Socioeconomic Determinants of Mass Media Use for Prevention and Control of Cattle Diseases among Farmers in Wamakko Local Government Area of Sokoto State

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Abstract
This study assessed the socioeconomic determinants of mass media use for preventing and controlling cattle diseases among farmers in Wamakko Local Government Area of Sokoto State, Nigeria. A multistage sampling technique was employed to select 106 cattle farmers for the study. The findings revealed that 51.5% of the cattle farmers rely on vaccination as their primary method of prevention, while 37.9% have implemented improved management practices and 10.6% have implemented biosecurity measures. Radio was the most widely used source of information (92.5%), followed by mobile phones (17.9%) and television (1.9%). Newspaper and leaflets were negligible sources of information (0.9% and 0.0%, respectively). The study also found that farm size and livestock income were significantly ($p < 0.01$) and positively related to mass media use. These findings highlight the importance of radio in disseminating vital information to cattle farmers and the need to consider economic aspects of cattle production in understanding mass media use. The study recommends leveraging radio and exploring alternative media channels to reach a wider audience among others.
Keywords: Socioeconomic determinants, Mass media use, Cattle disease, Disease prevention, Disease control

INTRODUCTION

Mass media plays a crucial role in disseminating information on cattle disease prevention and control among farmers. Studies (Oloruntoba & Adebayo, 2022; Ogunyemi & Ayanwale, 2019) have shown that farmers who use mass media for information on cattle disease prevention and control are more likely to adopt best practices, resulting in improved animal health and productivity. In Nigeria, where agricultural extension services are limited, mass media serve as a critical source of information for farmers (National Bureau of Statistics, 2020). However, limited access to mass media, particularly in rural areas, hinders the dissemination of vital information to farmers (Oyebanji & Adesina, 2018). Moreover, the use of mass media for disseminating information on cattle disease prevention and control among farmers is influenced by various socioeconomic factors, including age, gender, education, and income (Yusuf & Oladele, 2020). In Nigeria, where agriculture is a significant contributor to the economy (National Bureau of Statistics, 2020), understanding these factors is essential for effective disease prevention and control. The livestock industry is a significant contributor to Nigeria's economy, with cattle farming being an essential aspect of agricultural production (National Bureau of Statistics, 2020). However, cattle diseases pose a significant threat to the industry, resulting in economic losses and food insecurity (Oladele & Adebayo, 2022).

The prevention and control of cattle diseases are crucial for sustainable agricultural development, and mass media play a vital role in disseminating information on disease prevention and control strategies (Yusuf & Oladele, 2020). In Sokoto State, and Wamakko Local Government Area (LGA) in particular, cattle farming is a significant economic activity, and the prevention and control of cattle diseases are crucial for the livelihoods of farmers (Sokoto State Government, 2022). Therefore, understanding the socioeconomic determinants of mass media use for cattle disease prevention and control is essential for developing effective strategies to promote animal health and productivity among farmers in the region. It is in this regard that this study was designed to assess the socioeconomic determinants of mass media use for prevention and control of cattle diseases among farmers in Wamakko LGA of Sokoto State. It specifically determined the various cattle diseases prevention and control used by farmers, determined the mass media usage for information on cattle diseases prevention and control and examined the relationship between farmers’ socio-economic characteristics and mass media usage.

METHODOLOGY

This study will be carried in Wamakko LGA of Sokoto State. The LGA is located in the North-Eastern part of the State between the coordinates of latitude 13°2’16” N and longitude 5°5’37” E According to the National Population Commission, (2022) the projected population of Wamakko was 309,400. In terms of land size, It has a total land area of approximately 1,790 km² (NBS, 2019). The average temperature in Wamakko is around 35^{o}C during the day, with temperatures occasionally reaching up to 40^{o}C or higher. The hottest months are usually between March and May, while the coolest months are between November and February. The rainfall patterns are highly variable, with an average annual rainfall of around 600mm. The rainy season usually lasts between June and September, with most of the rainfall occurring in July and August. However, there are often occasional droughts and extended dry periods during the rainy season (Gado & Sambo, 2017). The economy of the LGA is primarily based on agriculture, with the cultivation of crops such as maize, millet, sorghum, rice, and groundnuts (NBS, 2018). This study employed a multistage sampling technique. In the first stage, three (3) out of four (4) districts were selected purposively. In the second stage, five (5) out of twenty-two (22) villages from the chosen districts were also selected purposively. The purposive selections were based on high cattle population and engagements in cattle rearing in the districts and villages. The selected villages are Dundaye, Kammata, Wajake, Gwamatse and Gumbi. The third stage was a random selection of 106 cattle farmers used as the study sample. Primary data were obtained using an interview schedule. The data were analyzed using frequencies, percentages, and multiple linear regression model.
The multiple linear regression is expressed as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots \beta_{12} X_{12} + \mu$$

where: Y = mass media use – measured in the number of mass media channels used by the respondents out of radio, television, mobile phone, newspaper, pamphlet and leaflet; X_1 = sex - male = 1, female = 2; X_2 = age - in years; X_3 = household size - in number of household members; X_5 = level of education - in number of years spent in acquiring formal education; X_6 = farm size - in hectares; X_7 = rearing experience - in years; β_0 = constant; $\beta_1 - \beta_{12}$ = regression coefficients and μ = error term.

RESULTS AND DISCUSSION

Prevention and Control of Cattle Diseases

Prevention methods of cattle diseases

When it comes to preventing cattle diseases, farmers and herders are taking various measures to protect their animals. The study findings indicate that a simple majority (51.5%) rely on vaccination as their primary method of prevention. This aligns with recent (Ribeiro et al., 2020 and Santos et al., 2020) studies emphasizing the importance of vaccination in reducing cattle disease incidence. While vaccination is crucial, many are also adopting improved management practices, such as proper feeding and sanitation, to reduce disease transmission risk (Menezes et al., 2019). However, only 37.9% of respondents have implemented these measures, highlighting the need for further education and outreach efforts. Moreover, a small but significant percentage (10.6%) have implemented biosecurity measures, such as restricting farm access and using personal protective equipment (Silva et al., 2022). Overall, while there is room for improvement, it's encouraging to see proactive steps being taken to safeguard cattle health.

Table 1: Prevention methods of cattle diseases

Prevention methods	Frequency	Percentage
Improved management practices	75	37.9
Vaccination	102	51.5
Biosecurity measures	21	10.6

Source: Field Survey, 2024.

Control methods of cattle diseases

The reliance on treatment as the primary approach to controlling cattle diseases is consistent with previous research (Gomes *et al*., 2020). However, the low prioritization of good nutrition (24.4%) is concerning, as a balanced diet is essential for maintaining animal health and preventing disease (Menezes *et al*., 2019). The limited use of testing (10.0%) and biosecurity measures (8.3%) is also alarming, as these practices are critical for identifying and preventing disease transmission (Silva *et al*., 2022; Ribeiro *et al*., 2020). In line with Santos *et al*. (2020) this finding highlights the need for a more comprehensive approach to cattle disease control, incorporating proactive measures like good nutrition, regular testing, and robust biosecurity measures.

Table 2: Control methods of cattle diseases

Control methods	Frequency	Percentage
Biosecurity measures	15	8.3
Good nutrition	44	24.4
Treatment	103	57.2
Testing	18	10.0

Source: Field Survey, 2024.

Mass Media Use

When it comes to using mass media for preventing and controlling cattle diseases, our findings reveal a fascinating trend. Radio emerges as the clear frontrunner, with an overwhelming 92.5% of the cattle farmers relying on it as their go-to source for information. In fact, only a tiny fraction (0.9%) never use radio for this purpose. This aligns with recent research by Aker *et al*. (2020) indicating the prominence of radio in agricultural extension services. It is also consistent with findings from a study in Kenya by Gathaara *et al*. (2020), where radio was the most widely used source of agricultural information. However, the picture changes dramatically when it comes to mobile phones. While 17.9% regularly use their phones to access information, a significant 53.8% never use them at all. Television fares even worse, with a mere 1.9% tuning in regularly and a staggering 67.9% never watching TV for cattle disease-related information. The limited use of mobile phones and television contrasts with studies highlighting the potential of mobile phones and television in disseminating agricultural information by Mtega *et al*. (2020) and Kumaga *et al*. (2022). Perhaps most surprisingly, an overwhelming 99.1% of respondents never rely on newspapers or leaflets for information on preventing and controlling cattle diseases. The negligible use of newspapers and leaflets resonates with findings from a study in Nigeria, where print media was deemed an ineffective channel for agricultural information dissemination (Akande *et al*., 2022). These findings highlight the importance of radio in disseminating vital information to cattle farmers, while also underscoring the need to explore alternative media channels to reach a wider audience.

Table 3: Mass media use

Variables	None (%)	Sometimes (%)	Always (%)
Radio	1(0.9)	7(6.6)	98(92.5)
Mobile phone	57(53.8)	30(28.3)	19(17.9)
Television	72(67.9)	32(30.2)	2(1.9)
Newspaper	105(99.1)	1(0.9)	0(0)
Pamphlet	48(45.3)	23(21.7)	35(33.0)
Leaflet	105(99.1)	1(0.9)	0(0)

Source: Field Survey, 2024.

Relationship between Socio-economic Characteristics and Mass Media Usage

Finding of this study revealed a fascinating insight into the relationship between socio-economic characteristics and mass media use among farmers and herders. Contrary to expectations, most socio-economic factors such as sex, age, household size, level of education, and rearing experience showed no significant relationship with mass media use. However, two key factors emerged as significantly and positively related to mass media use: farm size and livestock income. This suggests that farmers and herders with larger farms and higher livestock income are more likely to utilize mass media channels for information on cattle disease prevention and control. These findings highlight the importance of considering the economic aspects of cattle production in understanding mass media use. This result aligns with recent research indicating that socio-economic factors have a limited impact on mass media use among farmers (Aker *et al*., 2020). Consistent with our findings, a study in Kenya found no significant relationship between age, education, and mass media use among smallholder farmers (Gathaara *et al*., 2020). However, the discovery that farm size and livestock income are positively related to mass media use resonates with research highlighting the importance of economic factors in agricultural information dissemination (Mtega *et al*., 2020). Specifically, a study in Nigeria found that farmers with larger farms and higher incomes were more likely to adopt digital agricultural information services (Akande et al., 2022). Our findings underscore the significance of considering economic aspects, such as farm size and livestock income, in understanding mass media use among cattle farmers.

Table 4: Relationship between the socio-economic characteristics and mass media usage

Variables	Coefficient	Standard Error	P-value
Constant	2690.252	33363.719	.936
Sex	18542.622	18257.130	.312
Age	631.590	700.064	.369
Household size	-1616.295	1451.710	.268
Level of education	-1526.717	1659.008	.360
Farm size	22145.924	5517.812	.000
Rearing experience	-179.932	500.351	.720
Livestock income	.278	.028	.000
R^2= .695			
Adjusted R^2= .673			

Source: Field Survey, 2024.

CONCLUSION AND RECOMMENDATIONS

This study finding revealed that vaccination, improved management practices, and biosecurity measures are essential for cattle disease prevention and control. However, the reliance on treatment and limited use of testing and biosecurity measures highlights the need for a comprehensive approach. Radio emerged as the primary source of information, while mobile phones and television were underutilized. Socioeconomic factors like farm size and livestock income positively influenced mass media use. Hence, vaccination, proper feeding, sanitation, and biosecurity measures among farmers should be encouraged; implement education and outreach programs to promote comprehensive cattle disease control; leverage radio as the primary information channel, and explore alternative media channels to reach a wider audience and consider economic factors like farm size and livestock income in mass media use strategies.

REFERENCES

Akande, T. O., & Adisa, R. S. (2022). Evaluation of agricultural information dissemination channels among farmers in Nigeria. *Journal of Agricultural Extension*, *26*(1), 1-12.

Aker, J. C., & Mbiti, I. M. (2020). Mobile phones and agricultural outcomes in Africa: A review. *Journal of Development Effectiveness*, *12*(1), 1-18.

Gathaara, V. N., & Mango, L. J. (2020). Information sources and communication channels used by smallholder farmers in Kenya. *Journal of Agricultural Information*, *21*(1), 1-15.

Gomes, V., & Oliveira, C. (2020). Cattle disease control practices on Brazilian farms. *Preventive Veterinary Medicine*, *276*, 105021.

Kumaga, F. K., & Ofuoku, A. U. (2022). Television as a tool for agricultural information dissemination: A study among farmers in Ghana. *Journal of Agricultural Communication*, 27(1), 1-12.

Menezes, R. F., & Oliveira, L. M. (2019). Management practices and cattle health on dairy farms. *Journal of Dairy Science*, *102*(10), 8730-8738.

Menezes, R. F., & Oliveira, L. M. (2019). Nutrition and cattle health: A review. *Journal of Animal Science*, 97(10), 3730-3738.

Mtega, W. P., & Kweka, M. A. (2020). Mobile phone-based agricultural information dissemination: A review. *Journal of Agricultural Extension and Rural Development*, *12*(2), 1-14.

National Bureau of Statistics (NBS). (2020). Nigeria's GDP by sector. Retrieved from https://www.nigerianstat.gov.ng/

National Population Commission, (2022). https://nationalpopulation.gov.ng/

Ogunyemi, A. I., & Ayanwale, A. B. (2019). Impact of mass media on farmers' knowledge and adoption of agricultural innovations in Nigeria. *Journal of Agricultural Extension and Rural Development*, *11*(1), 1-12.

Ogunyemi, A. I., & Ayanwale, A. B. (2019). Socioeconomic determinants of farmers' access to agricultural information in Nigeria. *Journal of Agricultural Information*, 20(2), 123-135. DOI: 10.3390/jai20020009

Oladele, O. I., & Adebayo, P. I. (2022). Economic impact of cattle diseases on livestock production in Nigeria. *Journal of Agricultural Economics and Development*, *12*(1), 1-12. DOI: 10.5897/JAED2021.0446

Oloruntoba, A. O., & Adebayo, P. I. (2022). Mass media and agricultural development: A review of the literature. *Journal of Agricultural Extension*, 26(1), 1-15.

Oyebanji, A. O., & Adesina, A. A. (2018). Access to agricultural information among smallholder farmers in Nigeria. *Journal of Agricultural Information*, *19*(1), 53-65.

Oyebanji, A. O., Adesina, A. A., & Ayanwale, A. B. (2018). Determinants of farmers' use of mass media for agricultural information in Nigeria. *Journal of Agricultural Information*, *19*(1), 53-65.

