in developmental activities. Expectedly, the coefficient (0.0393896) of occupation was positive and significant at 10.0% alpha level. This implies that a higher level of contribution to agricultural development is observed among women who take farming as their primary occupation. This may be due to the fact that rural women with farming as their primary occupation tend to be more engaged in social networks probably because they have more time for informal socializing. The coefficient of indigene status (0.0051274) made positive contribution to the equation and was significant at 10.0% risk level. This finding is in congruence with *a priori* expectation. An indigene of a community would better appreciate the conditions of his community because he has to contribute his quota to the development process. However, Sharon, (2008) noted that place of birth, and length of residence in a community influences participation.

Table 3: Multiple Regression Estimates of Factors that Influence Level of Women's Contributions to Agricultural Development in Ohaukwu Local Government Area of Ebonyi State.

Variable	Functional Forms			
	Linear	Semi-Log	Exponential+	Double-log
Constant	551.187***	172.9173***	18.15622	59.24734***
	(3.00)	(3.77)	(3.77)	(2.97)
Age	0.515515	0.1070962	-1.289909***	0.050466
	(0.83)	(0.58)	(-3.45)	(0.75)
Education	0.9930311	0.5113172**	0.0482555***	0.1009939
	(1.35)	(2.34)	(2.50)	(1.26)
Household size	4.09058**	0.4831165	0.0325572	0.425429**
	(2.09)	(0.83)	(0.63)	(2.00)
Membership of social network	-59514.18	-0.069418	62560.09	-55045.36
	(-1.23)	(-0.24)	(0.16)	(-1.50)
Marital status	-36.38067***	-1789134***	0.0057909	3.31463**
	(-2.55)	(-4.23)	(0.39)	(-2.14)
Occupation	1.070285	0.3372534	0.0393896*	0.118837
	(1.28)	(1.36)	(1.80)	(1.31)
Annual income	-0.0584029**	-0.0067501	-0.0007291	0.0063386**
	(-2.33)	(-0.91)	(1.11)	(-2.33)
Indigene status	0.0001563	0.0004333	0.0051274*	-0.0000992
	(0.04)	(8.95)	(11.46)	(0.23)
R^2	0.8034	0.9096	0.9320	0.7920
Adjusted R^2	0.7279	0.8757	0.9065	0.7140
F-value	10.90***	26.83***	36.56***	10.15***

Source: Field survey data, 2019. + Lead Equation; ***,**, * indicates that variables are significant at 1.0%. 5.0% and 10.0% risk levels, respectively; figures in parentheses are t-ratios.

CONCLUSION

In conclusion, the women played significant roles which include agricultural financing, Post harvest/processing activities, sourcing of training on the use of improved farm input, participation in Agricultural Development Programme among others. The study further revealed that the result on the determinant factors influencing level of women contribution to agricultural development were age, educational level, occupation and indigene status. Based on the findings of this study the following recommendations were made; Government should initiate different agricultural development programs for the betterment of rural woman. Significance of women participation in agricultural growth should be recognized in agricultural development plans and policies. Agricultural women should be facilitated with financial help to seek new skills related with agricultural activities.

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PROCEEDINGS

55th Annual Conference

Agricultural Society of Nigeria

25-29 Oct., 2021

Rufus Giwa Polytechnic, Owo Ondo State

"OWO MADE"

ADDENDA

Various Sub-Themes

Influence of Acetylsalicylic Acid Supplementation on Cloaca Temperature, Testicular Morphometry and Gonadal Sperm Reserve of Barred Plymouth Rock Cocks

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ABSTRACT

The cloaca temperature, testicular morphometry and gonadal sperm reserve of Barred Plymouth Rock cocks fed varied supplemental levels of acetylsalicylic acid were investigated in this research work. Forty-eight Barred Plymouth Rocks breeder cocks of 24 weeks old were used. Four treatment diets were formulated. Diet 1 (T1) had no inclusion of Acetylsalicylic acid (ASA), Diet 2 (T2) contained 0.025% ASA, Diet 3 (T3) contained 0.050% ASA and Diet 4 (T4) had 0.075% of ASA. At the end of 12 week feeding trial, the weight, volume and density of each testis were determined; also the gonadal sperm reserve, daily sperm production and spermatogenic efficiency were equally evaluated. The morphometric assessment of the testes revealed that cocks fed 0.075% ASA had significantly higher ($P<0.05$) left testicular weight and left testicular volume of 15.42±2.56g and 14.13±2.71ml respectively. It was observed that cocks fed control diet had the highest gonadal sperm reserve and daily sperm production values, which were not significantly different ($P>0.05$) from the values obtained in cocks fed 0.075% ASA. It could be inferred from this experiment that feeding ASA supplemented diets does not have any detrimental effect on the reproductive performance of domestic cocks.

Keywords: Cloaca temperature, Testicular morphometry, Gonadal sperm reserve, Barred Plymouth Rock cocks, Acetylsalicylic acid

INTRODUCTION

The high population in the developing countries, most especially in Nigeria, has led to increased demand for animal protein, and poultry meat and eggs is the most affordable source to alleviate the problem of protein malnutrition. For efficient and maximum production of meat and egg, a thorough understanding of the reproductive potential of the cock is highly essential, because, the ability of a breeder cock to fertilize eggs is rivaled only by his genetic influence on the progeny performance. Knowledge of the basic morphometric characteristics of the reproductive organs is important in assessing and predicting quantitative changes in components of testicular tissues, sperm production, storage potential, spermatogenic efficiency and fertilizing ability of the breeder male (Egbunike *et al.*, 1976). Similarly, Osinowo *et al.*, (1981) and Togun and Egbunike (2006) reported that the testes size is a good indicator of the present and future sperm production in animals.

Assessment of sperm producing ability of breeding animals gives room for the evaluation of the efficiency of spermatogenesis in males kept under different environmental conditions and thus helps in evaluating the effects of season, breed, age, bioclimatic factors, hormones, chemicals and drugs. Direct counts of maturing spermatids in the testes or physical enumeration of maturation-phase spermatid and spermatozoa in testicular homogenates have been carried out in various domestic animals, this method with suitable modifications has been used to determine gonadal and extragonadal sperm reserves for various animal species: goats (Bitto and Egbunike, 2006), rats (Adedapo *et al.,* 2003), wild boar (Almeida *et al*., 2006), rabbits (Ogbuewu *et a*l., 2009), mammals (Gage and Freckleton, 2003), partridge (Baraldi-Artoni *et al.*, 2007), sheep (Bielli *et al.*, 2000), donkey (Neves *et al.*, 2002), domestic fowl (Obidi *et al*, 2008 mammals (Gage and Freckleton, 2003), partridge (Baraldi-Artoni *et al.,* 2007), sheep (Bielli *et al.,* 2000), donkey (Neves *et al.,* 2002), domestic fowl (Franca and Godinho, 2003, Obidi *et al.,* 2008), cats (Franca and Godinho, 2003), turkeys (Noirault *et al*., 2006). Berndtson (1977) also reviewed the method of quantification of daily Sperm Production (DSP) based on histometric data and this method has been utilized in determining daily sperm production for boars (Swierstra, 1971; Egbunike *et al*., 1976, 2007), rabbits (Amann, 1970) and humans and rats (Johnson *et al*., 1980), goats (Bitto and Egbunike, 2006). It has however noticed that despite the fact that poultry meat and eggs is the most affordable source to alleviate the problem of protein malnutrition in tropical countries, high environmental temperature and humidity have been a major factor of concern militating against the production of poultry species. It has been reported that heat stress affects all phases of semen production in breeder cocks (Obidi *et al*., 2008). Franca and Godinho, (2003) also reported changes in testicular morphometry and sperm reserves of domestic cats due to seasons. It is therefore pertinent for researches to be carried out on ways of easing and mitigating this problem, so as to enhance efficient reproductive performance in breeding stocks. Various dietary alternatives have been recommended to alleviate high environmental temperature effect on livestock, these includes, dietary nutritional changes such as replacing carbohydrates by lipids or reducing crude protein level, the use of salts and additives such as ascorbic acid in the drinking water (Stilborn *et al*., 1988; Borges *et al.,* 2003). To boost the search for ways of mitigating heat stress associated challenges in poultry production, there is need to carry out more researches on compounds that aid the induction of heat shock protein expression**, one of such compounds is Aspirin.** The usage of acetylsalicylic acid as feed supplement is not green, many researchers have worked on aspirin as livestock feed supplement (ElKholy, 2008; Al-Obaidi and Al-Shadeedi, 2010; Bealish *et al*., 2011), but there has been paucity of information on its effect on testicular mophometry and the sperm production of cocks, hence, this trial investigated the effect of varied supplemental levels of acetylsalicylic acid on cloaca temperature, testicular morphometry and gonadal sperm reserve of Barred Plymouth Rock cocks, with the view of identify the level of supplementation than enhances reproductive performance of the experimental birds.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Teaching and Research Farm (poultry unit) of the Federal University of Technology Akure, Nigeria. The farm is located in the equatorial climatic zone of Western Nigeria, characterized by two rainfall peaks, high temperature and high humidity especially during the rainy season. The mean annual rainfall is about 1,500mm and last for 9 months usually from March to November every year. It also has a mean annual temperature of about 27oC and relative humidity of over 75%.

Experimental Birds and Management Practices

Forty-eight (48) Barred Plymouth Rocks breeder cocks of 24weeks old were purchased from a reliable source. On arrival at the experimental site, the birds were weighed and given 7 days of physiological adjustment to the feed and environment before data collection. The cocks were housed in a wooden cage with drinkers and detachable feeding troughs and were fed ASA supplemented breeder's feed containing 15.7% **crude protein,** cool clean water was offered *ad libitum* throughout the feeding trial, each cock was fed with 150g of breeder's diet per day. The experimental feeds were formulated to meet the nutrient requirement of the birds (NRC, 1998). Good hygienic condition was maintained throughout the period of the feeding trial which lasted for 12 weeks.

Experimental Diets and Layout

Four treatment diets were formulated. Diet 1 (T1) which is the control had no inclusion of Acetyl salicylic acid (ASA), Diet 2 (T2) contained 0.025% ASA, Diet 3 (T3) contained 0.050% ASA and Diet 4 (T4) had 0.075% of ASA. The cocks were randomly allotted into four dietary treatments at 12 birds per treatment and 3 birds per replicate of four. Table 1 shows the gross composition of the breeder cock's diets.