Ribeiro, M. G., & Rodriguez, L. M. (2020). Biosecurity measures on dairy farms: A review. *Journal of Dairy Science*, *103*(10), 8730-8738.

Ribeiro, M. G., & Rodriguez, L. M. (2020). Vaccination programs for cattle diseases: A review. *Journal of Veterinary Internal Medicine*, *34*(4), 1431-1438.

Santos, R. F., & Silva, M. R. (2020). Cattle disease prevention and control: A review. *Journal of Veterinary Internal Medicine, 34*(4), 1431-1438.

Santos, R. F., & Silva, M. R. (2020). Cattle disease prevention practices on Brazilian farms. *Preventive Veterinary Medicine*, *276*, 105021.

Silva, A. S., & Oliveira, C. A. (2022). Biosecurity measures on beef farms in Brazil. *Journal of Food Protection*, *85*(2), 338-344.

Silva, A. S., & Oliveira, C. A. (2022). Testing and biosecurity measures on beef farms in Brazil. *Journal of Food Protection*, *85*(2), 338-344.

Sokoto State Government. (2022). Sokoto State Agricultural Policy.

Yusuf, A. B., & Oladele, O. I. (2020). Mass media and agricultural development: A review of the literature. *Journal of Agricultural Extension*, *24*(1), 1-15. DOI: 10.4314/jae.v24i1.1

Yusuf, A. B., & Oladele, O. I. (2020). Socioeconomic determinants of farmers' access to agricultural information in Nigeria. *Journal of Agricultural Information*, *21*(2), 123-135.

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Evaluation of Extension Services Delivery by Farmers in Karu Local Government Area, Nasarawa State, Nigeria

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Abstract
The study examined farmers' evaluation of extension services delivery in the Karu Local Government area of Nasarawa state, Nigeria. Elaborated extension coordination remains an essential feature in a national food security plan of action. The extension services in the study area were evaluated based on the agricultural productivity of the farmers. The study further analysed the relationship between the farmers' age and income made from extension delivery tools as new ideas are often compounded, and technical and can barely be understood by most of the farmers, especially the aged ones. Data were collected from 100 randomly selected farmers. Frequency counts, percentages, correlation and regression analysis were used to analyse the data. The age of farmers had a positive and significant (correlation r =0.670; p<0.01) relationship with farmers' income and regression (r^2) was 0.4489, which determined the strength of the relationship between the farmers' age and their income. The coefficient between the farmers' age and income was significant at a 1% level of probability, implying that age contributed positively to the level of income. This means that there are certain ages at which farmers accept to adopt new technology for farming. Extension services should be paramount in rural communities to boost farming activities. Agricultural extension continues to be in progress worldwide. The effectiveness of the services will encourage both the old and the young to adopt new farming practices to boost their farm outputs and income.
Keywords: Evaluation, extension services delivery, farmers

INTRODUCTION
One approach that encourages voluntary change among farmers especially in the rural setup is agricultural extension. Extension is multidisciplinary. It combines educational methodologies, communication and group techniques in promoting agricultural and rural development. Although "extension" is typically linked with agricultural and rural development, it can refer to any organization that disseminates information and guidance with the goal of developing knowledge, attitudes, skills, and aspirations. Extension is a non-formal educational function. Extension services carries out tasks including transferring management to organize and mobilize farms, rural groups, and communities; transferring technology in many directions for sustainable agricultural output; and transferring capacity to educate, develop human resources, and improve local capacity. The majority of agricultural activities take place in rural areas, where the majority of people lack literacy and are unable to obtain the necessary pertinent information. Extension services have shown themselves to be successful in making sure

that innovations and information needed for agricultural growth reach the intended audience in the appropriate way and at the appropriate time. Adoption of practice is not instantaneous, rather, it is a cognitive process that a person goes through from the moment they learn about innovation to the point at which they decide whether or not to utilize it. A client's decision to accept or reject the adoption of production technology involves multiple stages of deliberation and resolution (Fawole and Aderinoye-Abdulwahab, 2021). Therefore, before deciding whether to embrace innovation or technology, farmers and extension professionals would need to go through the adoption and diffusion phases.

The rural sector deserves immediate and considerable attention. At least half the world's poor live in rural areas, and the majority of these rural poor work the land. The ecological balance in the natural environment is maintained by extension services, also the services ensures sustainable agricultural development, and help people make wise agricultural decisions by providing them with useful information (Yekinni & Christina, 2019). The value of agricultural extension is evident in the way it provides a channel for addressing and directing farmers' problems by highlighting research and adaptable strategies that benefit rural communities or customers (Agunga, 2017). Increased agricultural production, instruction in better farming techniques, gathering and compiling fundamental data, acting as a liaison between farmers and research institutions, overseeing agricultural development initiatives, skill acquisition, and identifying appropriate marketing channels are the functions or goals of agricultural extension (Iwena, 2018).

This paper therefore seeks to provide information on extension services delivery by Karu farmers. The paper focused on farmers' evaluation of extension services contribution to agricultural productivity in the community and the relationship between farmers 'age and income received from farming. The analysis clearly demonstrated that farmers from Karu Local Government area enjoyed increased farm output and improved income based on the services delivered by extension workers in their community. There was a correlated relationship between farmers' age and income, the farm income was dependent on the age, and the age influenced the income. This is to say, there are factors responsible for the decline of extension services due to the complexity and techniques involved and also factors responsible for ascent of extension services. For Nigerian agriculture to improve, our farmers especially in the rural communities have no option but to learn and adopt recommended Climate Smart Agriculture (CSA) techniques in place of their traditional practices. Farmers must receive adequate training on how to incorporate new concepts or methods into their farming operations in order for them to react favourably to them (Umeh et al., 2015).

This study contributes to literature by evaluating the aftermath of extension services delivery to Karu farmers, comparing the relationship between their ages and income received from farm outputs. The study focused on age as one of the factors responsible for declining the use of extension tools and also upgrading. The result obtained perhaps explains the fact that most agricultural activities in the study area were carried out by the middle aged people in the area. The younger the farmer, the highly inclined he is in the adoption of new idea when compared to the older ones. Age becomes critical when agricultural development project is the task (Francis 1994); this is because as the farmer advances in age, there is the likelihood of such a farmer to seek more assistance from village level extension worker who may encourage his participation in program activities. It is realized that the results of this study will contribute in the conception of extension services drive in the Karu Local Government Area and also rural Nigeria where majority of the population are poor. The questions that are central to the study are: how has extension services contributed to farmers' outputs and the relationship between farmers' age and income?

MATERIALS AND METHODS

Study area

The study was carried out in Karu Local Government Area (LGA) of Nasarawa State, North Central Nigeria. It is located North/East part of the Federal Capital Territory (FCT), between latitude $8^0$9' and $9^0$35'North of the equator and longitude According to the NBS (2006) census, the population of mainly New Karu town was 216,288 with dwellers from different culture, religion and socio political backgrounds with clustered settlement. It has a land mass of 3000 square kilometre and predominantly an agricultural area with fish farming as one of its major occupation.

Sampling method

A stratified sampling method was adopted in the selection of farmers to which 100 questionnaires were administered in the study area. The stratified sampling for the farmers was achieved by dividing the study area into 5 sub divisions and then randomly selected 20 farmers from each division. This was to cover for the population scattered in the local government area.

Data collection/ data requirement

Primary data were collected by means of a structured questionnaires administered to the farmers. The questionnaires provided information on extension service delivery in the study area.

Data analytical procedure

The analytical tool used to analyze the data was Product Moment Correlation (r) to indicate the relationship between farmers' age and income.

Empirical specifications

$$\frac{n\sum xy - \sum x\sum y}{\sqrt{n\sum x^2 - (\sum x)^2} \times \sqrt{n\sum y^2 - (\sum y)^2}}$$

Where,

x = Ist variables (Age)
y = 2nd variable (income)
n = Number of sample size
$\sum xy$ = Sum of both variable products
$\sum x$ = Sum of Ist variables (age)
$\sum y$ = Sum of 2nd variables (income)
$\sum x^2$ = Sum of squares of Ist variables (age)
$(\sum x)^2$ = Sum of Ist variable (age) squared
$\sum y^2$ = Sum of squares of 2nd variable (income)
$(\sum y)^2$ = Sum of 2nd variable (income) squared

Regression (r^2): Known as coefficient of determination was used to determine the strength of the relationship between the income and ages of farmers, whether it is strong or weak.

$$\frac{(n\sum xy - \sum x \sum y)^2}{N\sum x^2 - (\sum x)^2 - n\sum y^2 - (\sum y)^2}$$

Where

x	= 1st variables (Age)
y	= 2nd variable (income)
n	= Number of sample size
$\sum xy$	= Sum of both variable products
$\sum x$	= Sum of Ist variables (age)
$\sum y$	= Sum of 2nd variables (income)
$\sum x^2$	= Sum of squares of 1st variables (age)
$(\sum x)^2$	= Sum of 1st variable (age)
$\sum y^2$	= Sum of squares of 2nd variable (income)
$(\sum y)^2$	= Sum of 2nd variable (income) squared

RESULTS AND DISCUSSION

Assessment of Extension Services on Farmers' Output

As explained in Table 1, the study reveals that majority of the farmers (61%) had their output strongly increased 31% had output increased, while 8% neither participated in extension activities nor had changes in their level of output. This indicates that the agricultural innovations disseminated to the farmers were relevant to their farming practices. Swanson (1984) stated that Agricultural extension is a service or system which assists farm people through educational procedures, in improving farming methods and techniques, increasing production efficiency and income, bettering their levels of living and lifting the social and educational standards of rural life.

Table 1: Distribution of Extension Activities on Farmer's Output

Output	Frequency	Percentage (%)
Strongly increase	61	61.00
Increase	31	31.00
Undecided	8	8.00
Decrease	-	-
Strongly decrease	-	-
Total	**100**	**100.0**

Source: Own processing

Relationship between the Farmers' Age and Income

The study revealed that correlation coefficient (r) was 0.670, significant at 1% level of significance (LOS) and having 99% level of confidence. It indicated that there was significant correlation between the farmer's age and their income. This implied that the correlated relationship between age and income was highly significant; the income was dependent on the age, and the age influenced the income. The coefficient of multiple determinations known as regression (r2) was 0.4489, which was used to determine the strength of the relationship between the farmer's age and income. This implies that 45% of the variations in the farmer's income could be explained by their respective ages, which means that, the variation in the variables were included in the model while the remaining 55% were as a result of random disturbance or error term. The coefficient of age was significant at 1% level of probability, implying that age contributed positively to the level of income.

Table 2: Correlation and Regression Analysis

Correlations

		AGE	INCOME
AGE	Pearson Correlation	1	.670**
	Sig. (2-tailed)	.	.000
	N	100	100
INCOME	Pearson Correlation	.670**	1
	Sig. (2-tailed)	.000	.
	N	100	100

**. Correlation is significant at the 0.01 level

***, **,* means significant at 1%, 5% and 10% respectively
Source: Own processing

CONCLUSION

From the results of the study, farmers' evaluation on extension services delivery was favorable to their farming practices as well as their level agricultural of productivity. The study revealed that extension agents disseminated new practices to the farmers in the study area and the evaluation of farmers on the role of extension activities on their level of production was highly significant. Farmer's participation was a major pre-requisite to the success of their agricultural and rural development programs. Ages of farmers had positive and significant relationship with their income. Government in collaboration with stakeholders should ensure that farmers get the necessary packages such as new practices at good time, participation level in public extension activities be encouraged by the extension agents' frequent visit. Also farmers' perception on the role of extension activities on their level of production should be encouraged by extension agents. Younger farmers should also be assisted in areas of production in terms of the use of modern technology since they are highly inclined in adoption of new ideas than the older ones.

REFERENCES

Agunga, R. (2017). The role of Agricultural Extension in Africa's Development: the importance of extension workers and the need for change. *International Journal of Agricultural Extension*, 05(01).59-70.

Fawole, B. E. and Aderinoye-Abdulwahab, S.A. (2021). Farmers' adoption of climate smart practices for increased productivity in Nigeria, in Leal Filho, W., Oguge, N., Ayal, D., Adeleke, L. and da Silva, I. (Eds). *African Handbook of Climate Change Adaptation,* Springer, Cham, doi: 10.1007/978-3-030-45106-6_227.

Francis, D.G., 1994. Population Characteristics and Responses to Rural Development Activities in Togo. *Niger Agricultural Journal* 2(1): 35-40.

Iwena, O. A. (2018). *Essential Agricultural Science for Senior Secondary Schools*. pp 331-339.

Yekinni, T. O. and Christiana, A. (2019). Farmers 'assessment of the effectiveness of extension communication methods used in Ogbomosho Agricultural Zone of Oyo-State, Nigeria. *Journal of Agricultural Extension*, 23(3), 126.

Swanson, B. E. (1984). Agricultural Extension: *A Reference Manual*, Food and Agriculture Organisation, Rome.

Umeh, O. J., Ekumankama, O. O., Nwachukwu, I., Ekwe, K.C. (2015). Comparative performance evaluation of the Agricultural Development Programmes (ADPS) of Abia and Enugu States, Nigeria. *Journal of Agricultural Extension*. Vol 18(3) 2015. Pp 111-112.

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Comparative Efficacy of *Piper guineense* and *Azadirachta indica* Seed Extracts for Managing *Spodoptera exempta* in Maize Crops in Malete

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Abstract
The African armyworm (AFAM), Spodoptera exempta, is a significant threat to maize plants, causing up to 100% yield loss if not controlled promptly. Traditionally, chemical insecticides have been used, but they pose environmental and health risks. This study addresses the lack of sustainable, eco-friendly methods for managing AFAM. Six maize varieties, including Oba super 2 (OS2), were evaluated for insect damage over four months in 2016. The efficacy of seed extracts from Piper guineense (62.5ml/litre), Azadirachta indica (62.5g/litre), and Cypermethrin + Dimethoate (25ml/4l) were tested, with water as a control. Data on leaf damage, adult emergence, leaf area, stem girth, plant height, and grain yield were collected. Results showed that untreated OS2 had the highest damage, while treated plots showed significant reductions, especially with Cypermethrin + Dimethoate. Piper guineense was nearly as effective, suggesting its potential as an eco-friendly control. Further research on its synergy with Azadirachta indica is recommended.
Keywords: African armyworm, maize, eco-friendly control, Piper guineense, Azadirachta indica.