Table 1: Composition (g/100g) of experimental diets for breeder cocks

Ingredients	**Acetyl salicylic acid (%)**			
	T_1	**T_2**	**T_3**	**T_4**
Maize	52.00	52.00	52.00	52.00
Wheat Offal	24.00	24.00	24.00	24.00
Groundnut Cake	3.00	3.00	3.00	3.00
Soya Bean Meal	9.00	9.00	9.00	9.00
Palm Kernel cake	7.00	7 .00	7 .00	7.00
Fish Meal	1.00	1.00	1.00	1.00
Bone meal	1.50	1.50	1.50	1.50
Limestone	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50
Premix	0.50	0.50	0.50	0.50
Total	**100.00**	**100.00**	**100.00**	**100.00**
Acetylsalicylic acid (ASA)	0.00	0.025	0.050	0.075
Calculated Analysis				
Crude Protein (%)	15.70	15.70	15.70	15.70
Metabolizable Energy (MJ/Kg)	10.88	10.88	10.88	10.88
Ether Extract (%)	4.47	4.47	4.47	4.47
Crude Fibre (%)	5.29	5.29	5.29	5.29
Phosphorus (%)	0.83	0.83	0.83	0.83
Calcium (%)	1.01	1.01	1.01	1.01
Lysine (%)	0.71	0.71	0.71	0.71
Methionine (%)	0.78	0.78	0.78	0.78

T1 = Diet with 0.00% ASA; T2 = Diet with 0.025% ASA; T3 = Diet with 0.050% ASA; T4 = Diet with 0.075% ASA

Data Collection

Determination of the cock's weight, cloaca temperature and gonadal morphometry

The initial weights of all the cocks were taken at the arrival at the site of the experiment. At the end of the feeding trial, 24 cocks (6 birds per treatment) were randomly selected, starved for 12hours, after which the final weight, and the cloaca temperature of the cocks were taken with a digital thermometer and recorded accordingly, then the birds were weighed and slaughtered with a sharp knife by making a vertical cut at the throat for proper bleeding. The experimental cocks were carefully opened up and the testes were removed, trimmed, freed of adhering fat and connective tissues. The weight, volume and density of each testis were determined. The weight was measured using sensitive scale. The volume of the testis was determined by water displacement, with a 200ml measuring cylinder filled up to the mark with physiological saline (Aro, 2010). The density was calculated using the formula below:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Determination of gonadal sperm reserve

gonadal sperm reserve was determined by homogenate method. The parenchyma of each testis was cut into tiny pieces with a dissecting knife and then homogenized in 500ml of normal saline solution for two minutes at 6000 rotations/ minute broken to an interval of 1 minute. The homogenate was filtered through a double ply of clean cheesecloth and the filtrate was used for the determination of testicular sperm count following the procedure of Almquist and Amann (1961). The haemocytometry method using the improved Neubauer haemocytometer was employed in the testicular sperm count; only the elongated and fully matured sperm cells were counted in the microscopic field using the x 40 objective lens. Calculation of the testicular sperm count per milliliter was from the formula by Laing (1979) from haemocytometry using the Neubauer haemocytometerie Testicular sperm concentration= Number in 5 large Thoma squares x 32000 x dilution.

Counts were made in duplicates and average value of the two was recorded from the testicular count, the total sperm cells in the two testes i.e. the gonadal sperm reserve were as computed. The daily sperm production was calculated as:

$$\text{DSP} = \frac{\text{Gonadal sperm reserve}}{\text{Time divisor (1.93)}}$$

The time divisor is the number of days of production that these reserves represent (Almquist and Amann 1961).
Gonadal sperm reserve/ gram testis was calculated as:

$$\text{GSR/GT} = \frac{\text{Gonadal sperm reserve}}{\text{Paired testis weight}}$$

The spermatogenic efficiency or efficiency of sperm production was calculated as:

$$\text{Spermatogenic Efficiency} = \frac{\text{The daily sperm production}}{\text{Paired testis weight}}$$

Statistical Analysis
Data obtained were subjected to one-way analysis of variance (ANOVA) using a completely randomized design (CRD) of SAS (2008) statistical package. Duncan s multiple range test of the same statistical package was used to compare the means.

RESULTS AND DISCUSSION

The body weight, cloaca temperature and testicular morphometry of cocks fed dietary supplementation of acetylsalicylic acid
Table 2 shows the body weight, cloaca temperature and testicular morphometry of cocks fed dietary supplementation of acetylsalicylic acid. The result revealed statistical variations ($P<0.05$) in the final weight of the experimental cocks across the treatment, with T4 having the significantly highest final weight value of 2.62±0.06kg. T1 and T3 were not statistically different from each other. T2 was observed to have the lowest weight value of 2.12±0.09kg. There was no significant difference ($P>0.05$) in the cloaca temperature of the experimental cocks across the treatments, but it was however observed that the cloaca temperature decreased numerically as level of ASA supplementation decreased. The morphometric assessment of the testes revealed that cocks fed 0.075% ASA had significantly higher ($P<0.05$) left testicular weight, left testicular volume and lowest left testicular density of 15.42±2.56g, 14.13±2.71ml and 1.09±0.04g/ml respectively. Cocks fed the control diet had the highest right testicular weight of 14.92±0.14g, which was statistically the same ($P>0.05$) with the value (13.78±1.79g) obtained in cocks fed 0.075% ASA, however, no particular trend was followed in the testicular weight and volume values across the treatment. The result obtained in this study is in consonance with the findings of Orlu and Egbunike (2010) who reported a significant ($p<0.001$) and positive correlation between the testicular weight and body weight of Barred Plymouth Rock and indigenous breeds of domestic fowl. This observation is obtained in most breeding animals; goats (Bitto and Egbunike, 2006a, b); boars (Egbunike *et al.,* 2007; Gbore and Egbunike, 2008). Orlu and Egbunike (2010) also revealed significant ($p<0.001$) and positive correlation between the testicular weight and gonadal sperm reserve ($r = 0.84$, $p<0.001$) gonadal sperm reserve per gramme ($r = 0.77$; $p<0.001$), extra-gonadal sperm reserve ($r = 0.86$; $p<0.001$) and extra-gonadal sperm reserve per gramme ($r = 0.50$, $p<0.001$). It is

noteworthy to say that the numerically low cloaca temperature recorded in T2, T3 and T4 could be attributed to the antipyretic effect of ASA which enhanced feed intake, final weight and testicular weight. This high testicular weight and volume recorded in cocks fed 0.075% ASA signifies that birds fed the T4 diet would be predisposed to higher sperm production and reserve.

Table 2: Body weight, cloaca temperature and testicular morphometry ofBarred Plymouth Rock cocks fed varied dietary supplementation of acetylsalicylic acid

Parameters	T1	T2	T3	T4
Initial weight (kg)	2.35 ± 0.01	2.35 ± 0.01	2.43 ± 0.03	2.30 ± 0.07
Final Weight (kg)	2.35 ± 0.25^{ab}	2.12 ± 0.09^{b}	2.38 ± 0.10^{ab}	2.62 ± 0.06^{a}
Cloaca Temperature(°C)	41.45 ± 0.04	41.37 ± 0.05	41.37 ± 0.10	41.32 ± 0.05
Right Testicular Weight (g)	14.92 ± 0.14^{a}	11.18 ± 1.49^{b}	11.35 ± 0.85^{b}	13.78 ± 1.79^{a}
Left Testicular Volume (ml)	11.88 ± 0.48^{a}	8.75 ± 1.89^{c}	10.48 ± 1.42^{b}	14.13 ± 2.71^{a}
Left Testicular Density(g/ml)	1.19 ± 0.09^{b}	1.34 ± 0.13^{a}	1.19 ± 0.06^{b}	1.09 ± 0.04^{c}

a, ab, b, c, = Means on the same rows but with different superscripts are statistically (P<0.05) significant. T1 = Diet with 0.00% ASA; T2 = Diet with 0.025% ASA; T3 = Diet with 0.050% ASA; T4 = Diet with 0.075% ASA.

Gonadal morphometry and gonadal sperm reserve of Barred Plymouth Rock cocks fed varied supplemental levels of acetylsalicylic acid

Table 3 shows the gonadal morphometry and gonadal sperm reserve of Barred Plymouth Rock cocks fed varied supplemental levels of acetylsalicylic acid. The result revealed statistical variation (P<0.05) in all parameters investigated. Cocks fed 0.075% ASA had the highest paired testicular weight and density with the values of 29.20±4.28g and 25.87±3.91ml respectively, which were statistically the same with the values obtained in cocks fed control diet. It was also observed that no particular trend was observed in all the parameters across the treatments. Cocks fed control diet had the highest gonadal sperm reserve and daily sperm production of 158.03±14.23 ($\times 10^9$) and 81.88±7.37 ($\times 10^9$) respectively, these values were also not significantly different (P>0.05) from the values obtained in cocks fed 0.075% ASA with the values 155.04±23.56 ($\times 10^9$) and 80.33±12.21($\times 10^9$) respectively. T1, T2 and T3 were observed to be statistically the same in spermatogenic efficiency with value 2.80±0.19 x10^6, 2.82±0.15 x10^6 and 3.08±0.28 x10^6 respectively. The high gonadal sperm reserve and daily sperm production in T4, with significantly highest spermatogenic efficiency recorded in T3 could be attributed to the ability of ASA to stimulates the leydig cell to produce more reproductive hormone (testosterone) by the testes, which enhances the process of spermatogenesis (Deviche *et al.*, 2010). The result also revealed that the testicular weight is highly significantly (p<0.001) related to gonadal and daily sperm production across the treatment, this is a pointer that the testicular weight determines to larger extent the amount of sperm being produced, as the weight of testis signify the seminiferous tubular diameter and consequently the amount of sperm produced by the male breeder, hence, gonadal sperm reserve and daily sperm production could be accurately estimated from testicular weight.

Table 3: Gonadal morphometry and gonadal sperm reserve of Barred Plymouth Rock cocks fed varied supplemental levels of acetylsalicylic acid (ASA)

Parameters	T1	T2	T3	T4
Paired Testicular Weight (g)	29.17 ± 0.65^{a}	22.93 ± 2.95^{b}	23.78 ± 1.91^{b}	29.20 ± 4.28^{a}
Paired Testicular Volume (ml)	24.19 ± 0.89^{a}	20.12 ± 3.51^{b}	21.10 ± 2.75^{b}	25.87 ± 3.91^{a}
Testicular Sperm Count ($\times 10^6$/ml)	5.40 ± 0.37^{b}	5.45 ± 0.29^{a}	5.96 ± 0.55^{a}	5.32 ± 0.47^{b}
Gonadal Sperm Reserve (x10^9)	158.03 ± 14.23^{a}	125.18 ± 19.39^{b}	142.35 ± 19.79^{b}	155.04 ± 23.56^{a}
Daily Sperm Production (x10^9)	81.88 ± 7.37^{a}	64.86 ± 10.05^{b}	73.76 ± 10.25^{b}	80.33 ± 12.21^{a}
Spermatogenic Efficiency (x10^6)	2.80 ± 0.19^{a}	2.82 ± 0.15^{a}	3.08 ± 0.28^{a}	2.76 ± 0.24^{b}

a, b = Means on the same rows but with different superscripts are statistically (P<0.05) significant. T1 = Diet with 0.00% ASA; T2 = Diet with 0.025% ASA; T3 = Diet with 0.050% ASA; T4 = Diet with 0.075% ASA.

CONCLUSION

It could also be concluded that cocks fed ASA supplemental diets compete well with cocks fed control diet in term of gonadal sperm reserve and daily sperm production, and thus feeding ASA supplemental diets does not have any detrimental effect on the reproductive performance of experimental cocks, but rather enhanced testicular weight, density and spermatogenic efficiency of experimental cocks.