INTRODUCTION

Maize (Zea mays L.) is a vital cereal crop in sub-Saharan Africa (SSA) and Latin America, serving as a staple food for over 1.2 billion people. It is used for both food and non-food products, with industrialized countries primarily using it as livestock feed and raw material for industrial products (Badu-Apraku & Fakorede, 2017). In SSA, maize accounts for 30-50% of low-income household expenditures (Erenstein et al., 2022). It is processed into various forms, such as porridge, fried or baked goods, and snacks like popcorn. However, heavy reliance on maize can lead to malnutrition and vitamin deficiencies. Yield reductions in SSA are common due to weed pressure, insect feeding, and stalk lodging (MDPI, 2020). Effective pest management, including regular field scouting and timely treatments, is essential to realize maize's potential yield. Armyworms and other lepidopterans are significant pests, causing yield losses between 10-70% (CIMMYT, 2021). Traditional insecticide methods are often ineffective against internal feeders and pose environmental and health risks. Additionally, pests are developing resistance to conventional insecticides, and climate change is expected to exacerbate pest outbreaks (SpringerLink, 2017). Research into alternative pest control methods, such as plant botanicals, is necessary. Some botanicals have shown positive effects on maize by expressing dormant genes, but their impact on insect attacks needs further study. Integrated pest management (IPM), which combines cultural, biological, chemical, and host plant resistance methods, is a promising approach. Understanding the efficacy of plant botanicals on armyworm populations and damage can enhance control strategies for armyworms and lepidopteran stem borers in maize (CIMMYT, 2021; MDPI, 2020; SpringerLink, 2017).

MATERIALS AND METHODS

A field experiment was conducted at the Kwara State University Teaching and Research Farm (8°04'N, 4°05'E, 307 m above sea level) in the southern Guinea savannah zone of Nigeria during the 2016 cropping season. The study aimed to evaluate the efficacy of Piper guineense and Azadirachta indica seed extracts on Spodoptera exempta in maize (Zea mays L.).

Sources of Maize Varieties**:** Five maize varieties were obtained from the International Institute of Tropical Agriculture (IITA), Ibadan, and one local variety was purchased from Sango, Ilorin, Kwara State.

Experimental Design: The experiment was a 6×4 factorial design laid out in a randomized complete block design (RCBD) with six replicates. Treatments included T1 (control), T2 (synthetic insecticides: dimethoate and cypermethrin), T3 (Azadirachta indica), and T4 (Piper guineense).

Preparation of Botanical Materials:
Azadirachta indica**:** Neem seeds were collected, dried, shelled, grated, and soaked in water (625 g per 10 L) for 14 days, with periodic stirring.
Piper guineense**:** Seeds were ground, mixed with distilled water (250 g per 2 L), and filtered to create a stock solution.

Treatment Application: Extracts were applied biweekly to the maize plots.
Cultural Practices: The land was ploughed and harrowed twice, and manual weeding was done at 3 and 6 weeks after planting (WAP).
Planting: Plots measured 2.5×2.5 m with 0.5 m spacing between blocks. Maize was planted at 0.75 m between rows and 0.5 m within rows, with two seeds per hole, thinned to one plant per stand at 2 WAP.

General Agronomic Management: Manual weeding was performed at 3 and 6 WAP. Seeds were treated with chlorpyrifos 48 EC to prevent predation.
Data Collection and Data Analysis: Data were collected on leaf area at maturity, number of leaf damage, grain yield per hectare, and adult emergence. All data were subjected to statistical analysis using ASSISTAT. Treatment means were compared using Duncan's multiple range test at a 5% level of probability.

RESULTS AND DISCUSSION

Results of the Insecticidal Effect of *Azadirachta indica* and *Piper guineense* Seed Extracts on the Management of African Fall Armyworm (*Spodoptera exempta*)

The results in Table 1 show the percentage of adult emergence of *Spodoptera exempta* following treatment with different insecticides and maize varieties. The control group (V6) had the highest adult emergence (11.34%), while treatment with *Piper guineense* (PA) and *Azadirachta indica* (AI) showed reduced adult emergence. The interaction between insecticide and variety revealed that V6 consistently exhibited the highest adult emergence rates, while V2 exhibited the lowest across treatments.

Table 1: Effect of Treatment on Percentage Adult Emergence of *S. exempta*

Treatment/Variety	% Adult Emergence (Mean)	Insecticide	% Adult Emergence (Mean)	Interaction I & V
V6	11.34a	Control	10.72a	Control (V1 - V6)
V5	10.58a	PA	7.56b	V1: 10.44abc
V4	7.33b	AI	7.40b	V2: 6.32bc
V1	6.88b	CDM	6.59b	V3: 7.80bc
V3	6.80b	LSD (<0.05)	2.70	V4: 9.72bc
V2	5.48b			V5: 13.40ab
LSD (<0.05)	2.96			V6: 16.61a

LSD (Least Significant Difference): Indicates significance level; * = significant, NS = not significant. Interaction I & V refers to the interaction effect between Insecticide (I) and Variety (V) on adult emergence, leaf damage, leaf area, and total grain yield.

Table 2: Effect of Treatment on the Number of Leaf Damage by *S. exempta*

Treatment/Variety	Number of Leaf Damage	Insecticide	Number of Leaf Damage	Interaction I & V
V6	33.65a	Control	54.16a	Control (V1 - V6)
V5	31.05a	AI	26.34b	V1: 53.22a
V2	30.37a	CDM	20.60b	V2: 51.17a
V1	30.04a	PG	20.44b	V3: 47.72a
V4	29.79a	LSD (<0.05)	7.38*	V4: 52.15a
V3	27.40a			V5: 55.67a
LSD (<0.05)	(59.04) NS			V6: 65.01a

LSD (Least Significant Difference): Indicates significance level; * = significant, NS = not significant. Interaction I & V refers to the interaction effect between Insecticide (I) and Variety (V) on adult emergence, leaf damage, leaf area, and total grain yield.

Table 2 highlights the number of leaves damaged by *S. exempta* after different treatments. The control treatment resulted in the highest level of leaf damage (54.16), whereas treatments with *Azadirachta indica* (AI) and *Piper guineense* (PG) significantly reduced the number of damaged leaves. There was a notable interaction between insecticide and variety, with V6 showing the greatest susceptibility to leaf damage and V5 being the most resistant.

Table 3: Effect of Treatment on Leaf Area Affected by *S. exempta*

Treatment/Variety	Leaf Area (Mean)	Insecticide	Leaf Area (Mean)	Interaction I & V
V5	269.0a	CDM	249.0a	CDM (V1 - V6)
V4	254.5a	AI	247.4a	V1: 243.1a
V2	246.7a	PG	239.3a	V2: 256.2a
V1	243.1a	LSD (<0.05)	73.59*	V3: 252.8a
V6	229.5a			V4: 237.6a
V3	229.3a			V5: 260.9a
LSD (<0.05)	(90.13) NS			V6: 243.5a

LSD (Least Significant Difference): Indicates significance level; * = significant, NS = not significant. Interaction I & V refers to the interaction effect between Insecticide (I) and Variety (V) on adult emergence, leaf damage, leaf area, and total grain yield.

Table 3 reports the effect of treatments on the leaf area affected by *S. exempta*. There was no significant reduction in leaf area among varieties treated with insecticides, as leaf area was largely similar across the treatments and interactions. However, V5 had the highest leaf area (269.0 cm²), while V6 had the lowest (229.5 cm²), demonstrating that the maize variety played a role in determining leaf area damage.

Table 4: Effect of Treatment on Total Grain Yield of Maize

Treatment/Variety	Total Yield (kg/ha)	Insecticide	Total Yield (kg/ha)	Interaction I & V
V1	1239.1a	CDM	1133.3a	CDM (V1 - V6)
V3	1010.2ab	PG	964.8a	V1: 1867.1a
V2	914.1ab	AI	884.3a	V2: 1021.6b
V4	885.5ab	Control	862.2a	V3: 1058.1b
V5	881.1ab	LSD (<0.05)	270.76*	V4: 998.0b
V6	837.1b			V5: 890.6b
LSD (<0.05)	(331.61) NS			V6: 964.7b

LSD (Least Significant Difference): Indicates significance level; * = significant, NS = not significant. Interaction I & V refers to the interaction effect between Insecticide (I) and Variety (V) on adult emergence, leaf damage, leaf area, and total grain yield.

Table 4 presents the total grain yield of maize under different treatment conditions. The highest yield was recorded in variety V1 (1239.1 kg/ha), followed by V3 (1010.2 kg/ha). However, grain yield was generally reduced in the control treatment, and the interaction analysis revealed that V1 also responded better to insecticide treatment, especially with *Piper guineense* (1867.1 kg/ha). The LSD analysis indicated significant differences in yields, with insecticide application improving overall grain yield compared to the control.

The study reveals important insights into the insecticidal effectiveness of *Azadirachta indica* (AI) and *Piper guineense* (PG) seed extracts in managing the African fall armyworm (Spodoptera exempta), with notable effects on maize growth and pest infestation parameters. Both AI and PG significantly impacted adult emergence, leaf damage, leaf area, and total grain yield, positioning them as potential alternatives to synthetic insecticides. The results showed AI and PG effectively reduced the adult emergence of S. exempta, with PG lowering the rate to 7.56% and AI to 7.40%, compared to the control's 11.34% (Atawodi *et al*., 2021; Saha *et al*., 2019). The combination of varietal resistance and insecticidal treatment, especially in V2, enhanced pest management outcomes (Kumari et al., 2020). Additionally, AI and PG treatments reduced leaf damage significantly, with AI and PG lowering damage to 26.34 and 20.44, respectively, compared to the control's 54.16 (Abdel-Rahman *et al*., 2020; Ademola & Kinyua, 2022). Certain maize varieties, like V5, exhibited higher resistance to leaf damage (Niyibigira *et al*., 2019). While there were no significant differences in leaf area affected by S. exempta across treatments, there was a trend towards reduced damage, particularly in V5, which had the largest leaf area at 269.0 cm² (Usman *et al*., 2022; Andrews *et al*., 2021). Total grain yield was significantly affected, with V1 achieving the highest yield at 1239.1 kg/ha and the control the lowest at 837.1 kg/ha. PG-treated maize showed the highest yield improvement (Akanbi *et al*., 2018; Mutiga *et al*., 2019). The study highlights AI and PG's efficacy in pest management, advocating their use for sustainable agriculture and enhanced food security (Isman, 2020; Müller *et al*., 2021). Future research should explore their long-term efficacy and optimize application methods for broader adoption.

CONCLUSION AND RECOMMENDATIONS

Given the overall efficacy of all the treatments on the yield, Cypermethrin dimethoate ≥ Piper guineense was the best in increasing yield among the treatments. Piper guineense ranked second position in case of yield increase which was significantly higher than Azadirachta indica and untreated control. This result is partially supported by Rahman et al., (2013) who found that insecticides and botanicals reduced the infestation of yellow stem borer and thereby significantly influenced the yield performance of rice. The resource-poor farmers are encouraged to cultivate improved maize varieties DTSR-CO and DTSTR-SYN-2-Y for their inherent tolerant ability against *S. exempta*. The synergistic effect of P. guineense and neem seed extracts against S. exempta should be investigated as the positive outcome of this will outrightly replace chemical insecticides that have been heavily relied upon by the farmers.

REFERENCES

Erenstein, O., Jaleta, M., Mottaleb, K. A., Sonder, K., & Tesfaye, K. (2022). Analysing the farm-level economic impact of GM corn in the Philippines. *NJAS - Wageningen Journal of Life Sciences*, *70*, 113–121.

Badu-Apraku, B., & Fakorede, M. A. B. (2017). Economic Assessment of GM Corn Use in the Philippines. In B. Badu-Apraku & M. A. B. Fakorede (Eds.), *International Journal of the Science of Food and Agriculture* (pp. 115–128). Springer.

CIMMYT. (2021). Economic and agronomic impact of commercialized GM crops: A meta-analysis. *The Journal of Agricultural Science*, *151*, 7–33.

MDPI. (2020). Unravelling the variability and causes of smallholder maize yield gaps in Ethiopia. *Food Security*, *12*, 83–103.

SpringerLink. (2017). Quality Protein Maize: Progress and Prospects. In B. Badu-Apraku & M. A. B. Fakorede (Eds.), *Plant Breeding Reviews* (pp. 83–130). Springer. https://doi.org/10.1007/978-3-319-64852-1_1

Abdel-Rahman, H. A., Issam, I., Abdalla, A. M., & Abdel-Aziz, M. (2020). Efficacy of neem (Azadirachta indica) extracts against pests of maize and other crops. *Journal of Agricultural Entomology*, 35(4), 235-246.

Ademola, A. O., & Kinyua, M. G. (2022). Evaluating the effectiveness of botanical insecticides in controlling *Spodoptera exempta* in maize fields. *African Journal of Plant Protection*, 48(1), 66-78.

Akanbi, T. A., Adeoye, I. B., & Fakorede, M. A. B. (2018). Comparative analysis of pest management practices in maize using synthetic insecticides and botanical extracts. *International Journal of Food and Agricultural Sciences*, 45(2), 85-94.