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Semen Quality of Barred Plymouth Rock Cocks Fed Varied Supplemental Levels of Acetylsalicylic Acid

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ABSTRACT
The semen quality of Barred Plymouth Rock cocks fed varied levels of acetylsalicylic acid was investigated in this study. Forty-eight (48) Barred Plymouth Rocks breeder cocks (BPRBC) of 24weeks old were used for this experiment. Four treatment diets were formulated: Diet 1 (T1) which is the control had no inclusion of Acetylsalicylic acid (ASA), Diet 2 (T2) contained 0.025% ASA, Diet 3 (T3) contained 0.050% ASA and Diet 4 (T4) had 0.075% of ASA. ASA supplemented diets were offered for 12 weeks. The fertility assessment of the semen was carried out on all the cocks on weekly basis for 8 weeks. The result revealed that cocks fed 0.050% ASA had significantly highest (P<0.05) ejaculate volume, spermatocrit, sperm concentration and total sperm cell/ejaculate values. It could be concluded that supplementation of ASA up to 0.05% improved semen quality of Barred Plymouth Rock cocks.

Keywords: Semen quality, Barred Plymouth Rock cocks, Acetylsalicylic acid

INTRODUCTION
Cock reproductive performance has a major impact on the reproductive efficiency of poultry operations (Adenokun and Sonaiya, 2001). and one of the major factor militating against effective breeding in farm animals is infertility, It has been discovered that 30% of the infertility problems are connected to males (Kabir *et al*., 2007; Khaki *et al*., 2009 and Barkhordari *et al*., 2013). It is therefore pertinent to carry out proper qualitative and quantitative assessment of semen for selection of breeding males, routine examination of their reproductive performance (Cheng *et al*., 2002) and for the purpose of efficient artificial insemination of chickens (Alkan *et al*., 2002). Many indicators currently used to evaluate semen quality include ejaculate volume, semen color, sperm concentration, sperm motility, sperm viability, and percent sperm deformity (Mocé and Graham, 2008).

Over the years, maintenance of fertile and high semen producing cocks in most poultry breeding farms has been difficult in hot humid tropical environments due to unfavorable climatic conditions, which exert significant influences on domestic birds. It has also been reported that heat stress affects all phases of semen production in breeder cocks. It decreased seminiferous epithelial cell differentiation, which led to decreased semen quality and quantity time (Lee *et al*., 2012). It was reported by McDaniel *et al*. (1995) and McDaniel *et al*. (1996) that serum calcium and phosphorus levels were significantly lowered in heat-stressed birds, decreased calcium and potassium ion exchange significantly reduced spermatogenesis. McDaniel *et al*. (1996) revealed that male fertility declined to 42% and in vivo sperm-egg penetration declined to 52%, when the male broiler breeder was subjected to a temperature of 32°C, compared to values obtained from males that were maintained at 21°C. As a result of the adverse effect of climate on reproductive performance of cocks in the tropical regions, there is constant need for researchers to find possible solutions to this challenges militating against effective reproductive ability in poultry species.

Acetylsalicylic acid (aspirin) is a potent antipyretic drug that has shown to lower the body temperature of heat-stressed chickens. Aspirin (acetylsalicylic acid) is one of the most widely prescribed non-steroidal anti-inflammatory drugs. Reports have shown that ASA modulates gonadotropin-releasing hormone from the hypothalamus; this enhances the production of luteinizing hormone (Osinowo, 2006), which stimulates the leydig cells to produce testosterone. This attributes of ASA has thus necessitated this experiment to investigate effect of feeding ASA supplemented diets on performance and semen quality of Barred Plymouth Rock cocks.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Teaching and Research Farm (poultry unit) of the Federal University of Technology Akure, Nigeria. The farm is located at rainforest zone of Western, characterized by two rainfall peaks, the rainy season was about 1500mm lasting for 9 months, usually from March to November every year, temperature of about 26°C and high relative humidity of 75% especially during the rainy season.

Experimental Birds and Management Practices

Forty-eight (48) Barred Plymouth Rocks breeder cocks of 24weeks old were purchased from a reliable source. Prior to the arrival of the birds, the site was swept, washed and disinfected, on arrival at the experimental site; the birds were weighed and given a week of acclimatization to the feed and environment before data collection. The cocks were kept in a wooden cage and were fed 150g of ASA supplemented breeder's feed per day throughout the 12weeks feeding trial. Good hygienic condition was maintained throughout the period. Breeder's feed were formulated to meet the nutrient requirement of the birds (NRC, 1998).

Experimental Diets and Layout

Four treatment diets were formulated. Diet 1 (T1) control, had no inclusion of acetylsalicylic acid (ASA), Diet 2 (T2) contained 0.025% ASA, Diet 3 (T3) contained 0.050% ASA and Diet 4 (T4) had 0.075% of ASA. The cocks were randomly assigned into four dietary treatments; each treatment contained 12 cocks which were replicated four times, with three birds per replicate. Table 1 shows the gross composition of the breeder cock's diets.

Table 1: Composition (g/100g) of Experimental Diets for Breeder Cocks

Ingredients	Acetyl salicylic acid (%)			
	T_1	T_2	T_3	T_4
Maize	52.00	52.00	52.00	52.00
Wheat Offal	24.00	24.00	24.00	24.00
Groundnut Cake	3.00	3.00	3.00	3.00
Soya Bean Meal	9.00	9.00	9.00	9.00
Palm Kernel cake	7.00	7 .00	7 .00	7.00
Fish Meal	1.00	1.00	1.00	1.00
Bone meal	1.50	1.50	1.50	1.50
Limestone	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50
Premix	0.50	0.50	0.50	0.50
Total	**100.00**	**100.00**	**100.00**	**100.00**
Acetylsalicylic acid (ASA)	0.00	0.025	0.050	0.075
Calculated Analysis				
Crude Protein (%)	15.70	15.70	15.70	15.70
Metabolizable Energy (MJ/Kg)	10.88	10.88	10.88	10.88
Ether Extract (%)	4.47	4.47	4.47	4.47
Crude Fibre (%)	5.29	5.29	5.29	5.29
Phosphorus (%)	0.83	0.83	0.83	0.83
Calcium (%)	1.01	1.01	1.01	1.01
Lysine (%)	0.71	0.71	0.71	0.71
Methionine (%)	0.78	0.78	0.78	0.78

T1 = Diet with 0.00% ASA; T2 = Diet with 0.025% ASA; T3 = Diet with 0.050% ASA; T4 = Diet with 0.075% ASA

Data Collection

Semen Collection and Evaluation

Semen collection began at the 4thweek of the experiment from all the cocks using abdominal massage technique (Lake, 1957) and evaluated for semen quality characteristics. The collection was made on weekly basis for a period of 8 weeks, between 8am-10am.This was done by "stimulating the copulatory organ (the phallus) of the cock to protrude, by massaging the abdomen and the back over the testes." Upon protrusion, the tail region was pushed forward with one hand. By using the thumb and forefinger, the semen was collected at the cock's body temperature in graduated semen collection tubes and at 42°C in a warm bath, until microscopically evaluated for quality. Contaminated semen samples (containing blood or faecal material) were discarded, while all ejaculate volumes were recorded directly from the graduated semen collection tubes. Each semen sample was evaluated after collection for semen volume, concentration, live, dead and abnormal sperm. The semen volume was determined by drawing the semen with tuberculin syringe of 1.0ml capacity and reading directly to the nearest 0.01ml. The concentration was determined by using haematocytometer (Aro, and Adeniyi, 2018). Percentage of live and dead sperm and morphologically abnormal sperm was determined using eosin-nigrosin vital staining techniques as described by McDaniel *et al.* (1995). The eosin-nigrosin was selected due to the more acceptable result being obtained using this technique when compared to the other staining methods (Łukaszewicz *et al.*, 2008). The live-dead staining principle is based upon the observation that certain strains e.g eosin-B penetrate and stains the dead sperms whereas the viable cell repel the strain.

The membrane of dead cell is not intact i.e the membrane is disrupted or damaged and therefore the dye easily penetrates the cytoplasm of the cell, making the cell coloured either pink or reddish. The membrane of the live sperm is intact, preventing the stain from penetrating and thus remain colorless. The staining mixture consists of 1gm of eosin B; 5gm of nigrosin in 3gms of sodium citrate dehydrate solution; One drop of raw semen is added to 5 drop of the stain, mix thoroughly and a fresh smear is made. The slide is examined under high power and at least 100 cells (both stained and unstained) are counted and a percentage of each estimated (Łukaszewicz *et al*., 2008).

The concentrations of sperm cells were determined using haematocytometer technique. The haematocytometer slide was charged with diluted sperm solution and the counting was carried out under the microscope using x40 objective lens and was expressed as the number of cells per cubic centimeter of semen.

Sperm concentration = Number of Spermatozoa x Multiplication Factor x Dilution Factor.
The spermatocrit was determined in the laboratory using haematocrit centrifuge and haematocrit reader. The spermatocrit was expressed as a percentage of the total volume of sperm.
Total sperm count = Sperm Concentration x Sperm Volume (expressed in million per mililiter (M/ml).

Statistical Analysis
Data obtained were subjected to one-way analysis of variance (ANOVA) using a completely randomized design (CRD) of (SAS, 2008) statistical package. Duncan s multiple range test of the same statistical package was used to compare the means.

RESULTS AND DISCUSSION

The importance of semen evaluation in poultry breeding for selection of breeding males or for routinely monitoring their reproductive performance is well recognized (Cheng *et al.,* 2002). The fertilizing ability of the semen can be accessed by its ejaculate volume, sperm concentration, percentage live, dead and abnormal sperm, and its morphological evaluations (Alkan *et al.,* 2002). Average weekly qualitative assessment of the ejaculate of Barred Plymouth Rock fed varying levels of acetylsalicylic acid is as shown in Table 2. The result of the semen evaluation revealed statistical variation ($P<0.05$) in ejaculate volume, spermatocrit, seminal plasma, sperm concentration, abnormal sperm and total sperm cell per ejaculate. It was observed that cocks fed 0.050% ASA had the highest ($P<0.05$) ejaculate volume, spermatocrit, sperm concentration and total sperm cell/ejaculate values of 0.43±0.03ml, 9.31±1.48 %, 3.41±0.31× 10^9/ml and 1.47±0.21x10^9 respectively. Cocks fed control diet was observed to have the highest seminal plasma value of 92.75±0.78%, which was statistically the same ($P>0.05$) with the value (92.03±1.20%) obtained in cocks fed 0.075% ASA. There were no statistical variations ($P>0.05$) in the percentage live sperm and dead sperm among the treatments, however, cocks fed control diet were observed to have the significantly lowest percentage abnormal sperm with the value of 3.90±0.26 % while cocks fed 0.025% ASA was observed to have the highest value of 4.15±0.23%. It was generally observed that no particular trend was followed in all the semen parameters evaluated. The high values of ejaculate volume, spermatocrit, sperm concentration and total sperm per ejaculate observed in T3 could be attributed to aspirin's inhibition of prostaglandins, which stimulates the leydig cell to produce more testosterone which enhances spermatogenesis (Migrenne *et al.,* 2001; Baker and O'Shaughnessy, 2001; Seshasai *et al.,* 2012). The ejaculate volume recorded in this experiment ranged between 0.29- 0.43mls, this value was contrary to the value of 0.40-0.50 ml reported by Okoro *et al.* (2016), who fed supplemental inclusion levels of onion and garlic mixture at 35-41 weeks of age to Koekoek breeder cock, but however, the range fell within 0.2-0.5ml reported by Hafez and Hafez, (2000). The variation in the ejaculate volume could be as a result breed (Murugesan *et al.,* 2013), line (Tarif, 2013), time of collection, frequency of collection (Riaz *et al.,* 2004) and nutrition (Kabir *et al.,* 2007).