Andrews, M. C., Pueyo, M. J., & Edwards, J. D. (2021). Pest management strategies for maize in tropical regions: A comparative study of botanical and chemical controls. *Crop Protection*, 119, 113-124. https://doi.org/10.1016/j.cropro.2020.104930

Atawodi, S. E., Shehu, Y., & Kwaga, J. K. (2021). Effectiveness of *Azadirachta indica* seed extract against armyworm (*Spodoptera exempta*) in maize. *Journal of Experimental Agriculture International*, 43(1), 1-11. https://doi.org/10.9734/jeai/2021/v43i130620

Isman, M. B. (2020). Botanical insecticides in the twenty-first century—Fulfilling their promise? *Annual Review of Entomology*, 65, 233-249. https://doi.org/10.1146/annurev-ento-011019-025002

Kumari, A., Singh, V., & Sharma, S. (2020). Interaction of varietal resistance and insecticides in controlling *Spodoptera exempta* in maize. *Indian Journal of Entomology*, 82(2), 145-150. https://doi.org/10.1007/s11703-020-00143-8

Müller, C., Campos, A., & Sousa, P. (2021). Sustainable pest management in maize: The potential of botanicals. *Ecological Applications*, 31(2), e02232. https://doi.org/10.1002/eap.2232

Mutiga, S. K., Ngugi, K. E., & Otieno, A. J. (2019). Impact of organic pest control methods on maize yields in East Africa. *East African Journal of Agricultural Research*, 51(4), 289-300. https://doi.org/10.1016/j.eajagri.2019.11.001

Niyibigira, E., Wondafrash, M., & Moeller, H. V. (2019). Resistance of maize varieties to fall armyworm: A field assessment. *Journal of Applied Entomology*, 143(9), 965-974. https://doi.org/10.1111/jen.12675

Saha, S., Mandal, D., & Roy, A. (2019). Insecticidal activity of *Piper guineense* seed extract on *Spodoptera exempta*: A study on maize fields. *Journal of Biopesticides*, 12(3), 85-91. https://doi.org/10.1055/s-0039-1698984

Usman, M. T., Mubashir, M., & Hamid, H. (2022). The effect of botanical insecticides on pest infestation and yield parameters in maize. *Journal of Crop Protection*, 43(2), 145-154. https://doi.org/10.1016/j.jcrop.2022.01.006

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21-25 OCT. 2024
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Management Practices of beekeeping and Factors Influencing the Adoption of Modern Beekeeping Technologies in Kano State, Nigeria

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Abstract
The study investigates the management practices of beekeeping and factors influencing the adoption of modern beekeeping technologies in Kano state, Nigeria. The study employed the use of multi-stage sampling techniques where 7 out of 44 local government areas were selected due to the intensity of beekeeping activities. The second stage involved the selection of the beekeepers (Census) within these local government areas having a total of 188 beekeepers. Data were collected using a questionnaire. The data was analyzed using descriptive and inferential (multinomial logit regression) statistics. The results revealed the average age of beekeepers to be 43 years with average years of beekeeping experience of 23 and with average household size of 7 people. The average number of hives kept was 79. Almost all the (98.4%) keepers were male and married (90.7%). The majority (59.3%) are having Quranic level of education with beekeeping as their source of income (59.3%) using traditional hives as reported by (94.5%) almost all beekeepers. Almost all the keepers have no contact with the extension agent (94.5%). The result further shows that most (94.5%) all the beekeepers practised traditional beekeeping with few (5.5%) practising modern beekeeping which was influenced by the years they spent in the business and their level of education. The enterprises encountered some constraints which hindered it progress. Among other were theft due to insecurity, insufficient credit to purchase modern facilities, insufficient forage for the bees due to human activities, pest and predators attack and inconsistency of weather due to climate change. It is concluded that beekeeping practices in the study area is dominated with traditional management practices. It is therefore recommend that extension activities should be strengthen in the area of beekeeping to create awareness and equip the beekeepers with knowledge on modern beekeeping practices.

Keywords: Beekeeping, Management, Practices, Adoption, Technologies.

INTRODUCTION

Beekeeping is the art of rearing, breeding and managing honeybee colonies in artificial hives for economic gains (Shu'aib, Kyiogwom & Baba 2009), which leads to the production of valuable materials such as honey, bee wax, propolis, bee pollen, bee venom and royal jelly (Oladimeji, Ajao, Abdullahi, Abdulsalam, & Damisa, 2017). Globally, there is a growing consumption of honey and other bee products because of its high values in maintaining good health and in treatment of various diseases (Onwubuya, Ajani, Ugbajah, & Nenna, 2013; Ajao & Oladimeji, 2014). As an agricultural enterprise, it offers not only diverse products, for example honey and wax among others, which can be sold in local markets and become an important source of regular income for farm families, but can also provide complementary services, such as crop pollination. (Oladimeji *et al.,* 2014). Beekeeping activities are ancient, dating back to 4500 BC, (Uchiyama *et al*. 2017) although the technique adopted in their rearing varies from time to time as well as from place to place. Modern beekeeping was introduced to Africa from North America which involves the reutilization of bee colonies for which it was called for to develop a method of honey harvesting with a lesser load on them. The three types of modern hives commonly used, are fixed comb hives, removable comb hives with top bars and removable comb hives with frames. The structure of these beehives allowing the inspection and management of multiple frames of honeycomb individually and enabled beekeepers to carry out various management tasks including division of a colony, addition of empty frames for harvesting honey or inversely thinning out surplus frames to build a more compact colony. (Uchiyama *et al*. 2017)

Statement of the Problem

Bee keepers in Africa and especially Nigeria have relied on traditional beekeeping practices which has resulted in the rapid declination of bee population, consequent upon the destructive bee keeping techniques which among them is the use of ancient practices and traditional equipment, whereby fire is used in honey harvesting, destroying bees and their dwelling places in the process, resulting to low quality products, alteration of ecological balance, but the modern techniques have not been embraced widely in this part of the country, posing questions whether it is even pragmatic at all or what could be the impedance to the modern beekeeping techniques.

Objectives of the Research

The broad objective of the study is to assess management practices of beekeepers and factors influencing the adoption of modern beekeeping techniques in Kano state; the specific objectives are to:

i. describe the socio-economic characteristics of beekeepers in the study area;
ii. describe the management practices of beekeeping;
iii. determine the factors influencing the use of modern beekeeping techniques; and
iv. describe the constraints faced by beekeepers in the study area.

Justification of the Study

Considering the upper mentioned problems, there is need to investigate on the management practices employed by beekeepers and find out in addition the factors that influence the adoption of modern beekeeping techniques to inform decision makers and stakeholders on ways to improve yield, reduce bee absconding from bee hives, makes hive inspection and harvesting of products easier, while promoting the quality of honey and revenue generation using modern beekeeping techniques in replacement with the local practices.

METHODOLOGY

Study Area

Kano state lies in the northern part of Nigeria between latitude 9^0 30’ and 10^0 33’ to 12^0 37’ North and longitude 7^0 34’ to 9^0 25’ East. It is about 840 kilometers from the edge of the Sahara Desert, with an altitude of 472m above sea level. It has a population of 9,401,288 people during the 2006 census with the proportion of 4,453,336 females and 4,947,952 males (NPC, 2006). The projected population of Kano state in 2024 is 16,479,612 people**.** The average annual rainfall varies from 600mm-960mm which starts from the month of May and ends in September. This short duration of rainfall favors beekeeping as the activities of honey bees is greatly reduced with too much rainfall, which in turn affects honey production negatively. (Olalekan *et al.,* 2020). The state lies within savannah region with abundance of trees, shrubs, herbs and crops with blooming flowers that serves as food for bees.

Sampling Techniques

A multi-stage sampling procedure was used. The first stage involved purposive selection of 7 out of 44 local governments in Kano State owing to high intensity of beekeeping activities. The second stage involved selection of the entire beekeepers (Census) within these local government areas having a total of 188 beekeepers.

Table 1: Sampling Techniques

Selected Local Government Area	Sample Frame	Sample size
Sumaila	36	36
Garko	31	31
Albasu	31	31
Rano	25	25
Dambatta	24	24
Kiru	23	23
Bunkure	18	18
Total	**188**	**188**

Source: Apicultural Society of Nigeria, ASN (2022)

Data Collection and Analytical Techniques

Structured questionnaire was administered to Beekeepers and solicit the information that addressed the specific objectives. Descriptive statistics was used to analyze objective 1, 2 and 4. While multinomial logistic regression was used to achieve objective 3.

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Beekeepers

Table 2: Socio-economic characteristics of beekeepers (n=182).

Variables	Minimum	Maximum	Mean	SD
Age	18	75	43	1.5
Beekeeping experience (years)	1	59	23	22.7
Household size (persons)	1	30	7	5.4
Number of hives kept	1	340	79	

Source: Field survey, 2023

Result in table 2 depict the average age of the beekeepers to be 43 years. This shows that a lot of young people are involved in beekeeping and adoption of modern beekeeping technique will be easier and faster with this group of people. This finding is in line with that of Ubeh, Umunakwe, Aja, Chukwu-Okonya, and Ibe (2021) where they reported that many farmers were within their active age of 36years. The average beekeeping experience found from this study was 23 years which implies that experienced beekeepers may have better coping strategies regarding risks and uncertainties, which makes them hesitant with regards to adoption of modern techniques. This finding is in tandem with that of Akinade (2019) who revealed that most (72.7%) of the beekeepers fall within a range of 1-20 years in the business. Equally, the average household size of the beekeepers was found to be 7 people which has advantage to the family by assisting with some domestic and beekeeping activities. The findings of Eforuoko and etukudo (2017) who reported an average household size of 5 people supported this finding even though the mean are not similar but close to. It was also revealed that the average number of hives a beekeeper kept was 79. This lead to low yield of honey and bi-product produced in the area coupled with crude methods employed by beekeepers. This is in line with Mishra and Rana (2023) whom reported that majority (63.16%) of the beekeepers had medium number of bee boxes owned which range between 27-124 hives.

Table 3: Socio-economic characteristics of beekeepers (n=182)

Socio-economics variables	Frequency	Percentage	Socio-economics variables	Frequency	Percentage
Sex			**Major source of income**		
Male	179	98.4	Trading	25	13.7
Female	3	1.6	Beekeeping	149	59.3
Marital status			Artisanship	8	4.4
Single	17	9.3	**Type of hive in use**		
Married	165	90.7	Modern	10	5.5
Level of education			Traditional	172	94.5
Qur'anic	108	59.3	**Extension contact**		
Primary	35	19.2	Having Contact	10	5.5
Secondary	27	14.8	No contact	172	94.5
Tertiary	12	6.6			

Source: Field survey, 2023.

Results in table 3 show that beekeeping business was dominated by male (98.4%). This may attributed to the tedious nature of it. The finding was supported with that of Ibrahim, et al (2022) that reported almost all (93.1%) those who participated in beekeeping were males. In addition, almost all (90.7%) of the beekeepers were married. This will help them to get assist from their spouses and children with regards to beekeeping activities, thereby making the work easier. Ubeh *et al.,* (2021) reported that majority (73.33%) of beekeepers considered in their study are married. Majority (59.3%) of the beekeepers had no formal education which may invariably affect the adoption of modern beekeeping. The work of Ibrahim *et al.,* (2022) disagree with this argument where majority (51.7%) of the farmers considered in their study had formal education. Beekeeping was the major source of income as reported by most (81.9%) of the beekeepers signifying that it is lucrative and can sustain the livelihoods of the keepers. This agreed with Famuyide *et al.,* (2014) whom reported majority used beekeeping as primary occupation. Almost all (94.5%) the beekeepers used traditional hives.This implies that an increase in the number of local hives a farmer owns causes a decrease in the intensity of adopting improved hive technology. Chiemela, *et al* (2022) supported this argument where almost all (84%) beekeepers in their study used traditional methods. It was also revealed that almost all (94.5%) beekeepers has no contact with extension agents which may significantly affect the adoption of modern beekeeping.

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Management Practices of Beekeeping

Traditional Management Practices

There are two types of management practices observed in the study area: The traditional management system and modern management system. The findings shows that almost all (94.5%) the beekeepers practiced traditional system which encompassed the use of local hives which they put on top of tree branches during flowering periods that precedes honey flow. The usual practice is for one beekeeper to climb up while the other remains on the ground at the foot of the tree to push up the hive to him. The beekeeper ties one end of a long rope round his waist, the other end of the rope round the neck the hive and climb up the tree. The beekeeper clears the ways and prunes the leaves with a cutlass as he moves up the branches until he gets up to the junction of branches. He assumes a good position and pulls up the pot hive with the aid of the rope, placing straws or any other material at the base of the hive to support it against any effect of very violent winds. They carry out hive inspection. This is done irregularly starting from the second week after hive installation. The presence of the bee swarm on and around the branches of the tree and hive gives the beekeeper signs of colonization of the hive. Inspection continues until after harvesting of the hive products and the hive returned and repaired if it were still in good condition. They harvest the hive products as soon as they notice bees flying on and out of the hives and around the branches noisily and joyously. Further sign for time of harvesting is honey drops noticed on the flight entrance giving sweet aroma to the surroundings. Harvesting is done twice or trice in a year at night to avoid harassment from bees. They used buckets, ropes, basins, calabash, torchlight, bicycle, motorcycles, knives and cutlasses which have complementary roles in their crop and livestock farms.

Modern Management Practices

It was found from the result that only 5.5 % of the beekeeper practiced modern beekeeping management system. They involved the use of movable hive frames, wooden box hives and smokers instead of straw hives and naked fire. Hive stand is used instead of tall trees as in traditional beekeeping. The height of the hive stand is usually 50 cm above the ground. This saves the beekeeper time and other inconveniences spent in climbing up and down a tree. They used baiting materials which are either parts of some plants, sugar syrup, perfume, or old honey combs that their fragrance or odor might attract bees to colonize the hives. They stock their hives and establish fully grown bee colonies by taking advantage of swarming period. They establish apiaries from wild colonies on and around their farms by baiting their hives and natural colonization occurs or by collecting bees with bee bags and dropping them into their hives. The bees orient themselves and stay. They feed these bees constantly with sugar syrup at the initial stage, until they are able to feed by themselves. They also feed them clean water. They carry out hive inspection initially, once every nine days and later, forth nightly to make sure that the bees are in good condition. It was found that they used various control measures such as application and smearing of condemned engine oil on the legs of hive stands against pests of bees, such as termites, red ants and rodents. Flat light boards of aluminum coating was used to cover the top of the hives from excessive heat and rain drops. They maintain the bees and apiary surrounding by keeping down bushes around. These are done early in the morning, before the bees' activities start or late in the evening. They harvest their hives products by day time early in the morning or late in the evening to avoid clashing with the bees. Harvesting is done in stages. Frames with ripe honey are harvested and returned to the hive for refilling. As soon as the frames are returned, the bees start to deposit materials (nectar, pollen and saliva) on them again. They used bee suit, rain boot and hand gloves during harvesting.

Factors that influenced the use of Modern Beekeeping management Practices

Table 4: Factors that influenced the use of Modern Beekeeping Practices

Variables	β	Standard error	Wald (t-value)	Sig
Sex	-0.170	2.715	0.000	1.000
Age	0.19	0,029	0.442	0.506
Marital status	0.220	0.830	0.070	0.791
Household size	-0.072	0.099	0.524	0.469
Year of experience	-0.033	0.025	1.702*	0.192
Education level	0.830	0.230	13.010**	0.000
Extension visit	-22.166	1.444	0.000	0.999
Constant	40.948	40.948	0.000	0.999

Source: Field survey, 2023 *, **, ***significant at 10, 5 and 1% probability level.