Table 2: Average weekly qualitative assessment of the ejaculate of Barred Plymouth Rock cocks fed varied supplemental levels of acetylsalicylic acid (ASA)

Parameters	T1	T2	T3	T4
Ejaculate Volume (ml)	0.37 ± 0.05^{b}	0.37 ± 0.04^{b}	0.43 ± 0.03^{a}	0.29 ± 0.04^{c}
Spermatocrit (%)	7.25 ± 0.76^{d}	8.75 ± 1.23^{b}	9.31 ± 1.48^{a}	7.97 ± 1.22^{c}
Seminal Plasma (%)	92.75 ± 0.78^{a}	91.25 ± 1.09^{b}	90.69 ± 1.48^{c}	92.03 ± 1.20^{a}
Sperm Concentration (× 10^{9}/ml)	2.97 ± 0.16^{c}	3.29 ± 0.25^{b}	3.41 ± 0.31^{a}	3.12 ± 0.26^{b}
% Live Sperm	93.08±0.51	93.67±0.36	93.36±0.58	93.23±0.42
% Dead Sperm	6.92±0.48	6.33±0.36	6.64±0.58	6.77±0..42
% Abnormal Sperm	3.90 ± 0.26^{c}	4.15 ± 0.23^{a}	4.02 ± 0.26^{b}	4.03 ± 0.26^{b}
Total Sperm Cell / Ejaculate x 10^{9}	1.10 ± 0.17^{b}	1.20 ± 0.16^{b}	1.47 ± 0.21^{a}	0.96 ± 0.22^{c}

a, ab, b = Means on the same row but with different superscripts are statistically (p<0.05) significant. T1 = Diet with 0.00% ASA; T2 = Diet with 0.025% ASA; T3 = Diet with 0.050% ASA;T 4 = Diet with 0.075% ASA

CONCLUSION

This study established the potentiality of ASA in improving the semen quality of cocks. Cocks fed 0.050% ASA had high ($p<0.05$) ejaculate volume, spermatocrit and sperm concentration, hence it could be concluded that supplementation of ASA up to 0.050% in the diets enhanced semen quality of Barred Plymouth Rock cocks.

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Morphometry and Quality of Tibia Bone of Two Breeds of Layers Fed Varied Supplemental Levels of Acetylsalicylic Acid

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ABSTRACT

The morphometry and quality of tibia bone of Isa Brown and Harco Black breeds of layer fed dietary supplementation of acetylsalicylic acid were studied in this experiment. One hundred and ninety-two (192) sixty week old layers (96Harco Black and 96 Isa Brown) were used in a 12weeks feeding trial. Four treatment diets were formulated with acetylsalicylic acid at 0% (T1), 0.025% (T2), 0.050% (T3), and 0.075% (T4) inclusion levels. Each treatment was replicated four times, in which there were 12 birds per replicate and 48 birds per treatment. At the end of the feeding trial, 48 hens (12 birds per treatment) were randomly selected and slaughtered. Data were collected on morphometric parameters (length, weight, diameter, volume and density) of tibia, the proximate and mineral composition, and tensional and compressional force of the tibia. The result revealed that Harco Black had a significantly higher (P<0.05) right tibia diameter, left tibia diameter and right tibia length value of 8.74±0.09mm, 8.60±0.20mm and 12.05±0.06cm respectively. Layer fed 0.075% ASA had the significantly highest (P<0.05) right tibia diameter and left tibia diameter of 9.01±0.12mm, 8.98±0.12mm respectively. It was also observed that the right tibia diameter increased as the level of ASA supplementation increased. It was observed that layers fed control diet had the highest percentage right and left tibia weight of 17.51±0.58% and 17.54±0.54% respectively; while layers fed 0.075% ASA had the highest percentage flesh weight of right and left tibia with values of 84.59±0.39% and 84.33±0.33% respectively. The lowest right tibia weight and left tibia weight values of 15.41±0.39% and 15.67±0.33% were recorded in layers fed 0.075% ASA. Layers fed 0.050% ASA were observed to have the highest compressional and tensional force values of 0.07±0.00Kn and 0.05±0.01Kn respectively. Significant breed effects and treatment versus breed (P<0.05) interactions were also observed in all the parameters investigated. It could be concluded that feeding varied supplemental levels of acetylsalicylic acid up to 0.05% improved bone structure and prevented bone health deterioration through its high compressional and tensional vales, diameter and proximate and mineral composition; hence bone of layers could be fortified through ASA supplementation, to resist mechanical force and fracture at old age.

Keywords: Morphometry, Bone Quality, Layer, Acetylsalicylic Acid

INTRODUCTION

Rapid remodelling occurs in laying hen bones due to its unique bone turnover synchronized with a daily egg laying cycle, also the incidence of bone fractures, osteoporosis and weakness at the end of lay in older laying hensis a concern in the poultry industry (Riczu *et al.,* 2004; Kim *et al.,* 2004 and Kim *et al.,* 2008).Thus, to improve bone quality in poultry, it is essential to understand the physiological basis of bone maturity and strength, this involves complex array of structural, architectural, compositional, physiological, and nutritional factors. One of the nutritional steps that could be taken to improve the bone quality of layers at old age is through dietary supplementation of layer's feed with acetylsalicylic acid. Acetylsalicylic acid is the prototype drug for non-steroidal anti-inflammatory drugs (NSAIDs), with known antipyretic, analgesic, and inflammatory effects (Fuster and Sweeny, 2011; Paez et *al.,* 2012).

Evidence from cellular and animal studies suggests that aspirin possesses bone protective effects (Waters *et al.,* 1991). In vitro studies showed that aspirin could enhance the survival of bone marrow mesenchymal stem cells, the progenitors of osteoblasts, and stimulate the differentiation of preosteoblasts (Zeng *et al.,* 2016). Aspirin also inhibited the nuclear factor kappa-B (NFκB) pathway (Tak and Firestein, 2001; Lawrence, 2009), decreased the expression of receptor activator of nuclear factor kappa-B, increases osteoprotegerin, thereby suppressing the formation of osteoclast (Zeng *et al.,* 2016). Thus, bone health deterioration is prevented in aspirin-treated animal subjected to bone loss. Waters *et al.* (1991) also conducted an experiment on 14-week-old female dogs subjected to hind-limb immobilization, in which the dogs were treated with 25 mg/kg aspirin every eight hours for 28 days. The result revealed that aspirin was able to reduce the rate of bone loss and Prostaglandin E_2 level significantly in these animals (Waters *et al.,* 1991). It was also reported by Chen *et al.* (2011) that aspirin increased bone mineral density. In his work, he administered aspirin at the doses of 8.93, 26.79 and 80.36 mg/kg/day to three-month-old ovariectomized rats (Chen *et al.,* 2011). All three treatment groups showed significantly higher vertebral bone mineral density (BMD) value compared to ovariectomized control. X-ray microtomography (micro-CT) also revealed significant improvements in bone structural indices and volumetric bone mineral density BMD in rats treated with the three doses of aspirin (Chen *et al.,* 2011).

MATERIALS AND METHODS

Procurement of Dietary Supplement

The aspirin (acetylsalicyclic acid) used in this study was purchased from a reliable Pharmaceutical store in Akure Town of Ondo State, Nigeria.

Experimental Birds and Management Practices

One hundred and ninety-two point of lay birds (96 Isa Brown and 96 Harco Black breeds) of 60th weeks old were purchased from reliable sources. On arrival at the site, the birds were properly weighed and given 7 days of physiological adjustment to the feed and environment before data collection. The layers were kept in battery cages equipped with drinkers and detachable feeding troughs. Good hygienic condition was maintained throughout the period of the feeding trial. ASA supplemented layer's diets were offered till the end of feeding trial (12weeks). Layer's feed was formulated to meet the nutrient requirement of the birds and each layer was fed with 113g of layer's diet per day.

Experimental Diets and Layout

Four treatment diets were formulated. Diet 1 (T1) which is the control had no inclusion of Acetyl salicylic acid (ASA), Diet 2 (T2) contained 0.025% ASA, Diet 3 (T3) contained 0.050% ASA and Diet 4 (T4) had 0.075% of ASA. The layers were randomly divided into four dietary treatments, each treatment comprising 48 birds, which was replicated 4 times with 12 birds per replicate, The experimental diets were formulated to meet the nutrient requirement of the birds, the amount of feed offered and the left over were weighed and recorded. Table 1 shows the gross composition of the layer's diets from 60th– 72nd week of age.

Table 1: Composition (G/100g) of Experimental Diets for Layers (60^{th}-72^{rd}weeks of Age)

Ingredients	Acetyl salicylic acid (%)			
	T_1	**T_2**	**T_3**	**T_4**
Maize	50.00	50.00	50.00	50.00
Wheat Offal	16.25	16.25	16.25	16.25
Groundnut Cake	6.50	6.50	6.50	6.50
Soya Bean Meal	12.00	12.00	12.00	12.00
Palm Kernel cake	3.50	3.50	3.50	3.50
Fish Meal	1.00	1.00	1.00	1.00
Bone meal	2.60	2.60	2.60	2.60
Limestone	6.50	6.50	6.50	6.50
Lysine	0.10	0.10	0.10	0.10
Methionine	0.25	0.25	0.25	0.25
Salt	0.30	0.30	0.30	0.30
Premix	1.00	1.00	1.00	1.00
Total	**100.00**	**100.00**	**100.00**	**100.00**
Acetylsalicylic acid (ASA)	0.00	0.025	0.050	0.075
eCalculated Analysis				
Crude Protein (%)	16.70	16.70	16.70	16.70
Metabolizable Energy (MJ/Kg)	10.50	10.50	10.50	10.50
Ether Extract (%)	4.21	4.21	4.21	4.21
Crude Fibre (%)	4.48	4.48	4.48	4.48
Phosphorus (%)	0.94	0.94	0.94	0.94
Calcium (%)	3.32	3.32	3.32	3.32
Lysine (%)	0.86	0.86	0.86	0.86
Methionine (%)	0.53	0.53	0.53	0.53

T1 = Diet with 0.00% ASA; T2 = Diet with 0.025% ASA; T3 = Diet with 0.050% ASA; T4 = Diet with 0.075%

Bone Physiology of Layers

At the end of the 12week feeding trial, 48 hens (12 birds per treatment) were randomly selected and slaughtered, by making a vertical cut at the throat for proper bleeding with a sharp knife. After slaughtering, the drumsticks were carefully cut off the carcass, de-feathered and weighed. The tibia of both legs was obtained by removing accompanying flesh surrounding it with knife and thereafter weighed. The bone was oven dried at 60^0C, after which the length and diameter (at midpoint) were measured with a digital caliper (mm), bone breaking strength was determined by Instron Testing Machine (Model Lloyd, LRX 5N), and the bones were subjected to test at the mid shaft of each bone until they fractured (Norgaard-Nielsen, 1990). The centre of each bone was aligned with the breaking probe (10 mm diameter) which approached at 30 mm min^{-1}. The supports for each bone were 30 mm apart. The breaking strength was determined from the failure point (peak) of each loading curve. Proximate analysis of bone was carried out to determine the percentage moisture, crude protein, fat and ash according to A.O.A.C. Procedures of 1995.The ash content of tibia bone was determined after heating in a muffle furnace at 550°C for 16 h. The ash from the samples were dissolved in 10% HCL (Hydrochloric Acid) and poured into a beaker already containing a funnel shaped filter paper to filter the solution. Distill water was added to make the sample up to 50ml

Calcium

10ml of sample was pipetted into 250ml conical flask. 50ml of distilled water was added, followed by 5ml of 20% KOH, followed by 5 drops of 2% KCN, followed by 5 drops of 5% hydroxyl aminehydrochloride (OH.NH2.HCL). A pinch of calcine indicator was added. The resulting solution was titrated with 0.01M EDTA from wine red to deep blue.

% Calcium = (T x M EDTA x V1 x 100 x 40) / (1000 x V2 x W)

Where,

T= Titre value

V1= Volume of ash

V2= Volume of sample used

W= Weight of sample used

Phosphorus

5ml of Vanadium Molybdate was added to 5ml of sample and distilled water was added to make the solution up to 25mls. A blank sample was prepared containing 5ml of sample made up to 25mls with distilled water. Each sample was read using the spectrophotometer apparatus to obtain the absorbance reading.

Phosphorus (in ppm) = (R x V x dil.factor) / W

And R = (6 x sample absorbance) / 0.61 absorbance standard

Where,

R = Concentration

V = Volume of ash

W =Weight of sample used

Statistical Analysis

Data obtained from layers were subjected to 2 x 4 factorial analyses in a completely randomized design, according to the procedure of SAS (2008). Duncan s multiple range Test of the same statistical package was used to compare the means.

RESULT AND DISCUSSION

The Morphometry, Compressional and Tensional Forces of Left and Right Tibia of Laying Chickens Fed Varied Levels of Supplemental Acetylsalicylic Acid (ASA)

The morphometry, compressional and tensional forces of left and right tibia of laying chickens fed varied levels of supplemental ASA is as shown in Table 2. The result revealed that Harco Black had a significantly higher ($P<0.05$) right tibia diameter, left tibia diameter and right tibia length value of 8.74±0.09mm, 8.60±0.20mm and 12.05±0.06cm respectively. Layers fed 0.075% ASA had the significantly highest ($P<0.05$) right tibia diameter and left tibia diameter of 9.01±0.12mm, 8.98±0.12mm respectively. It was also observed that the right tibia diameter increased as the level of ASA supplementation increased. Layers fed 0.050% ASA were observed to have the highest compressional and tensional force values of 0.07±0.00Kn and 0.05±0.01Kn respectively. All the parameters investigated were statistically different ($P<0.05$) in the interactions between the breeds and treatments. The significantly higher compressional and tensional force values recorded in layers fed 0.050% ASA could be attributed to the effect of acetylsalicylic in increasing blood free calcium levels and blood bicarbonate availability thereby enhancing calcium mobilization in bone, thus improving bone structure and preventing bone health deterioration (McCormack, 2001 and Liu *et al*., 2015). This study was contrary to result obtained by McCormack, (2001) and Konca *et al*. (2009) who reported that there was no significant treatment effect on bone tensional and compressional force of broilers fed diets supplemented with ascorbic acid. In contrasts, Lohakare *et al*. (2005) showed that dietary ASA addition increased tibia breaking strength and ash.

Table 2: Morphometry, Compressional and Tensional Forces of Left and Right Tibia of Laying Chickens Fed Varied Level of Acetylsalicylic Acid (Asa)

T		B	RTD(mm)	LTD(mm)	RTL(cm)	LTL(cm)	TCF(KN)	TTF(KN)
		HB	8.74±0.09[a]	8.60±0.20[a]	12.05±0.06[a]	11.58±0.26	0.06±0.00	0.04±0.00
		IB	8.10±0.37[b]	8.48±0.22[b]	10.95±0.48[b]	11.65±0.25	0.07±0.00	0.05±0.00
T1			7.68±0.51[b]	8.33±0.17[ab]	11.04±0.70	12.09±0.07[a]	0.06±0.00[ab]	0.05±0.01[a]
T2			8.02±0.51[ab]	8.03±0.52[b]	11.00±0.70	10.70±0.68[b]	0.05±0.00[b]	0.40±0.01[b]
T3			8.97±0.08[a]	8.83±0.12[ab]	12.03±0.06	10.69±0.07[b]	0.07±0.00[a]	0.05±0.01[a]
T4			9.01±0.12[a]	8.98±0.12[a]	11.92±0.09	11.97±0.10[a]	0.06±0.00[ab]	0.04±0.01[b]
T1	×	HB	8.37±0.24[c]	8.61±0.17[c]	12.12±0.10[a]	12.17±0.09[a]	0.06±0.01[c]	0.05±0.01[a]
T1	×	IB	7.00±0.97[d]	8.04±0.29[d]	9.98±1.35[c]	12.02±0.11[ab]	0.07±0.01[b]	0.04±0.01[b]
T2	×	HB	8.64±0.15[bc]	8.06±0.75[f]	12.12±0.11[a]	10.58±0.97[e]	0.05±0.01[d]	0.03±0.01[c]
T2	×	IB	7.39±1.00[d]	7.99±0.75[e]	9.88±1.34[d]	10.83±0.99[d]	0.05±0.01[d]	0.06±0.01[a]
T3	×	HB	9.08±0.07[a]	8.86±0.15[b]	12.05±0.09[ab]	11.58±0.11[c]	0.07±0.00[b]	0.04±0.01[b]
T3	×	IB	8.85±0.14[b]	8.88±0.18[b]	12.02±0.08[ab]	11.80±0.08[bc]	0.08±0.01[a]	0.06±0.01[a]
T4	×	HB	8.87±0.16[b]	8.88±0.16[b]	11.92±0.16[b]	11.98±0.15[b]	0.05±0.01[d]	0.04±0.01[b]
T4	×	IB	9.15±0.17[a]	9.08±0.18[a]	11.92±0.08[b]	11.95±0.13[b]	0.06±0.01[c]	0.04±0.01[b]
B			*	*	*	NS	NS	NS
T			*	*	NS	*	*	*
T × B			*	*	*	*	*	*

*a, ab, b, bc, c, d, e, f = Means on the same column for each factor and their interactions, but with different superscripts are statistically (P<0.05) Significant. T= Treatment; B = Breed; RTD= Right Tibia Diameter; LTD= Left Tibia Diameter; RTL= Right Tibia Length; LTL= Left Tibia Length; TCF= Tibia Compressional Force; TTF= Tibia Tensional Force; T1= Diet with 0.00 ASA; T2= Diet with 0.025 ASA; T3= Diet with 0.050 ASA; T4= Diet with 0.075 ASA; NS = Not Significant; Significant; * = significant at 0.05%; HB= Harco Black; IB= Isa Brown; B = Breed; T= Treatment; B ×T = Breed × Treatment.*

Percentage Tibia Weight, Percentage Flesh Weight of Drumstick, Tibia Volume and Density in Isa Brown and Harco Black Layers Fed Varying Levels of Acetylsalicylic Acid

Table 3 shows the Percentage tibia weight, percentage flesh weight of drumstick, tibia volume and density in Isa Brown and Harco Black layers fed varying levels of acetylsalicylic acid. There were significant treatment effects (P<0.05) in all the parameters investigated. It was observed that layers fed control diet had the highest percentage right and left tibia weight of 17.51±0.58% and 17.54±0.54% respectively; while layers fed 0.075% ASA had the highest percentage flesh weight of right and left tibia with values of 84.59±0.39% and 84.33±0.33% respectively. The lowest right tibia weight and left tibia weight values of 15.41±0.39% and 15.67±0.33% were recorded in layers fed 0.075% ASA. Significant breed effects and treatment versus breed (P<0.05) interactions were also observed in all the parameters investigated.

Proximate and Mineral Composition of Left Tibias of Isa Brown and Harco Black Layers Fed Varying Levels of Supplemental Acetylsalicylic Acid (ASA)

Table 4 shows the proximate and mineral composition of left tibias of Isa brown and harco black layers fed varying levels of supplemental acetylsalicylic acid (ASA). As laying hens get older, egg size increases, but the eggshell percentage decreases. This leads to higher nutrient requirements for older hens. Nutrient deficiencies will lead to weaker eggshell with a decrease of eggshell weight and eggshell strength (Bar *et al*., 2002). Bones are the minerals and nutrients storage organs and more precisely medullary bone (*Wang et al*., 2005). Phosphorus is an important nutrient for eggshell quality. Phosphorus and calcium have strong effects on bone strength. If phosphorus and calcium provided from the feed is not enough to support the calcium requirement for the eggshell formation, these minerals are mobilized from the bone. The proximate and mineral composition of left tibias of Isa Brown and Harco Black layers fed varying levels of supplemental acetylsalicylic acid (ASA) (Table 4) revealed significant differences (P<0.05) only in percentage moisture and dry matter of the tibia in the two breeds of layer. Layers fed the control diet had significantly high (P<0.05) nitrogen and crude protein value, which were not significantly different (P>0.05) from values obtained in layers fed

0.050% ASA with nitrogen and crude protein values. Layers fed 0.050% ASA had the highest ($P<0.05$) ash and phosphorus values, while layers fed control diet had the highest ($P<0.05$) calcium. The high nitrogen and crude content recorded in layers fed 0.050% ASA suggests that the bones of layers fed ASA supplemental diets compared well with the control diet in terms of these nutrients. Similarly the highest ($P< 0.05$) ash and phosphorus contents recorded in layers fed 0.050% ASA is a pointer of the ability of ASA to mediate and synthesize collagen (McCormack, 2001), which is one of the determinants of bone quality, this collagen protein has been reported to decline with age, hence, bone of layers could be fortified through ASA supplementation, to resist mechanical force and fracture even at old age.