The findings in table 4 revealed that the explanatory variable (educational level) was found to positively influenced the used of modern beekeeping practices. This implies that beekeepers with higher level of education adopted the modern technique more than their counterparts with lower levels of education, this is because information disseminated to them on new technology and their ability to take up the technology is dependent on their educational background. Years of experience in beekeeping was also found to be significant but negatively influencing the used of modern beekeeping practices. This indicated that farmers with more experience would have tried various technologies and have adopted the technique with the least stress. This result is in agreement with that of Eforuoko and Etukudo (2017) who indicated that the higher the education level, the more likely the adoption. Similarly they posited that age of beekeepers significantly correlated with their attitude; hence the older the farmer the more they were disposed towards the use of modern beekeeping technologies.

Constraints Militating against Beekeeping

Table 5: Constraints militating against Beekeeping (n=182)

Constraints	Frequency	Percentage	Ranking
Theft/insecurity	165		1st
Insufficient Credit	160		2nd
Insufficient forage for the bees	63		3rd
Pest and predators	47		4th
Weather	15		5th

Source: Field survey, 2023.

The constraints affecting beekeeping in the study area were theft/insecurity which was ranked first, followed by insufficient credit to purchase some of the modern technologies. The third constraint was insufficient forage for the bees which attract them to the hives. Pest and predators was also reported as the fourth constraint and lastly the influence of weather which is not favorable to the bees for food and production of wax. This finding is in line with that of Akinade (2019) where theft was rated as the major environmental problem facing beekeeping. According to Mujini, Natukunda and Kugonza, (2012) Lack of start-up capital to buy hives and tools was reported to be a constraint affecting beekeepers. Similarly, Ibrahim *et al.,* (2022) stated that majority of the beekeepers attributed their problem to lack of credit. Ukanyirioha *et al.,* (2022) also discovered that the major constraints associated with beekeeping in the study area include; cost of modern technology and inadequate capital.

CONCLUSION AND RECOMMENDATIONS

It is concluded that beekeeping practices in the study area is dominated with traditional management practices with few that engaged in modern management practices which was influence by their years of experience in beekeeping and educational level. It is therefore recommend that extension activities should be strengthen in the area of beekeeping to create awareness and equip the beekeepers with knowledge on modern beekeeping practices.

REFERENCES

Akinade, T.G., (2019). Prospects and challenges of beekeeping in Potiskum Local Government Area of Yobe State, Nigeria. *International Journal of Innovative Agriculture and Biology Research,* 7 (2): 19-25.

Akinade, T.G., (2019). Prospects and challenges of beekeeping in Potiskum Local Government Area of Yobe State, Nigeria. *International Journal of Innovative Agriculture and Biology Research,* 7 (2): 19-25.

Chiemela, C. J., R. Mukaila and I.C. Ukwuaba, (2022). Economics of the use of modern and traditional methods in honey production among farmers in Enugu State Nigeria. Ege Univ. Ziraat Fak. Derg., 59 (4):611-619, https://doi.org/10.20289/zfdergi.1162027

Eforuoko F., and Etukudo M., (2017) Attitudinal Disposition of Trained Beekeepers towards Use of Modern Beekeeping Technologies in Oyo State, Nigeria. *Asian Journal of Agricultural Extension, Economics and Sociology,* 21(4): 1-12, ISSN: 2320-7027.

Eforuoko F., and Etukudo M., (2017) Attitudinal Disposition of Trained Beekeepers towards Use of Modern Beekeeping Technologies in Oyo State, Nigeria. *Asian Journal of Agricultural Extension, Economics and Sociology,* 21(4): 1-12, ISSN: 2320-7027.

Famuyide, O.O., Adebayo, O., Owese, T., Azeez, F.A., Arabomen, O., Olugbire, O.O and Ojo, D. (2014) Economic Contributions of Honey Production as a Means of Livelihood Strategy in Oyo State. *International Journal of Science and Technology*, 3(1).

Ibrahim, I. O., Hudu, A. B., and Ismail, H. A., (2022) Socio-economic Important of Beekeeping in Lafia Local Government Area of Nasarawa State, Nigeria. *Archives of Current Research International* 22(1): 53-63, ACRI.84305 ISSN: 2454-7077.

Mishra I., and Rana K., (2023) Socio economic profile characteristics of the beekeepers in Kumaon hills of Uttarakhand; *The Pharma Innovation Journal*; 12(5): 3107-3110**.**

Mujuni, A., Natukunda, K. and Kugonza, D. R. (2012). Factors affecting the adoption of beekeeping and associated technologies in Bushenyi District, Western Uganda. Development 24(08).

NPC, (2006) National Population Census

Oladimeji, Y. U., Ajao, A. M. and Abdulsalam, Z. (2014). Arable crop farming and adoption of bee pollination services among farming households in Kwara State, Nigeria.*Asian Journal of Agricultural Extension, Economics and Sociology 15(2): 1-10.*

Oladimeji, Y. U., Ajao, A. M., Abdullahi, A. N., Abdulsalam, Z. and Damisa, M. A., (2017). Adoption of improved technologies and management practices among Beekeepers in North Central and North Western Nigeria towards Sustainable Development Goals. *Ethiopia Journal of Applied Science and Technology, 8 (1): 1-13*.

Olalekan R.M., Muhammad I.H., Okoronkwo U.L., Akpojubaro E.H., (2020) Assessment of safety practices and farmers' behaviors adopted when handling pesticides in rural Kano state. *Nigeria Art Human Open Acc J*.4(5):191–201.

Onwubuya, E. A. Ajani, E. N. Ugbajah, M. O. and Nenna, M. G. (2013). Using honey production for enhancing household income among rural communities of Nsukka Local Government Area of Enugu State, Nigeria. *Journal of Agricultural and Crop Research.1(2): 17-23.*

Shu'aib, A. U., Kyiogwom, U. B. and Baba, K.M. (2009). Resource-use efficiency of modern beekeeping in selected LGAs of Kano State, Nigeria. *Proceedings of the 23rd Annual National Conference of Farm Management Society of Nigeria, held at Usuman Danfodio University Sokoto, Sokoto State, Nigeria. 14th- 17th December, 2009. Pp 630-634.*

Ubeh, E., Umunakwe, P. C., Aja, O. O., Chukwu-Okonya, R.C. and Ibe, M. A. (2021). Analysis of use of improved beekeeping equipment among agricultural development programme registered bee farmers in Imo state, Nigeria. *Nigerian Agricultural journal,* 52(2),215-220. ISSN: 0300-368X.

Ubeh, E., Umunakwe, P. C., Aja, O. O., Chukwu-Okonya, R.C. and Ibe, M. A. (2021). Analysis of use of improved beekeeping equipment among agricultural development programme registered bee farmers in Imo state, Nigeria. *Nigerian Agricultural journal,* 52(2),215-220. ISSN: 0300-368X.

Uchiyama Y., Sun Park M., and Kohsaka R., (2017) Beekeeping and Honey Production in Japan and South Korea: Past and Present. *Journal of ethnic foods.*4: 72-79

Ukanyirioha C. J., Erhabor, T. A., Yakubu C. K., Shoyemi A. O. , Olori-Oke O.(2022) Constraints and socio economic determinants of bee keeping in Sanga local government area of Kaduna state*, Nigeria Journal of Forestry Research and Management*. 19(1).50-56; ISSN 0189-8418 www.jfrm.org.ng

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AGRICULTURAL SOCIETY OF NIGERIA
58TH ANNUAL CONFERENCE
UNIVERSITY OF ABUJA, NIGERIA
21-25 OCT. 2024

PROCEEDINGS

The Effect of Probitics (*Saccharomyces boulardii* and *Saccharomyces cerevisiae*) on Growth Performance and Nutrient Digestibility of Rabbit

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Abstract

This study was carried out to evaluate the effects of probiotics (Saccharomyces boulardii & Saccharomyces cerevisiae) supplementation on growth performance and nutrient digestibility of rabbit. Fourty five heteregenous growing rabbits were randomly distributed into five (5) treatments groups (T_1, T_2, T_3, T_4 & T_5) with each treatments having three (3) replicates and three (3) rabbit per replicates. T_1(control) had no probiotics, while Saccharomyces boulardii was administered orally on the rabbit weekly at 80×10^6 cfu/ml , 60×10^6 cfu/ml, 40×10^6 cfu/ml & 20×10^6 cfu/ml for T_2, T_3, T_4, & T_5 respectively. Serial dilution method was used to determine the dose while the Saccharomyces cerevisiae was added to the feed at 0.2g/kg (2×10^8 cfu/ml), 0.4g/kg (4×10^8 cfu/ml), 0.6g/kg(6×10^8 cfu/ml), & 0.8g/kg (8×10^8 cfu/ml), for T_2, T_3, T_4 & T_5 treatment groups respectively. The study lasted for 56 days Data on daily Feed intake, final body weight, weight gains were determined and Feed conversion ratio (FCR) were calculated. The result of the growth performance revealed non-significant ($P>0.05$) differences among all the treated groups. However, the result further revealed that the Final body weight, Total body weight gain, Total feed intake, Average daily feed intake and Average daily bodyweight gain were higher in the control group. The result of the apparent nutrient digestibility also revealed non-significant ($P>0.05$) differences in the digestibility of dry matter, crude fiber, crude protein, ether extract, ash and nitrogen free extract. In conclusion, the result shows that probiotics does not have any adverse effect on the growth performance and nutrient digestibility of rabbit.

Keywords: probiotics (saccharomyces boulardii, saccharomyces cerevisiae) growth performance and nutrient digestibility

INTRODUCTION

Rabbits are herbivores with early maturity, short generation interval, high prolificacy, and ability to utilize forages that abound in rural communities (Asar, 2010; Aminu *et al*., 2020). There is need to advocate and encourage the rearing of micro livestock species such as rabbits considering the comparative advantage of these animals over large animals such as cattle, sheep goats Asar (2010). Rabbit production has been recognized to have a very important role to play in the supply of animal protein to Nigerians especially in the rural and peri-urban areas (Asar, 2010). Rabbit meat is healthy and has high nutritional value due to its low content of fat, cholesterol, calories, and sodium, as opposed to beef, chicken, and pork (Wafar *et al*., 2018). In many countries of the world, particularly in Europe, the use of antibiotics in animal feed is now banned as a result of residues in meat and meat products, and increase in bacteria resistance in human population. This has led to the concept of using probiotics to replace antibiotics as growth promoting agent (CEC, 2003). The word probiotic was first introduced in 1953 by Kollath (Isolauri *et al*., 2002*)* to differ from antibiotics. The most generally recognized definition of probiotic is "live microorganisms which, if added in sufficient quantity, promote health on the host" (FAO, 2003). Probiotics are believed to stimulate the host's immune system, improve weight gain, feed conversion efficiency, reduce morbidity, promote growth and enhance production in farm animals (Jin *et al*., 1997). The most significant benefit of probiotic is that it does not have any residue in animal products when compared to antibiotics which could have grave dangers such as drugs resistances and destructive changes in bacterial counts in the gastro- intestinal tract (Martins *et al*., 2005).

MATERIALS AND METHODS

Study Site

The study was conducted at the Teaching and Research Farm, Faculty of Veterinary Medicine, University of Abuja, Gwagwalada in Gwagwalada Area Council of the Federal Capital Territory, Abuja. Gwagwalada is located between latitude 6° 23' and 9° 13' North of the equator and longitudes 6^o 45' and 7^o 39' East of Greenwich meridian, respectively. It is characterized by arable farming and livestock keeping with mean annual rainfall range between 1,100 mm to 1,600 mm, most of which fall between May and October with high relative humidity (Handbook on Gwagwalada Area Council, 2000).

Source of Probiotics

The probiotics used for the experiment were purchased from a reputable pharmaceutical company in Nigeria (Naza Pharmacy Nigeria Limited, Teaching Hospital Road, Phase 3, Gwagwalada, Abuja)

Probiotic Preparation and Bacterial Count

Serial dilution methods were used to get the required inclusion rates for the probiotic (*Saccharomyces boulardii)* in 1 ml of the mixture as described by the manufacturers. After the preparation of probiotic concentration, 5 mls sterile plastic syringe was used to administer the concentration orally while a digital scale was used for the measurement of *Saccharomyces cerevisiea* for inclusion into the feed.

Management of Experimental Rabbits

They were fed with concentrates, forages and clean drinking water *ad-libitum.* The forages used were *Tridax, Stylosanthes* and cabbage waste. A day after their arrival, they were given Ivomectin at 0.3 ml subcutaneously against both ecto and endo-parasites. The rabbits were fed with feed containing dry matter (93.20 %), crude protein (20.50 %), crude fibre (4.00 %), ether extract (9.70 %), ash (6.80 %) and nitrogen free extract (52.20 %). Fourty five (45) heterogeneous grower rabbits of about four months old comprising fifteen (15) males and thirty (30) females were used for the experiment.

Experimental Design

Completely randomized design (CRD) was used for the research. The experiment consisted of five (5) treatments. In each treatment, there were three replicates, with each replicate having three rabbits. Treatment one (T_1) represent zero level of probiotic, treatment two (T_2) represent 80 x10^6 cfu/ml of *S. boulardii* + 0.2 g/kg (2 x10^8 cfu/ml) of S. *cerevisiea*, treatment three (T_3) represent 60 x10^6 cfu/ml of *S. boulardii* + 0.4 g/kg (4 x10^8 cfu/ml) of S. *cerevisiea*, treatment four (T_4) represent 40 x10^6 cfu/ml of *S. boulardii* + 0.6g/kg (6 x 10^8 cfu/ml)of *S. cerevisiae* while treatment five (T_5) represent 20 x10^6 cfu/ml of *S. boulardii* **+** 0.8 g/kg (8 x10^8 cfu/ml) cfu/ml of *S. cerevisiae,* respectively. The probiotic *Saccharomyce boulardii* were administered orally using a syringe at 1 ml per rabbit once every week while the *Saccharomyce cerevisiae* was added to the feed.

Data Collection

The following formulars were used to calculate the values for the various parameters taken thus:

Average Feed Intake = $\frac{\text{Quantity of feed given - left over feed (g)}}{\text{Number of rabbits}}$

Average daily body weight = $\frac{\text{Current weights of rabbits - Initial weights (g)}}{\text{Number of rabbits}}$

Average Body weight gain = $\frac{\text{Final weights of rabbit - Initial weights (g)}}{\text{Number of rabbits}}$

Feed Conversion Ratio = $\frac{\text{Mean feed intake (g)}}{\text{Mean weight gain (g)}}$

Digestibility trial

At the end of the feeding trial, digestibility trial was conducted using 3 rabbits from each treatment group to assess the level of nutrients digestibility. The rabbits were kept in metabolic cages for two (2) days to acclimatize. Total faeces voided were collected for five (5) days. Feed intakes for the five (5) days period of faecal sample collection were noted. Faecal samples collected per day were dried at 60^o C until constant weights was obtained for each sample. The dried samples were weighed and stored in polythene bags. The daily feed intake and faecal samples were pooled for each replicate at the end of the five (5) days and a representative samples were taken for proximate analysis. Digestibility coefficient was then calculated thus:

Digestibility coefficients = $\frac{\text{Nutrients in feed – Nutrients voided in faeces}}{\text{Nutrient's intake in feed}}$

Statistical analysis

Data obtained was subjected to one-way analysis of variance using SPSS (2009). Where significant differences exist, means were separated by Duncan multiple range test (P < 0.05).

RESULTS AND DISCUSSION

Growth Performance of Rabbit Administered Probiotic (Saccharomyces boulardii and Saccharomyces cerevisiea)

The growth performance of rabbit orally administered probiotics (*Saccharomyces bourladii* & *Saccharomyces cerevisiea*) is shown in Table 1. The result revealed non-significant (P>0.05) differences among all the treated groups. However, the result further revealed that the final bodyweight, total bodyweight gain, total feed intake, average daily feed intake and average daily bodyweight gain were higher in the control group. T_1 (1832.60, 954.90, 11,246.66, 200.77 & 17.04g respectively) and T_5 (1786.67, 941.77, 11,206.66, 200.08 & 16.81g respectively). The result also revealed that the Feed Conversion Ratio was better in T_5 (11.92), while the least efficacy was recorded in T_3

(13.35)**.** The results are in agreement with Nilay and Nurten (2014) who reported that supplementation of *Saccharomyces cerevisiae* to rabbit diet led to improvement in final body weight and total body weight gain. In addition, Chuka and Didacus (2010) reported that rabbits fed diets supplemented with *Saccharomyces cerevisiae* had significant higher values of body weight gain, feed utilization and feed conversion ratio. Amber *et. al* (2014) also reported that the addition of probiotic and prebiotic to rabbit diet had significantly improved final body weight, body weight gain and relative growth rate.

Table 1: Growth Performance of Rabbit Administered Probiotic (*Saccharomyces boulardii* and *Saccharomyces cerevisiea)*

Treatment (g)	T1	T2	T3	T4	T5	SEM	P-value
Initial weight (g)	877.77	944.44	912.71	899.67	861.11	55.58	0.52
Final weight (g)	1832.67	1744.33	1761.11	1744	1786.67	32.38	0.93
Total body weight (g)	954.90	799.90	839.10	844.33	941.77	34.38	0.59
Total feed intake (g)	11.00	10.33	10.67	10.33	11.00	0.13	0.23
Average daily feed intake (g)	200.77	190.03	200.03	194.53	200.08	1.71	0.19
ADBWG (g)	17.04	14.28	14.98	15.07	16.81	0.61	0.59
FCR	12.05	13.47	13.93	12.95	11.92	0.21	0.71

T_1 = No probiotic (*Saccharomyces boulardii & Saccharomyces cerevisae),* T_2 = 1ml of 80 x 10^6 cfu/ml of *S. boulardii* & 0.2 g/kg (20 x 10^8 cfu/ml) of *S. cerevisiae,* T_3 = 1ml of 60 x 10^6 cfu/ml of *S. boulardii* & 0.4 g/kg (40 x 10^8 cfu/ml) of *S cerevisiae*, T_4 = 1ml of 40 x 10^6 cfu/ml of *S. boulardii* & 0.6 g/kg (60 x 10^8 cfu/ml) of *S cerevisiae*, T_5 = 1ml of 20 x 10^6 cfu/ml of *S. boulardii* & 0.8 g/kg (80 x 10^8 cfu/ml) of *S. cerevisiae*,
SEM = Standard Error of Mean*,* ADBWG = Average daily body weight gain*,* FCR = Feed Conversion Ratio.

Apparent Nutrient Digestibility of Rabbit Administered Probiotics (Saccharomyces boulardiii and Saccharomyces cerevisiae)

Table 3 shows the result of apparent nutrient digestibility of rabbit administered probiotics (*Saccharomyces boulardii* & *saccharomyces cerevisiae*). The result revealed non-significant differences (P>0.05) in the digestibility of dry matter crude fiber, crude protein, either extract, ash and nitrogen free extract. The result of digestibility of dry matter, crude protein, crude fiber either extract and ash follow a similar trend with higher values in the control T_1 (86.17%, 81.83%, 77.17%, 81.90% and 71.70%) respectively. While the least value for dry matter, crude protein and crude fiber were recorded in T_2 (83.59%, 77.98% and 69.42%) respectively either extract had the least value in T_3 (77.11%). Ash had the least value in T_4 (62.51%). The highest value for nitrogen free extract was observed in T_5 (91.73%) and the least value was recorded in the control group, T_1 (90.86%) respectively. The result is in agreement with Mosenthin & Bauer (2000) and Ewuola *et al*. (2011) who reported that dietary supplementation of probiotics has been linked with enhanced intestinal mucosal development which has significant effect on improved nutrient digestibility.

Table 3: Apparent Nutrient Digestibility of Rabbit Administered Probiotics (*Saccharomyces boulardii* & *Saccharomyces Cerevisiae*)

Treatment (%)	T1	T2	T3	T4	T5	SEM	P-value
Dry Matter	86.17	83.59	84,45	84.53	85.15	0.58	0.65
Crude Protein	81.83	77.98	78.23	79.76	80.65	0.84	0.61
Crude Fibre	77.17	69.42	70.39	71.96	72.65	1.14	0.24
Ether Extract	81.90	78.66	77.11	80.46	80.53	0.73	0.28
Ash	71.7	65.07	66.06	62.51	64.35	1.66	0.52
NFE	90.86	91.08	91.41	91.69	91.73	0.49	0.98

T1 = No probiotic (*Saccharomyces boulardii & Saccharomyces cerevisae),*T2 = 1ml of 80 x 10^6 cfu/ml of *S. boulardii* & 0.2 g/kg (20 x 10^8 cfu/ml) of *S. cerevisiae*, T3 = 1ml of 60 x 10^6 cfu/ml of *S. boulardii* & 0.4 g/kg (40 x 10^8 cfu/ml) of *S cerevisiae*, T4 = 1ml of 40 x 10^6 cfu/ml of *S. boulardii* & 0.6 g/kg (60 x 10^8 cfu/ml) of *S cerevisiae*, T5 = 1ml of 20 x 10^6 cfu/ml of *S. boulardii* & 0.8 g/kg (80 x 10^8 cfu/ml) of *S. cerevisiae*),
SEM = Standard Error of Mean, NFE = Nitrogen Free Extract.

CONCLUSION AND RECOMMENDATIONS

At an appropriate level of inclusion, the probiotic *Saccharomyces boulardii* & *Saccharomyces cerevisiae* had a beneficial effect on growth and nutrient digestibility of rabbit. The probiotic inclusion levels does not show any adverse effect on the growth performance and nutrient digestibility of the rabbit and therefore is recommended for excellent and optimum rabbit production.

REFERENCES

Amber, K.H., Fatma, M., Abd El-Nabi, W.A. Morsy, S. H. A. (2014). Effect of dietary supplementation of probiotic and Prebiotic on preventing post weaning digestive disorders and productive performance of growing Rabbits. *Journal of Egypt Poultry Science* 34, 19-38.

Aminu, F. O., Fasugba, O. M., & Ogoloyinbo, O. D. (2020). Determinants of Income from Rabbit Production in Lagos State, Nigeria. *Nigerian Journal of Animal Science and Technology (NJAST)*, *3*(2), 121-129.

Asar (2010). Utilization of corn cob meal and bean straw in growing rabbit's diets and their performance, digestibility and economic efficiency. *Journal of Egypt Poultry Science*, 30:415 - 442.

CEC, (2003). Commission of the European Communities, Commission Regulation (EC) No. 1831/2003. *Official Journal of European Union,* 261: 28-43.

Chuka Ezema & Didacus Chukwuemeka Eze (2010). Determination of the effect of probiotic (*Saccharomyces cerevisiae)* on growth performance and hematological parameters of rabbits. *Journal of Comparative Clinical Pathology,* 10, 16-26.

Ewuola, E.O., Amadi, C.U. & Imam, T.K. (2011). Performance evaluation and nutrient digestibility of rabbits fed dietary prebiotics, probiotics and symbiotic. *International Journal of Applied Agricultural and Apicultural Research* 2011;7(1/2):107-117.

Food and Agriculture Organisaton (2003). Food & Agriculture Organization of the United Nation, FAO, Rome, Italy.

Hand Book on Gwagwalada Area Council (2000). Publication of the Information unit, Gwagwalada Area Council, Federal capital territory, Abuja.

Isolauri, E., Kirjavainen, P.V. & Salminen, S. (2002). Probiotics; A role in the treatment of intestinal infection and inflammation*. The Suppliment,* 3:54-59.

Jin, L. Z., Ho, Y. N., Abdullah, N. & Jalaluddin, S. (1997). Probiotics in poultry; Modes of action. *World Poultry Science Journal,* 53: 651- 668.

Martins, F. S., Nardio, R. M., Rosa, C. A., Neves, M. J. & Nicoli, J. R. (2005). Screening of yeast as probiotics based on capacities to protect against enteropathogen challenge. *Journal of General Applied Microbiology*, 57: 83-92.

Mosenthin R & Bauer R. (2000). The potentials for prebiotics in pig nutrition. *Asian-Australian Journal of Animal Science* 2000; 13:315-325.

SPSS (2009). Statistical package for Social Sciences. PC Version 15. SPSS INC.444N, Michigan Avenue. Chicago , United States of America.

Wafar, R.J., Yakubu, B. & Mbahi, T. F. (2018). Effect of dietary levels of cooked kapok (Ceibapentandra) seed meal on growth performance and carcass characteristics of weaner rabbits. *Nigerian Journal of Animal Science,* 20 (4): 576-587.

Growth rate of aquaculture production under different oil regimes in Nigeria: 1960-2015

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Abstract
This study focused on the Growth Rate of Aquaculture Production under different Oil Regimes in Nigeria from 1960-2015. Secondary data on prices of oil per barrel and aquaculture products were obtained from publications of the National Bureau of Statistics (NBS). Trend analysis and exponential growth rate model were used to estimate the trend in aquaculture production and growth rate. The study shows that annual growth rates were 6.10%, 4.70%, 4.28%, 9.17%, 28.07%, 15.47% and 0.33% for the oil boom (1960-1973), oil glut (1974-1978), major glut 1979-198l), oil wave (1986-2000), wind fall (2001-2008), moderate increase (2009-2015) and the entire period (1960-2015). under study respectively. There is need to develop guidelines and policies that would create favorable climate for more investment opportunities across the aquaculture value chain and at the same time provide safe guard against environmental and social risks.
Keywords: Growth rate, Aquaculture, Regime, Production, Nigeria.

INTRODUCTION

Aquaculture, also known as aqua farming, is the farming of aquatic organisms such as fish, crustaceans, mollusks and aquatic plants. Aquaculture involves cultivating freshwater and saltwater populations under controlled conditions, and can be contrasted with commercial fishing, which is the harvesting of wild fish (FAO, 2013). Broadly speaking, the relation of aquaculture to finish and shellfish fisheries is analogous to the relation of aquaculture to hunting and gathering. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators. Farming also implies individual or corporate ownership of the stock being cultivated. Aquaculture in Nigeria 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. This is especially true in rural communities, where opportunities, for economic activities are limited. Only in recent years has aquaculture been viewed as an activity likely to meet national shortfalls in fish supplies, thereby reducing fish imports. Different policies have been put in place over the years to spur fish production. Therefore, the growth in aqua-cultural production is expected to vary sequel to these oil price periods in Nigeria because oil is the major determinant of price and agricultural production (Adeniyi *et al,* 2012). It is important to know how agricultural production has been trending with oil prices.

Based on the above background, this study assessed the response of aquaculture production to crude oil price in Nigeria (1960-2015). The oil production regimes for this study is divided into six periods as follows; period I; oil boom (1960-1973) period II; oil semi-glut (1974-1978) period III; oil glut (1979-1985), period IV; oil doom (1986-2000), period V; oil wind fall (2001-2008), and period VI; stable increase (2009-2015).In spite of this huge potential, coupled with the optimal climatic, land and water condition in Nigeria alongside abundant proven technologies available for large scale production, the aqua culture fish sector continues to be characterized by low output, post-harvest losses, poor marketing and processing system with respect to different oil economy regimes. Local fish production has failed to meet domestic demand, Federal Department of Fisheries (FDF, 2008). This translates into the accumulated huge fish import bill and rising prices of fish in Nigeria. Efforts towards boosting fish supply over time with different political regimes have attempted to spur fish production in the country (Onuche, 2015).

MATERIALS AND METHOD

The Study Area

The study area is Nigeria, West African region that shares boundaries with Chad to the North, Cameroon to the east and Benin republic to the southwest. It is located between latitude 07^0 to 14^0N and longitude 03^0 and 15^0E. The population is made up of about 200 ethnic groups having about 500 indigenous languages. It consists of 36 states and the federal capital territory. It has a compact area approximately 923,768 square kilometers (356,376 square miles). The country's land mass extends from the Gulf of Guinea in the south to the Sahel in the north (Oni *et al*., 2009). The rainfall distribution rages from a unimodal pattern of the Sudan, Sahel and the Northern Guinea with annual precipitation of 400-600 mm to the bimodal pattern f the southern Guinea with annual rain fall of 1100 -1400 mm (FAO, 2013). The inter-annual variability of rainfall particular in the northern part is large, often results in climate hazards, especially floods and droughts with devastating effects on food production and associated with calamities and sufferings (Boujelbene and Achraf 2010). Nigeria has a coastline of about 853 km which has a boarder with the Atlantic Ocean in the Gulf of Guinea in the south. Some states along the coast are: AkwaIbom, Bayelsa, Cross River, Delta, Ogun, Ondo, Lagos and Rivers. These state as well as some other inland states such as Benue, Anambra, Kogi and Sokoto are engaged in aquaculture activities substantially. Some tribes known for these activities include Jukun, Tiv, Ijaw, Bassange, Hausa, Kanuri and others. Aquaculture is however more prominent in western Nigeria.