Table 3: Percentage Tibia Weight, Percentage Flesh Weight of Drumstick, Tibia Volume and Density in Laying Chickens Fed Varied Supplemental Levels of Acetylsalicylic Acid (ASA)

T	B	RTW (%)	LTW (%)	FWRT (%)	FWLT (%)	LTV(cm^3)	LTD(g/cm^3)
	HB	16.06±0.34	16.44±0.35	83.94±0.34	83.56±0.35	3.76±0.15	1.29±0.06
	IB	16.78±0.29	17.35±0.32	83.22±0.29	82.65±0.32	3.91±0.16	1.27±0.07
T1		17.51±0.58^a	17.54±0.54^a	82.49±0.58^d	82.46±0.54^b	3.70±0.21^b	1.35±0.12^a
T2		16.03±0.33^c	16.96±0.55^b	83.98±0.33^b	83.04±0.55^b	4.19±0.18^a	1.13±0.05^b
T3		16.75±0.36^b	17.41±0.41^a	83.25±0.36^c	82.59±0.41^b	3.72±0.24^b	1.35±0.09^a
T4		15.41±0.39^d	15.67±0.33^c	84.59±0.39^a	84.33±0.33^a	3.73±0.22^b	1.31±0.08^a
T1 ×	HB	17.43±0.84^a	16.97±0.68^b	82.57±0.84^d	83.03±0.68^c	3.82±0.25^b	1.24±0.09^b
T1 ×	IB	17.58±0.85^a	18.12±0.82^b	82.42±0.85^d	81.89±0.83^d	3.58±0.35^b	1.46±0.20^a
T2 ×	HB	15.80±0.48^c	16.94±0.82^b	84.21±0.48^{ab}	83.07±0.82^c	4.25±0.24^a	1.12±0.08^c
T2 ×	IB	16.26±0.48^b	16.99±0.76^{bc}	83.75±0.48^b	83.01±0.76^c	4.13±0.28^a	1.15±0.08^b
T3 ×	HB	16.36±0.54^b	16.96±0.66^b	83.64±0.54^c	83.05±0.66^c	3.37±0.31^c	1.47±0.13^a
T3 ×	IB	17.67±0.47^a	17.87±0.47^a	82.86±0.47^d	83.14±0.47^c	4.07±0.36^a	1.23±0.13^b
T4 ×	HB	14.67±0.65^d	14.90±0.50^c	85.34±0.65^a	85.10±0.50^a	3.63±0.32^b	1.36±0.13^a
T4 ×	IB	16.15±0.37^b	16.45±0.32^b	83.85±0.37^b	83.55±0.32^b	3.84±0.30^b	1.26±0.11^b
B		NS	NS	NS	NS	NS	NS
T		*	*	*	*	*	*
T×B		*	*	*	*	*	*

a, ab, b, c, d = Means down the same column for each factor and their interactions, but with *different superscripts are statistically (P<0.05) Significant. T1 = Diet with 0.00% ASA; T2 = Diet with 0.025% ASA; T3 = Diet with 0.050% ASA; T4 = Diet with 0.075% ASA; HB =Harco Black; IB = Isa Brown; B= Breed; T= Treatment; B ×T = Breed ×Treatment; NS = Not significant; Significant; * = Significant at 0.05%. B= Breed; T= Treatment; RTW= Right Tibia Weight, LTW= Left Tibia Weight, FWRT= Flesh Weight Of Right Tibia, FWLT= Flesh Weight Of Left Tibia, LTV= Left Tibia Volume, LTD= Left Tibia Density*

CONCLUSION

It could be concluded that feeding varied supplemental levels of acetylsalicylic acid up to 0.05% improved bone structure and prevented bone health deterioration through its high compresional and tensional vales, diameter and proximate and mineral composition; hence bone of layers could be fortified through ASA supplementation, to resist mechanical force and fracture at old age.

Table 4: Proximate and Mineral Composition of Left Tibia of Layers Fed Varied Supplemental Levels of Acetylsalicylic Acid

T	B	% Fat	% Nitrogen	% CP	% Ash	% P	Ca (%)	% Moisture	% DM
	HB	23.40±0.86	4.61±0.14	28.80±0.87	43.36±1.27	1.59±0.07	4.50±0.04	8.24±0.21^{b}	91.76±0.21^{a}
	IB	24.04±0.75	4.52±0.15	28.25±0.90	43.12±1.38	1.60±0.07	4.50±0.03	8.94±0.25^{a}	91.06±0.25^{b}
T1		23.08±0.85^{b}	4.85±0.27^{a}	30.28±1.69^{a}	43.55±1.65^{ab}	1.67±0.10^{ab}	4.63±0.06^{a}	8.39±0.42^{b}	91.61±0.41
T2		24.84±1.19^{a}	4.10±0.11^{b}	25.64±0.71^{b}	40.53±1.72^{b}	1.52±0.08^{b}	4.46±0.04^{bc}	8.09±0.37^{b}	91.91±0.37
T3		22.11±1.23^{c}	4.83±0.18^{a}	30.16±1.13^{a}	47.45±2.30^{a}	1.86±0.14^{a}	4.35±0.05^{c}	8.90±0.25^{a}	91.10±0.25
T4		24.84±1.19^{a}	4.48±0.17^{ab}	28.01±1.09^{ab}	41.43±1.48^{b}	1.32±0.05^{c}	4.55±0.03^{b}	8.99±0.24^{a}	91.01±0.24
T1 ×	HB	22.92±1.17^{b}	4.78±0.39^{ab}	29.88±2.41^{ab}	43.22±2.65^{b}	1.82±0.15^{ab}	4.65±0.01^{a}	7.50±0.28^{b}	92.50±0.28^{a}
T1 ×	IB	23.25±1.27^{b}	4.91±0.39^{a}	30.68±2.46^{a}	43.88±2.09^{b}	1.5±0.11^{d}	4.60±0.05^{a}	9.27±0.71^{a}	90.73±0.71^{d}
T2 ×	HB	24.80±1.59^{a}	4.19±0.15^{c}	26.19±0.94^{c}	40.69±2.33^{c}	1.34±0.06^{e}	4.46±0.06^{c}	8.03±0.57^{b}	91.97±0.57^{b}
T2 ×	IB	24.88±1.84^{c}	4.01±0.17^{d}	25.08±1.09^{d}	40.37±2.64^{c}	1.71±0.13^{c}	4.47±0.06^{c}	8.15±0.47^{b}	91.85±0.49^{b}
T3 ×	HB	21.35±1.90^{b}	4.90±0.28^{a}	30.60±1.76^{a}	46.41±3.02^{a}	1.94±0.18^{a}	4.35±0.06^{d}	8.72±0.42^{a}	91.28±0.42^{c}
T3 ×	IB	22.88±1.62^{a}	4.75±0.24^{ab}	29.71±1.50^{ab}	48.48±3.58^{a}	1.78±0.21^{b}	4.34±0.07^{c}	9.08±0.27^{a}	90.92±0.27^{c}
T4 ×	HB	24.54±2.07^{a}	4.56±0.23^{ab}	28.52±1.45^{b}	43.09±2.11^{b}	1.28±0.07^{f}	4.52±0.05^{b}	8.71±0.30^{a}	91.29±0.30^{c}
T4 ×	IB	25.15±1.25^{a}	4.40±0.27^{b}	27.50±1.67^{b}	39.76±2.04^{c}	1.34±0.07^{e}	4.58±0.04^{a}	9.27±0.37^{a}	90.73±0.37^{d}
B		NS	NS	NS	NS	NS	NS	*	*
T		*	*	*	*	*	*	*	NS
B×T		*	*	*	*	*	*	*	*

*a, ab, b, c, d, e = Means on the same column for each factor and their interactions, but with different superscripts are statistically (P<0.05) Significant. T= Treatment; B= breed; CP= Crude Protein; Ca= calcium; P= phosphorus; DM= Dry Matter; T1= Diet with 0.00 ASA; T2= Diet with 0.025 ASA; T3= Diet with 0.050 ASA; T4= Diet with 0.075 ASA; NS = Not significant; Significant; * = Significant at 0.05%; B= Breed; T= Treatment; B × T = Breed ×Treatment.*

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Relationship Between Sea Surface Temperature and Chlorophyll-a of Phytoplankton Biomass in the Gulf of Guinea

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ABSTRACT
Ocean productivity lies on the abundant availability of marine primary source of food "phytoplankton" which its biomass could be quantified by chlorophyll-a concentration in the water. Present work investigates the relationship between sea surface temperature (SST) and Chlorophyll-a (Chl-a) of phytoplankton biomass in the Gulf of Guinea (GoG) using remote sensing satellite observations sourced from Copernicus Marine Environment Monitoring Service (CMEMS) data spanning from 2017 – 2019. Result of relationship between Chlorophyll-a and sea surface temperature shows a significant inverse relationship with Spearman's ranked correlation coefficient ($Rs = -0.701$, $p << 0.001$). Spatio-temporal results show variabilities in chlorophyll-a concentrations as its decreases in the direction of the ocean from the coast. Sierra Leonne and Liberia exhibit upwelling properties in boreal springtime and winter, with Cote d'Ivoire and Ghana exhibiting upwelling properties in boreal summer. Nigeria coastal water was perceived to be hottest and contains lesser chlorophyll-a concentration in GoG with mild exceptions in south southern part of the country.
Keywords: boreal, phytoplankton, sea surface temperature, spatio-temporal

INTRODUCTION
Understanding connection between physical and biological parameters in marine ecosystems is an important metrics for evaluation of impacts of climate change on the marine organisms. Majority of the ocean's productivity occurs within the tropics along the equatorial band of 10°N to 10°S (Longhurst, 1993), therefore Gulf of Guinea will be a significant fraction of tropical ocean productivity and also the site of important fisheries (Susanto *et.al.,* 2006). Gulf of Guinea is directly affected by five principal ocean currents: Benguela current, Canary current, South Equatorial Current, Counter Equatorial Current and Guinea Current (Longhurst, 1962). These currents are crucial for the meridional transport of water and heat in the region and play an important role in global circulation. In particular, when alongshore wind blows over the hot surface water, the wind set the water into motion, creating Ekman transport. According to the law of mass conservation, the hot surface water is replaced by nutrient rich subsurface cold water which converges at the coast, thereby driving coastal upwelling. SST plays an important role in the global climate change (Sukresno, 2008). for instance, SST patterns over the Gulf of Guinea clearly demonstrates its effects on the west African monsoon cycle (Ayinde *et. al*., 2019). SST is an independent variable and strong indicator for the marine environment such as fish, coral, pollution, and climate change (Emery, 2015). Phytoplankton is a primary fish source of food and detecting chlorophyll-a which is found in the phytoplankton can determine the fish habitat. With these two parameters, SST and Chl-a, potential ground fishing can be located. The biomass of phytoplankton can be gauged by the chlorophyll-a concentrations (Chl-a) (Vantrepotte *et. al*., 2011), which can be measured by remote sensing at a global scale with high spatial resolution, i.e., 1/24◦ or higher (Mao *et. al*., 2020.).

Present work uses GIS method to explore possible relationship between sea surface temperature and chlorophyll-a concentration in the Gulf of Guinea as these parameters determine biological abundance in the ocean and could be used to predict the potential fishing zone. For this objective, correlations between Sea Surface Temperature and chlorophyll-a concentration would be estimated for the four years under study. These calculations will be based on the compilation of robust and concise relevant data sets; these involve monthly mean Copernicus Marine Environment Monitoring Service (CMEMS) chlorophyll-a and sea surface temperature data (2016–2019) on $0.083^o x\ 0.083^o$ spatial resolution. Spatial and temporal distributions of these variables with their respective annual and monthly trend for the year under investigation in the Gulf of Guinea would also be evaluated.

METHODOLGY

Study area

Gulf of Guinea (GoG) is the northernmost part of the equatorial Atlantic located off the western coast of Africa as shown in figure 1, extending from Cape Palmas in Liberia to Cape Lopez in Gabon. A number of different rivers drain into the Gulf, these include River Niger in Nigeria and the Volta River in Ghana. The Gulf's coastline includes the Bight of Benin and Bight of Bonny and form the western edge Africa tectonic plate.