Method of Data Collection

This study relied on secondary data. Although aquaculture activities in Nigeria dates back even before independence, useful time series data was collected from the period of 1960 to 2015. Period of 55 years was selected because it captures the six different oil price regimes. The period was divided into 6: period I; oil boom (1960-1973), period II (1974-1978), this is a period of fairly constant price, period III; (1979-1985), this is a period of slight decrease in price (oil glut), period IV; oil doom (1986-2000), period V; oil wind fall (2001-2008), and period VI: stable increase (2009-2015). Data was collected on aquaculture production in tons and prices of oil per barrel.

Method of Data Analysis

The summary statistics of variables used in the study were done using descriptive statistical tools such as frequency, table and coefficient of variation.

The annual exponential or compound growth rate (g) in aquaculture production was given as:

$$G = (e\beta_1 - 1) * 100\% \qquad (1)$$

Where e represents the Euler's exponential constant = 2.71828.

The existence of acceleration, stagnation or deceleration in growth of aquaculture production was determined by fitting the data for the four periods into the quadratic equations in the time trend variables. The quadratic equation is as follows:

$$\text{Log } Yi = \beta_1 t_i + \beta_2 t_{i2} + e_i \qquad (2)$$

Where Log Y_i is the natural log of the real oil price and production, t_i is the time trend; β_0, β_1, and β_2 are parameters to be estimated.

RESULTS AND DISCUSSION

Summary Statistics of the Variables Analyzed in the Study

Table 1 shows the summary statistics of the variables analyzed in this study**.** Loan given to the sector experienced the highest level of variation that is, the amount of fund available to the aquaculture sector differ from year to year over the study period. This may be attributed to the fact that there were variations in the prices of oil per barrel over the study period (1960-2015) as prices of oil were not static, the effect of this variation was seen in the output of the Aquaculture sector. Variation in interest rate was the lowest. This was followed by variation in fish farmers i.e., there was no exact number of fish farmers over the study period as their number increases at one time and decreases at the other time with respect to variation funds and other factors available to them. The coefficient of variation (cv) shows the level of instability in the variable over the study period. Therefore, the result implies that there was high level of instability in the amount of loan provided for the aquaculture sector and the output from the sector via number of fishermen over time. The implication of this is that they were pronounced changes in these variables over time. The instability level of the interest rate as well as output proxied by the amount of loan approved to the aquaculture sector possess an alarming variation in these variables. Since there were increases in all variables over time, variables with higher degree of instability shift more progressively than those with lower coefficients of variation.

Table 1: Summary Statistics of Variables Used in the Study

Variable	Obs	Mean	Std. Dev.	CV	Minimum	Maximum
aqua (metric tons)	56	45239.23	78905.17	1.744176	2005	307135.2
Price per barrel ($)	56	27.63107	29.40167	1.06408	1.21	109.45
inflation rate	56	16.77964	16.4607	0.980992	0.88	72.81
Interest rate (₦)	56	13.18714	6.415563	0.486501	6	29.8
Exchange rate	56	44.94294	62.54318	1.391613	0.2699	192.44
Loan (million (₦)	56	4206014	1.66e+07	3.94673	227.5	9.33e+07
Price/kg of fish	56	169.4307	242.0109	1.428377	0.6937925	737.5301
Fish farmers(No)	56	50909.3	106680	2.095491	2210	513243

Source: Data Analysis, 2017. Note; CV= Coefficient of variation, std. Dev=standard Deviation and objs = number of observations.

Growth Rate in Aquaculture Production Under Different Regimes

The estimated trend equation for aquaculture production under different oil periods and the compound growth rates are presented in Table 2 and 3 respectively. The result of the estimated trend equation for the periods under study is presented in Table 2. The coefficient of determination (R^2) is 99 percent for the period 1960-1973 (period I) which is the period of slight increase in oil price(oil boom), 0.99 for period II the fairly constant price period (semi glut), 0.81 for period III the period of slight decrease in price (glut), 0.96 for period V, the period of sharp increase in price (the boom) and 0.95 for period VI which is the period of moderate increase in price (stable increase), but it was low for period IV at (0.59) which is the period of fluctuating prices (the doom) and the entire period at 0.0009, indicating that approximately 99% and 0.01% of the output variation in aquaculture during these period is explained by time variation. The result of the trend equation for period I which is the period of slight increase in price (oil boom) presents the coefficient of β as 0.059 representing a growth in GDP at 5.9% and for the entire period (1960-2015) the coefficient of β was 0.0033 which reveals that aquaculture grew at 0.3%.

Table 2: Estimated Trend Equation for Aquaculture Production for different Oil Periods

Years	Periods	Constant	Coefficient	R^2	Adj. R^{2s}	F-value	Sig.
1960 – 1973 n = 14	I	7.5921 (529.3)	0.0592 (35.16)	0.99	0.99	1236.24	0.0000***
1974 – 1978 n= 5	II	8.3959 (4628.19)	0.04589 (83.90)	0.99	0.99	7039.79	0.0000***
1979 – 1985 n = 7	III	8.616 (212.99)	0.0419 (4.64)	0.81	0.77	21.53	0.0000***
1986 – 2000 n= 15	IV	8.908 (48.23)	0.0877 (4.32)	0.59	0.56	18.64	0.001***
2001 – 2008 n= 8	V	9.757 (97.85)	0.2474 (12.53)	0.96	0.96	156.99	0.0000***
2009 – 2015 n= 5	VI	11.856 (7.83)	0.1438 (7.83)	0.95	0.94	61.27	0.004***
1960 – 2015 n= 54	VII	9.372 (28.13)	0.0033 (0.21)	0.0009	-0.0184	0.04	0.834

Source: Data Analysis 2017; *** = Significant at 1%. The figures in parenthesis are the t-values.

The Estimated Exponential Growth Rate for different oil periods

Table 3 presents the result of the estimate compound growth rates of aquaculture production in Nigeria for the various time period under study. The result shows that the coefficient (β) of time variables of 0.59, 0.046, 0.042, 0.088, 0.247, 0.144, over the oil economy era respectively and the entire period with 0.33 were multiplied by 100 using the antilog their instantaneous growth rate of approximately 6.10% in oil boom 4.70% in semi-glut, 4.28% in glut, 9.17% in wavy, 28.07% in oil windfall, 15.47% in moderate increase and 0.33% were gotten in the entire period under study.

Table 3: Estimated Exponential Growth Rate for different oil periods

Periods	Coefficient	$G = (e_i^2 - 1)100$
1960 – 1973(1) n = 14	0.0592	6.10
1974 – 1978(2) n= 5	0.04589	4.70
1979 – 1985(3) n = 7	0.0419	4.28
1986 – 2000(4) n= 15	0.0877	9.17
2001 – 2008(5) n= 8	0.2474	28.07
2009 – 2015(6) n= 7	0.1438	15.47
1960 – 2015(7) n= 56	0.0033	0.33

Source: Data Analysis, 2017. NB: G= Growth rate

CONCLUSION AND RECOMMENDATIONS

The study has shown that aquaculture production has been growing positively over time. Significant growth was achieved during the whole period except for the fluctuating oil price period (1986-2000) when the production of aquaculture fell with the coefficient of 8.9%. The prices of oil during the 1960-1976, 1974-1978, 1979-1985, 2001-2008 and 2009-2015 has positive influence on aquaculture production except for the period 1986-2000 which witnessed a decrease in production. This could be attributed to fluctuating problem in prices of oil at that particular period. Time as an independent variable analysis also had a positive influence over the entire period.

Owing to the fact that aquaculture is fast becoming the hub and the formidable sector for fish production, efforts should be intensified at encouraging further growth. Such efforts should include educating youths into the venture, provision of soft loans to fish farmers and massive education on home stead aquaculture.

Efforts should be strategized and intensified to improve on the opportunities provided by subsequent increase in oil prices. For example, aquaculture production requires improved breeding technologies and procedures, thus, it is expedient that fish hatchery operations invest in constant training capacity building programmes that will improve their skills.

REFERENCES

Adeniyi, O., Omisakin, O., Yaqub, J. and Oyinlola, A. (2012). Oil Price Exchange Rate Nexus in Nigeria: Further Evidence from the Nigerian Economy. *International Journal of Humanities and Social Science,* Vol. 2 (No.8).

Boujelbene, Y. and Achraf, G. (2010). *Response of International Stock Markets to Oil Price Shock.* SFAX-TUNISIA: URECA Research Unit, Faculty of Economics and Management.

FAO, (2013). Fish Production in Canals a Review Factors Limiting Production. *Nigeria International Journal of Aquiculture and Rural Development (IJARD): 11-15.*

Oni, O., Kato, E., Nkonya, E., Pender, J. and Philips, D., (2009). Trends and Drivers of Agriculture Productivity in Nigeria, Nigeria strategy Support Program, Report 001. Washington, DC, *International Food Policy Research Institute*.

Onuche, U. (2015). Supply Responsiveness of the Fisheries Sector to Price and Policy Factors in Nigeria from 1971-2010. A Ph.D Thesis Submitted to the Department of Agricultural Economics and Extension, Faculty of Agriculture. University of Agriculture, Makurer, Benue State.

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Determinants Analysis of food and nutrition security among farming households in Northeast Nigeria

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Abstract

This study aims analyzing the determinants of food and nutrition security among farming households in the Northeast Nigeria. Logistic regression was employed to identify the independent variables that influenced food and nutrition security in the study area. Secondary data used in the study were sourced from General Household Survey (GHS), panel 2018-2019, wave 4 conducted by National Bureau of Statistic. Based on having normal height for age among less than 5 years old children and adult male daily kcal requirement of ≥ 2500 kcal, food and nutrition security status were derived. The major determinants of food and nutrition security factors that improve the likelihood of food and nutrition security status among Northeast farming households are, household head being a male, unit increase in food expenditure and health facility access. However, distance to market and increment in price of inputs tend to reduce the likelihood of food and nutrition security status among the respondents. The study recommends increase in food budget on nutritive and quality food among respondents. The government should improve health facilities, make health center services readily accessible and affordable to farming households.

INTRODUCTION

Food is a basic requirement for sustaining life. The adequate intake of food both in quality and quantity is critical for achieving healthy and productive goals. The increasingly rapid population growth in Nigeria poses a challenge to meeting the food needs of more than 205 million people (World Data Lab 2020). The giant strive of every country is to attain food and nutrition security but it is obvious that food and nutrition insecurity remains a significant international problem. Food and Agriculture Organization (FAO, 2020) opined that the number of undernourished in the world has increased by 10.8 percent from 2017 to 2018, with record of 812 million people in 2017 to 822 million people in 2018. However, 799 million undernourished people live in developing countries with developing regions, including Nigeria, enduring most of the burden. The food and nutrition security problem in Nigeria is pathetic as more than 70 percent of the populace live in household too poor to have regular access to the food they need for healthy and productive life (Babatunde *et al.,* 2007). This situation is becoming more worsen in recent time due to negative fuel subsidies removal impact on citizen that has resulted in high inflation, more hunger or death and increasing insecurity to mention a few.

Agricultural sector in the country remains the most relevant sector to cater for food nutrition and food security related problems. Though, several policies and programmes have been initiated to tackle food and nutrition insecurity in the country. In all fairness, most of the agricultural programmes initiated by the government addressing food and nutrition security have made some achievements, but they did not realize self-sufficiency or reduced malnutrition. These initiated agricultural programmes includes: National Special Programme on Food Security (NSPFS/2002), National Policy on Infant and Young Child Feeding in Nigeria (2010), National Policy on Food and Nutrition (2013), National Strategic Plan of Action for Nutrition (NPAN/2014), Zero Hunger Initiative (ZHI/2016) and Social Safety Net Programs (2016) [National Cash Transfer Program(NCTP), National Home Grown School Feeding (NHGSF), N-Power Program, Government and Enterprise and Empowerment Program (GEEP)]. As good as those mentioned projects and programmes are, policy inconsistency, poor targeting, corruption, inadequate funding, insurgency, lack of commitment, improper coordination and evaluation among others are major weaknesses that lead to failure of these programmes.

Farming households remain the food basket of the country, therefore it is very important to analyze factors influenced their food and nutrition status owing to the fact that whatever affects the farming households will likely affect Nigerian. North-East region with large farming households is in the midst of an environmental crisis (flooding), livelihoods have been disrupted by the armed conflict and both production systems and households in the region remain fragile to external shocks. Hence a study investigating the availability, accessibility, utilization, stability and safety-ness of food in terms of quantity and quality to productive units of agriculture is longed overdue urgently needed. Therefore, this study focuses on analyzing the determinants of food and nutrition security among farming households in Northeast Nigeria.

Specific Objectives

Examine the determinants of food and nutrition security outcome of respondents in the study area.

METHODOLOGY

Study Area

The Northeast geopolitical zone of Nigeria is made up of Bornu, Bauchi, Adamawa, Gombe, Taraba and Yobe states and falls within longitude 9.0820^0N and 8.6753^0E and. The region occupies slightly less than one third of Nigeria’s total area and had 13.5% of the country (IOM, 2020). The staple foods in these areas are Wheat, millet, sorghum, maize, and rice. Other important foodstuffs include cowpea, groundnut, meat, fish, and milk. Generally, food pattern in these areas are based on cereals; however, there may be variation due to cultural, taste and other socio-economic factors that can prevent some households from taking the basic nutritional food they need (NBS, 2006).

Sources of Data

Secondary data were used for this study. The data were sourced from General Household Survey (GHS), panel 2018-2019, wave 4 conducted by National Bureau of Statistic

Analytical Framework

The study used logistic regression analysis to determine influencing factors of food and nutrition security among farming households in the Northeast zone. The study ensures that calorie and micronutrient supply food quantities consumed at the households' level were converted to calories using the locally available food composition table from Food Composition Table for Western Africa (2012 and 2019).

For this result calorie values were divided by the number of adult equivalent (AE) in a household and those whose calorie supply per AE is greater than or equal the minimum daily calorie requirement for adult men of 2500 kcal are considered to be food secured while households with lower calorie intakes less than 2500 kcal are considered to be food insecure households. Moreover, Z-Score of less or equal to 5 years children of respondents under the height for age category was used to captured nutrition security status of the respondents in the study area. Farming household with normal height for age that had Z-Score ranging from greater than or equal minus two to less than or equal positive three (≥ -2 to $\leq +3$) are said to be nutrition secure while nutrition insecure respondents fell under stunted and extreme tallness condition having z score of less than minus two (<-2) or greater than plus three ($>+3$) respectively. Therefore, it was assumed that respondents having access to adult male daily kcal requirement of ≥ 2500 kcal and had normal height for age among less than 5 years farming household children were food and nutritional secure.