Figure 1. The study area map

Data sources

Chlorophyll-a and SST data

The chlorophyll-a and SST data used in the study were sourced from Copernicus Marine Environment Monitoring Service (CMEMS) at *marine.corpenicus.eu* on NETCDF4 file format. The downloaded data were monthly mean datasets at 0.49-meter depth spanning from January 2016 to December 2019. CMEMS provides regular and systematic reference information on physical and biogeochemical ocean and sea-ice state for the global ocean and European regional seas. The products are based on the state-of-the-art data processing, advanced modelling and data assimilation techniques.

Methods of Data Analysis

CMEMS SST and chlorophyll-a data previously described were subjected to series of different analysis to achieve the objectives of the study. In other to determine spatial and temporal pattern of SST and chlorophyll-a concentration, downloaded three-year CMEMS data SST and chlorophyll-a were grouped into monthly mean (i.e. January – December). The grouped data were introduced into a GIS software analysis, the data together with the shapefile of the study area were visualized, georeferenced and gridded. The variables were also grouped into monthly mean as it was done for SST and Chlorophyll-a before visualization. in the process of analysis, some missed numbers were detected, bilinear interpolation method was employed to fill the missing numbers as we needed to plot the temporal trend of the extracted variables for both parameters under study. For detecting possible relations between the sea surface temperature and chlorophyll-a concentration, Spearman rank correlation coefficient was computed. The choice of Spearman rank correlation coefficient for detecting possible relationship were born out of the fact that not all the datasets were normally distributed and Spearman rank correlation coefficient is quite not affected by such differences in the data distributions. We understand that correlations do not ensure a cause–effect relationship, but they can be used together with other findings to reach useful conclusions. For this reason, we test the significance of our results using student's t-test at confidence level >95%, results are presented in the results section of the study.

RESULTS AND DISCUSSION

Spatial and temporal changes in monthly mean chlorophyll-a in the Gulf of Guinea as depicted in figure 3.1 shows temporal and spatial variabilities in chlorophyll-a concentrations as its decreases in the direction of the ocean from the coast. Boreal winter (December, January, February) and spring (March, April, May) upwelling properties were noticed in Sierra Leone and Liberia coasts as Chlorophyll-a concentrations values were recorded high during these periods. As against Sierra Leone and Liberia coasts, high Chlorophyll-a concentrations values recorded in summer (June, July, August) periods in Cote d'Ivoire and Ghana coast, suggesting boreal summer upwelling condition in the coast of Cote d'Ivoire and Ghana. This result agrees with (Karen *et. al*., 2016, Ayinde *et. al*., 2020). Although, Togo and Republic of Benin coasts recorded a reasonable amount of Chlorophyll-a concentrations in June with Nigeria coast recorded less throughout. On the other hand, Sea Surface Temperature converses chlorophyll-a concentrations almost in all respect as shown figure 3.2. Low SSTs were noticed in boreal winter periods in Sierra Leone and Liberia as against high chlorophyll-a concentrations in the same period of the year. Also, SST recorded low in Cote d'Ivoire and Ghana coast in boreal summer. Nigeria coastal water was perceived to be the hottest water in the region with $24.6^{o}C$ as the lowest SST recorded in September at an average SST of $27.3^{o}C$, this feat was well reflected in chlorophyll-a concentrations in Nigeria coastal water with mild exceptions in south southern part of Nigeria. The trend plots in figure 3.2a indicates low chlorophyll-a concentrations and high temperature recorded in the boreal winter periods. Conversely, high chlorophyll-a concentrations and low temperature were recorded through the boreal summer in the entire region within the year under investigation.

On monthly averages, July 2019 recorded the highest chlorophyll-a concentrations as opposed to 2017 and 2018 which recorded their respective highest chlorophyll-a concentrations in August, with 2017, 2018 and 2019 recorded their lowest chlorophyll-a concentrations in February, November and March respectively. Contrarily, highest SST values were recorded in March throughout the year under study with their respective lowest values recorded in August.

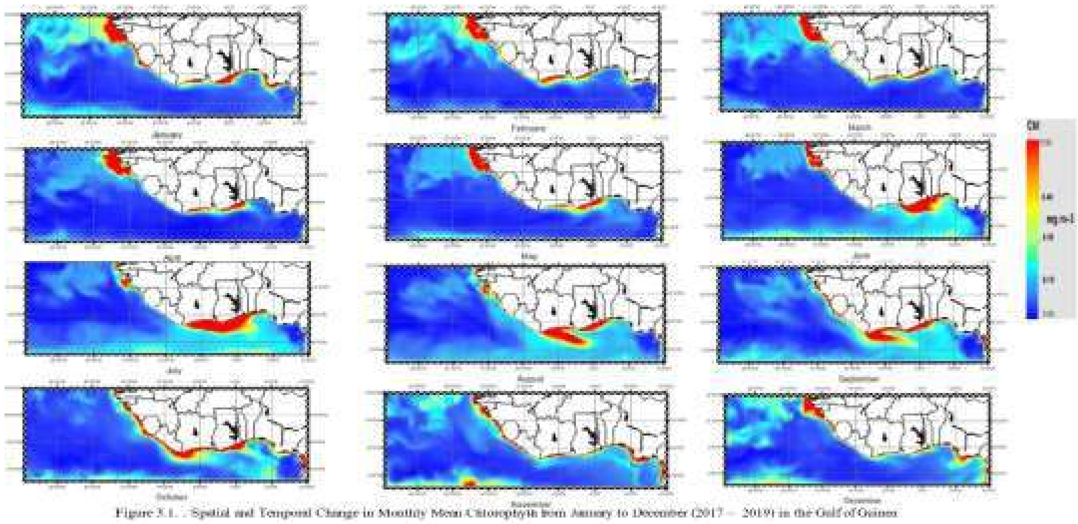

Figure 3.1. . Spatial and Temporal Change in Monthly Mean Chlorophyll from January to December (2017 – 2019) in the Gulf of Guinea

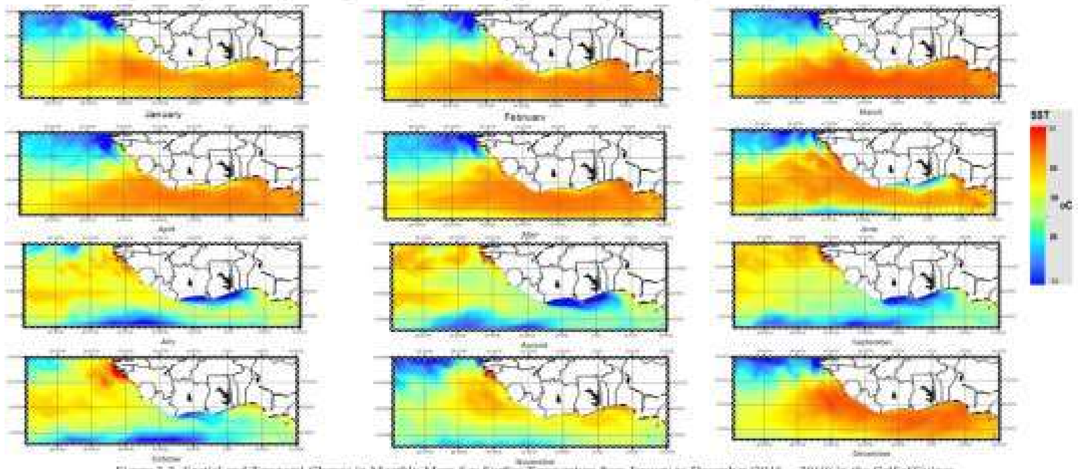

Figure 3.2. Spatial and Temporal Change in Monthly Mean Sea Surface Temperature from January to December (2016 – 2019) in the Gulf of Guinea

Analysis of relationship between Chlorophyll-a and Sea Surface Temperature presented a significant inverse relationship with Spearman's ranked correlation coefficient (Rs = -0.701, $p << 0.001$) in the Gulf of Guinea. This correlation agrees with the work of (Karen et al., 2016). The study titled 'Variability Chlorophyll-a concentration in the Gulf of Guinea and its relation to physical oceanographic variables,' reported that cold SST with negative Sea Level Anomaly (SLA) and moderate wind favors Chlorophyll-a concentration and upwelling conditions. It should be noted that, such an inverse relationship was anticipated between SST and chlorophyll-a or net primary production for the larger part of the oceans (Falkowski et al., (2016), Martinez et al., 2009) as high SST is known to deplete dissolved oxygen in the ocean,

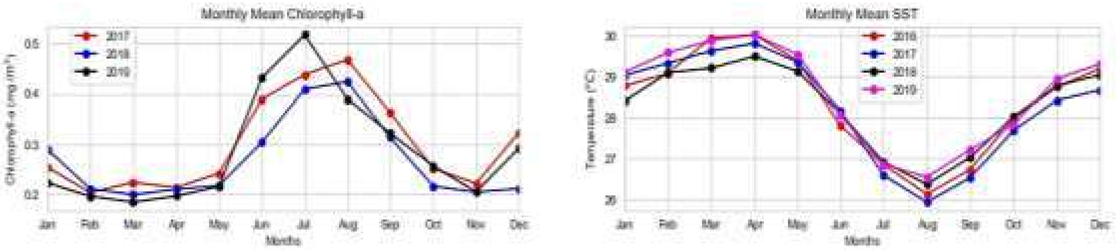

Figure 3.3a. Temporal trend of Monthly Mean Chlorophyll-a, and SST in the Gulf of Guinea

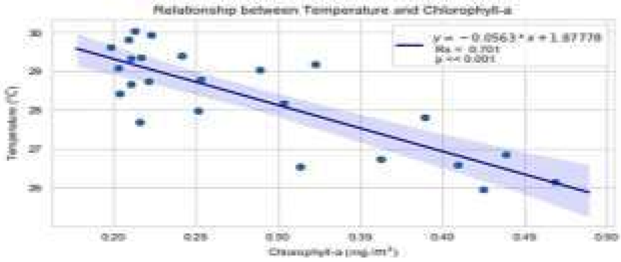

Figure 3.3b. Magnitude of connection between Chlorophylls, and Temperature in the Gulf of Guinea

CONCLUSION

Ocean productivity lies on the abundant availability of marine primary source of food "phytoplankton" which its biomass could be quantified by chlorophyll-a concentration. This research work focuses on the relationship between sea surface temperature and chlorophyll-a concentration with objective of identifying potential fishing zone in the Gulf of Guinea. Result of the analysis shows a negative correlation between sea surface temperature and chlorophyll-a concentration, meaning that SST could be used to study chlorophyll concentration in the Gulf of Guinea. Spatio-temporal results show variabilities in chlorophyll-a concentrations as its decreases in the direction of the ocean from the coast, this implies that the coastal waters are more productive than the open ocean. Sierra Leonne and Liberia exhibit upwelling properties in boreal springtime and winter, with Cote d'Ivoire and Ghana exhibiting upwelling properties in boreal summer. Nigeria coastal water was perceived to be hottest and contains lesser chlorophyll-a concentration in GoG with mild exceptions in south southern part of the country.

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Analysis of Gender-Based Farm Labour Participation in Cassava Production for Sustainable Economic Development in Ebonyi North Agricultural Zone of Ebonyi State, Nigeria

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ABSTRACT
Women, more than their male counterparts, take the lead in cassava production operations. However, it is ironical that their contributions to cassava production operations and agriculture in general are seldom noticed and they have little or no part to play in the agricultural development decision-making process. The women-in-agriculture programme in Nigeria, which was established in cognizance of this and the shortcoming in extension services for women farmers, has been a huge success. Women now have better access to farm inputs and credits although many barriers remain and would have to be addressed to further enhance their role. This study analysed gender-based farm labour participation in cassava production for sustainable economic development in Ebonyi North Agricultural zone. Data were collected from 150 respondents through a multistage sampling technique and analysed using simple descriptive statistics, Z-test and multinomial logit regression Finding revealed a significant difference in gender participation at 1% probability level. Analysis of participation in different cassava production activities showed that educational attainment was negative and significantly reduce participation in bush clearing (Z=-2.2), cultivation (Z=3.4), and weeding (Z=1.9) at the 5, 1 and 10% level while total monthly income significantly reduce participation in clearing (Z=1.9) and planting (Z=2.3) at 10 and 5% probability levels. It was recommended that the provision of adequate basic rural infrastructural facilities would enhance the life of rural dwellers and discourage rural-urban drift which is common among men.

Keywords: Gender, Labour Participation, Cassava Production, Sustainability

INTRODUCTION
Labour has significant role in agricultural production. As a critical production resource, labour accounts for a substantial portion of agricultural production. Undoubtedly, cassava is one arable crop that requires substantial amount of labour due to its tasking and labour intensive nature. Labour for cassava production is supplied by both men and women and production task are shared on the basis of gender. However, the last few decades have witnessed significant variation in gender participation in agriculture. For instance, ILO, (2016) reported that African women represent up to 50 per cent of total agricultural production. Friedman-Sanchez, (2006) reported that in Colombia, about 64 per cent of the work force directly growing fresh-cut flowers for export were women. Recently, significant changes in gender participation has occurred in cassava sub-sector which has resulted in shortage of labour supply for cassava production in the study area (Bassey, Akpaeti and Udo, 2014). One of such changes is the increase in migration of men out of agricultural sector due to increase in participation of off-farm income. FAO, (2006) attributed the continuous decline in labour participation in agriculture to migration out of agriculture. This has resulted in women taking up tasks that were originally undertaken by men. In the Eastern part of Nigeria, for instance, (Akannagbe, 2010) reported that women have taken up task that were before now undertaken by men. Uzokwe and Ofuoku, (2006) in their study attributed the increased women participation in

agriculture to increased family size, changing economic condition, absence of husbands, children education, quest for financial independence, and single parenthood. The migration of men out of farming has also resulted in high use of hired labour and its attendant high wages. These factors also constrained cassava production in the study area. As a result, there is great fear that agricultural growth and development may be retarded and the whole effort of attaining self-sufficiency in cassava production may remain unrealistic. In spite of the high participation of rural women in cassava production, several literatures still portrays their role as being unrecognized by men and the government (Ukonu, 2001). They are rather viewed as playing supportive roles to their spouses. At times, male migration out of agriculture most times leaves rural women with limited or no capital and other inputs. Most times, extension advices and other farm inputs elude them because they were not originally recognized. FAO, (2006) reported that extension agents frequently fail to provide adequate information to women farmers by failing to recognize their specific needs. Therefore, there is need to analyse gender-based farm labour participation in cassava production for sustainable economic development in Ebonyi North Agricultural Zone and Nigeria at large.

METHODOLOGY

The study was carried out in Ebonyi North agricultural zone, of Ebonyi state, Nigeria comprising of Abakaliki, Ebonyi, Izzi, and Ohaukwu local government areas. However, Abakaliki, Izzi and Ohaukwu were purposively chosen due to the high concentration of cassava farmers in these areas. Ebonyi State is located in South East region of Nigeria. The State shares boundaries on the North by Benue State, to the West by Enugu State, to the East by Cross River State and to the South by Imo and Abia State. The climate of Ebonyi State is that of a humid tropical climatic region. The mean annual temperature stands at 280C with an average rainfall of 1200mm - 2500mm (NPC, 2006). Data were collected using structured questionnaire and personal interview schedules administered to 150 respondents through a multi-stage sampling. The first stage involved the purposive selection of three (3) LGAs while the second stage involved the random selection of five autonomous communities from each of the selected LGAs. The third stage involved the selection of ten (10) cassava farmers from each of the selected autonomous community, making a total of 150 cassava farmers from the list of cassava farmers that were registered with the Ebonyi State Agricultural Development Programme. Z- test was used to compare the relative level of participation of male and female labour for different cassava production while multinomial logit regression was employed to estimate factors affecting labour participation for different cassava production operations.

RESULTS AND DISCUSSION

Utilization of male and female labour for cassava production

Results in table 1 present the mean relative hours spent by male and female labours in different cassava production operations in the study area. Finding from the table revealed that there was a wide variation in gender participation across all the cassava production operation in the study area while men participated more in bush clearing (X = 86.4) and cultivation (X = 76.4) women participated more in cassava planting (X = 94.4), weeding (X= 98.8) and harvesting (X = 106.9) respectively. The increase in participation of male in bush clearing and cultivation is because these are two production tasks that require energy, strength and vigour that men mostly possess. Also, the increase in participation of women in planting, weeding and harvesting reveals the dominance of women in these operations presumably because these are less tedious but time consuming tasks compared to the former. The differences in gender labour participation was significant for bush clearing, cultivation, planting and weeding at 5%, 5%, 1% and 1% level of probabilities respectively. This finding is consistent with that of Daudu, et al. (2015) who reported a significant difference between male and female participation in agricultural activities in Kwara State.

Table 1: Level of utilization of male and female labour for cassava production

Cassava production operations	Male Mean	SD	Female Mean	SD	Mean diff.	Zcal
Bush clearing	86.4	100.1	36.9	86.0	49.2	2.2
Cultivating	76.4	89.7	72.0	89.5	4.3	0.2
Planting	45.4	66.0	94.0	107.4	48.7	2.5
Weeding	28.2	56.2	98.8	112.7	70.5	3.7
Harvesting	48.9	62.3	106.9	90.4	57.9	3.4
Across all	285.2	374.3	408.8	283.4	123.8	37.2

Source: Field survey data, 2020

Factors influencing labour participation at different cassava production operations

The MNL estimates for factors influencing labour participation at different cassava production operations in the study area is presented in table 2. The diagnostic statistics yielded a pseudo R^2 value of 0.626 denoting that about 62.6% of the variability in labour participation in different cassava production operations is explained by the explanatory variable included in the model. The probability chi- square (0.000) value was significant and implies the strong explanatory power of the model. The best outcome was harvesting and its choice may be borne out of the fact that almost all cassava farmers partake in this tasks since it is less tedious of all the cassava production operations. Findings reveal that the coefficient of education was negative and significantly influence labour participation in bush clearing, cultivating and weeding at the 5%, 1%, and 10% probability levels, respectively. The coefficient of their marginal effect implied that increasing educational attainment of cassava farmers will reduce their participation in clearing, cultivating and weeding by 0.3%, 0.4%, and 0.24% respectively. This is expected because high educational attainment increases farmer's chances of securing alternative employment outside the farm. Bassey et al (2014) reported that higher educational attainment increases participation in off- farm work. The insignificant influence of education on labour participation on planting is preferred in that cassava planting is the easiest tasks compared to clearing, cultivating and weeding. As such educated farmers can easily allocate part of their time to planting after returning from their official duties. In South Africa, Anim (2017) had affirmed a negative relationship between education and farm labour supply while Fard and Basit (2011) reported a positive relationship.

The coefficient for marital status was positive and significantly influences labour participation in planting and weeding at 10 and 1% level of probability respectively. Their estimated marital effect coefficient indicated that a 10% variation in marital status will increase participation in planting and weeding by 1.7 and 0.4% respectively. The pleasurable fructification for this is that these are two cassava production operations that are mostly undertaken and dominated by women. Hence, number of married respondents which translate into more women for cassava planting and weeding. This finding corroborates that of Anim (2017) in South Africa. The abundant women in the study area participated fully in these production operations. The negative and significance of the variable for clearing and cultivation conflicts with Anim (2017) while the positively significant relationship with planting and weeding agrees with his findings.

Table 2: Determinants of labour participation for different cassava production operations

Variables	Clearing	Cultivating	Planting	Weeding
Education	-0.0242	-0.0538	-0.0172	-0.0374
	(-2.24)**	(3.35)(-	(0.22)	(1.98)**
	(-0.0332)	0.0474)	(-0.0012)	(-0.0242)
Farming experience	0.8943	-1.826	3.162	0.0684
	(1.113)	(-0.08)	(0.52)	(0.38)
	(0.0728)	(-0.0645)	(0.0036)	(0.0142)
House hold size	1.3681	0.047	0.133	0.3262
	(2.45)**	(3.82)***	(0.77)	(1.42)
	(0.2110)	(0.0116)	(0.0811)	(0.0632)
Total annual income	-4.665	-5.904	7.877	-2.3262
	(1.92)	(0.004)	(2.322**)	(1.11)
	(-0.0048)	(0.1038)	(-0.0035)	(-0.0312)
Age of farmer	0.037	0.3890	0.096	-0.0143
	(0.421)	(1.104)	(0.811)	(0.231)
	(-0.0382)	(0.1038)	(0.0242)	(0.0023)
Marital status	0.037	-0.017	0.874	2.194
	(0.43)	(1.04)	(1.88)*	(4.14)***
	(0.0845)	(-0.0056)	0.1739)	0.0408)
Sex	-0.4062	-6.883	1.494	3.36
	(2.26)**	(1.78)*	(2.03)**	(1.94)*
	(-0.0602)	(-0.1752)	(0.4605)	(-0.0397)
Farm distance	-0.2458	-1.9786	-0.6466	-2.638
	(2.78)**	(1.85)*	(-0.006)	(3.93)***
	(-0.0415)	(-0.0949)	(0.06295)	(-0.0412)
Constant	0.3972	2.516	1.582	-3.754
	(0.17)	(0.56)	(0.41)	(1.22)
LR Chi2=58.66*** ,				
Pseudo R^2 = 0.626				
Log = -88.342				

Source: Field Survey, 2020. ****, ** and * represent significant at 1%, 5% and 10% respectively.*

CONCLUSION

The role of women in cassava production is quite dominant and prominent. Their relevance and significance, therefore, cannot be overemphasized. This study analysed gender-based farm labour participation in cassava crop production in Ebonyi state. From the study, it was established that more women were involved in cassava production operations than men presumably because of men migration out of agriculture. Findings also revealed that gender participation for different cassava production operations were influenced by farmers' socio economic characteristics. The study therefore concludes that effort directed towards boosting labour supply should be tailored towards addressing male migration out of farming and related activities in the study area. Thus, it is recommended that basic rural infrastructural facilities should be provided to enhance the life of rural dwellers and discourage rural-urban drift. Besides, favourable agricultural production policies should be evolved to boost farm income and make agriculture more lucrative in the study area.

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