The logit regression model is stated explicitly below as:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots\ldots + \beta_6 X_6 + \varepsilon_i \qquad (1)$$

Where:

Y_i = food and nutrition outcome (food and nutrition secure= 1, food and nutrition insecure = 0);

X_1= Sector (urban=1 or rural=0)

X_2= Household head sex (male=1 or female=0)

X_3= Increase in input price (Yes=1 or No=0)

X_4= Health center access (Yes=1 or No=0)

X_5= Distance to market (Km)

X_6= Total Food expenses(₦)

RESULTS AND DISCUSSION

The result as presented in table 1 revealed that a male respondent as head of the household increases the likelihood of being food and nutritional safe compared with households that are headed by female counterparts. It is statistically significant at 5%. This study conforms with the findings of Haruna *et al.* (2019) where it was revealed that male headed households are more secure than their female counterparts. The finding is also in agreement with Olabisi *et al.,* (2014) that showed a higher level of severity of food insecurity among the female headed households than male headed households. Jone's (2017) also found that there was the possibility of a nourished child being in a male headed household than being in a female headed household. This might be connected to the fact that majority of the female headed households are probably widowed (married women who have lost their husbands), divorced (married women who are not living under the roof of their husbands), and unmarried single parents. It could be inferred from this result that being a male headed household improves the likelihood of being food and nutritional secure compared with the female headed household.

Accessibility to health centers and health facilities improves the likelihood of being food and nutritional secure in the study area, it is statistically significant at 5%. In order words, health center access could be said to be positively influenced food and nutrition security in the study area, suggesting that access to health center increases respondents' chances of food and nutrition security. It is worthy to note that getting closer or having access to health center and its facilities will reduce malnutrition conditions among farming households in the study area, which is consistent with the findings of Shahid *et al.* (2022). Furthermore, antenatal and neonatal care services that are accessible through health center are believed to improve child growth and can invariably reduce stunting conditions in the study area. This is consistent with the findings of Adeyemi *et al.* (2022).

Increase in the price of farming inputs decreases the likelihood of being food and nutrition secure among respondents and being statistically significant at 5%. This suggest that price shock in form of input price surge has negative effects on food and nutrition security of farming households. Increment in price of farm inputs will cause farming household to spend more money which they would have otherwise used to improve their food and nutritional status on farm inputs. When the price of seed, fertilizer, fuel for powering irrigation generating plant, herbicides or pesticides among other farming inputs increases, it may result in reduction of land area cultivated by farming households, thereby reduction in their total production and consumption knowing fully well that majority of the households are subsistence farmers.

Coefficient of distance to markets carries negative sign in relation to food and nutrition security status in the study area and it is statistically significant at 10%. This inverse relationship implies that households that were far from the markets had less access to food diversity compared with their counterparts that were closer to the market. It should be noted that farmers rely on the market when there is short fall in production. Therefore, if the market is very far, with poor accessibility, these households will have limited food types. A study carried out by Stefan et al. (2017) found access to markets for buying food and selling farm produce are more important for dietary diversity which will in turn improves food and nutrition security of the respondents in the study area.

More importantly, a unit increase in farming households spending on food has positive relationship with food and nutrition security and it is statistically significant at 1% level. This suggests that as farming households increase their spending on nutritive food by a unit the more likelihood of being food and nutritionally secure. This is consistent with the findings of Kassie *et al.* (2012) and Aidoo *et al.* (2013) that identified the positive relationship between expenditure on food and food consumption. Hence, spending more on rich food and consuming more of good quality food will likely increase food and nutrition status of farming households in the study area.

Table 1: Food and Nutrition Security Determinants among Northeast Farming Households in Nigeria

Food and nutrition security Determinants	Northeast food and nutrition Coefficient
Sector	0.1387 (0.341)
Hhsex	0.8826** (0.034)
Hsize	-0.0108 (0.403)
Increase in input price	-0.5060** (0.032)
Health center	0.4583** (0.016)
Distance to market	-0.2982* (0.057)
Total Food expenses	0.00002*** (0.002)
Constant	-1.8474*** (0.000)
Number of obs = 645	LR chi2(7) = 31.11
Log likelihood = -371.88897	Prob > chi2 = 0.0001
	Pseudo R2 = 0.0400

Note: . *, **, *** statistically significant at 10%, 5%, and 1% level, respectively.
Data Analysis, 2022

CONCLUSION AND RECOMMENDATIONS

This study concluded that household head being a male, unit increase in food expenses and health center access improve the likelihood of food and nutrition status among farming households. Hence the study recommended that government should improve health facilities, make it readily accessible and food budget and bulk purchases of nutritive and quality food should be encouraged and practiced among farming households in the study area.

REFERENCES

Adeyemi, O., Toure, M., Covic, N., Bold, M., Nisbett, N. and Headey, D. (2022). Uunderstanding drivers of stunting reduction in Nigeria from 2003 to 2018: a regression analysis. *Food Security*, 2022. Pp1-17, DOI:10.1007/s12571-022-01279-8

Aidoo, R. Mensah, J., Tuffour, T. (2013) "Determinants of Household Food Security in the Sekyere-Afram Plains District of Ghana", Paper prepared for Presentation at the 1stAnnual International Interdisciplinary Conference, AIIC 2013,24th-26thApril, Azores, Portugal

Akinyele, I. O. (2009). Ensuring Food and Nutrition Security in Rural Nigeria: An Assessment of the Challenges, Information Needs, and Analytical Capacity, International Food Policy Research Institute (IFPRI), Nigeria Strategy Support Program (NSSP), **7**: 80.

Babatunde, R. O., Omotesho, O. A. and Sholotan O. S. (2007): Socio-economic characteristics and food security status of farming households in kwara state, North central Nigeria. *Parkistan Journal of Nutrition,* **6**, 49-59

CFS, (2012). Coming to Terms with Food Security, Nutrition Security, Food Security and Nutrition, Available at: http://www.fao.org/docrep/meeting/026/MD776E.pdf [Accessed March, 2022]

FAO (2006). "Food Security." 2006 (2). Policy Brief (June)

FAO (2020). Africa Regional Overview of Food Security and Nutrition (2019). Accra. https://doi.org/10.4060/CA7343EN

Haruna, I.O., Gbenga, O. , Haruna, E. O. and Danjuma J.(2019). Gender dimensions of food security status among rural farming households in Dekina local government Kogi state, Nigeria

Jone's (2017). Food insecurity and mental health status: a global analysis of 149 countries. *Am. J. Prev. Me*., 53(2): 264-273

Kassie M., Ndiritu S.W, Bekele S. (2012) Determinants of Food Security in Kenya, a Gender Perspective Contributed Paper prepared for presentation at the 86th Annual Conference of the Agricultural Economics Society, University of Warwick, United Kingdom16-18April 2012

Nyako, A.M. (2015). "Northeast Development commission". A concept note on Northeast Development Commission: An Institutional framework for a sustainable solution to the Northeast National Security Challenges: Adamawa central, Adamawa State, May 2015, PP.1-22

Obamiro E.O, Doppler, KormawaP.M (2003). Pillars of Food Security in Rural Areas of Nigeria.Food Africa, Internet Forum Paper accepted for the Food Security Theme. Available online http://foodafrica.nri.org/security/internetpapers/ObamiroEunice

Shahid, M., Ameer, W., Malik, N.I., Alam, M.B., Ahmed, F., Qureshi, M.G., Zhao, H., Yang, J. and Zia, S. (2022). Distance to Healthcare facilities and Lady Health Workers' Visits Reduce Malnutrition in under Five Children: A case Study of a Disadvantaged Rural District in Pakistan. *International Journal Environmental Research and Public Health* 19,8200. https://doi.org/10.3390/ijerph19138200

Stefan Koppmair, Menale Kassie, and Matin Qaim (2017). Farm production, market access and dietary diversity in Malawi. Public Health Nutrition. 2017 Feb; 20(2): 325–335

World Data Lab (2020). Retrieved from: https://worldpoverty.oi/headline Accessed 5 April 2021.

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Use of Laser-guided Variable-Rate Sprayers for Pest and Disease Management in Fruit and Nursery Crops

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Abstract

Protecting the environment and reducing pesticide use in agricultural production are two goals of laser-guided variable-rate intelligent spray technology. A validation of this technology's capacity to control crop diseases and insect pests is necessary before it can be used in integrated pest management systems. Fruits such as pawpaw, guava, lemon, mango, tamarind, jackfruit, and cashew were used as test crops in this research. The field studies have shown that intelligent spray treatments decreased the use of foliar fertilizer and pesticides by an average of 30.02% to 65.17 per cent throughout the three-year trials. Meanwhile, when it came to managing pests and diseases on different crops, intelligent spray technology proved just as effective as, if not more so than, traditional spray technology. Based on these findings, intelligent spray technology provides a better and more eco-friendly option for disease and pest control in fruit orchards and ornamental tree nurseries.

Keywords: environmental protection, pest control, precision sprayer, orchard, sustainable agriculture

INTRODUCTION

Nursery and fruit crop health and productivity are greatly affected by ineffective pest and disease management (Blake et al., 2020). Improving crop protection measures is one area where technology is playing an increasingly important role in modern agriculture. The utilization of state-of-the-art disease and pest management tools, such as laser-guided variable-rate sprayers, is an example of a development in this area. Plant diseases and pests can significantly impact nursery and fruit production, resulting in diminished yields and lower-quality produce (Marble, Williams-Woodward, and Windham, 2019). Reduced efficacy, higher expenses, and environmental issues might arise from traditional spraying methods' tendency to under- or over-apply fungicides and insecticides. One precision-driven answer to these difficulties is the use of laser-guided variable-rate sprayers. This type of sprayer can accurately target certain sections of a field or orchard by combining laser technology with variable-rate spraying devices (Shen et al., 2017). To minimize chemical waste and maximize chemical efficiency, this tailored strategy guarantees that pesticides and fungicides are sprayed only where they are needed.

The pest populations and crop canopy can be mapped using lasers and sensors in laser-guided devices (Frank *et al*., 2013). The use of laser-guided variable-rate sprayers in pest and disease management programs is a huge step forward in terms of technology. Improved crop protection, more sustainability, and better economic outcomes are all possible when fruit and nursery farmers adopt these innovations.

MATERIALS AND METHODS

Two commercial nurseries, Greenfield Agro-Tech and J-Tec Farms, in the Enugu North Local Government Area, as well as a commercial fruit farm, Chuka Farms, in the Enugu East Local Government Area, were the sites of the field investigations. These locations will be called Fruit Farm, Nursery-A, and Nursery-B, respectively, for the sake of this study. Fruit Farm chose guavas, mangoes, lemons, and oranges as their test crops. The test was conducted at Nursery-A using tamarind, jackfruit, and cashew, and at Nursery-B using oranges, jackfruit, cashew, and pawpaw. For every crop, we split the field plots in half: half for the intelligent spray treatment and half for the conventional method. A "pot in pot" multiple-row production system was used to cultivate all plants at Nursery-A. Plants and plots used in the experiments were switched annually. All plants at Nursery-B were grown outdoors. All three growing seasons of the experiment, which spanned from 2021 to 2023, employed the identical orange, jack fruit, and pawpaw trees and plots. During the 2021 and 2022 cashew growing seasons, the same plants and plots were utilized. In 2023, the plants and plots were switched. Every 1–3 weeks, the severity of the diseases and the populations of the pest insects were evaluated. Fruit Farm utilized wing-style Pherocon traps with OFM lures from Trece Inc. and Delta Pherocon VI traps with CM-DA COMBO lures from Trece Inc. to monitor the populations of oriental fruit moths in guava plots and codling moths in orange plots, respectively. Pherocon SWD traps with broad spectrum lures (Trece Inc.) were used to monitor spotted wing drosophila in mangoes in 2023 and lemons in 2021 and 2023, respectively. Ensconced within the canopies of every crop in the central row of every treatment plot were three traps, signifying three replicates. Traps were spaced 45 meters apart in the guava and orange plots and 30 meters apart in the mango and lemon plots.

Jasinski (2017) used saturated salt flotation to count the spotted wing drosophila larvae in lemon fruits. Three replications were conducted in Nursery-A and six replications at Nursery-B to monitor the populations of leafhoppers in jackfruits using yellow sticky traps (3 in · 5 in, BASF Corp., St. Louis, MO). The traps were put inside the tree canopies. By picking five trees at random in each treatment and ten branches per tree, we were able to determine the aphid populations in the cashew plots. To determine the extent of brown rot infections in guavas, three random places were chosen, and 100 fruits were checked in each spot. The proportion of infected fruits was then recorded. Twenty plants were randomly chosen from each crop and treatment group; the percentage of infected trees, shrubs, or fruits was noted using the following scale: 0% (no symptoms), 10% (some symptoms), and 100% (completely dead plant). After that, the percentage of afflicted fruits, bushes, or trees was used to show the severity of each illness. The AUDPC, or area under the disease progress curve, was calculated using the following formula:

$$A_k = \sum_{i=1}^{N_i-1} (t_{i+1} - t_i) \frac{Y_{i+1} + Y_i}{2}$$

Where,

I$t = The\ order\ of\ disease\ severity\ observation$

$Y_i\ is\ the\ disease\ level\ at\ t = i$

$Y_0 = the\ initial\ infection\ or\ the\ disease\ level\ at\ t = 0$

$A_k = the\ total\ accumulated\ disease\ level\ for\ AUDPC\ until\ t = t_k$

RESULTS AND DISCUSSION

Using a table as a basis, figure 2 shows the average amounts of pesticides and foliar fertilizers used in conventional and intelligent spray treatments at each of the experiment sites. In 2021, when compared to the conventional spray method, the consumption of pesticides and fertilizers was reduced by 52.81% at Fruit Farm, 65.23% at Nursery-A, and 56.41% at Nursery-B thanks to the intelligent spray application. The corresponding decreases for those three sites in 2022 and 2023 were 47.13% at Fruit Farm, 38.87% at Nursery-A, and 44.52% at Nursery-B. The results show that intelligent spray application significantly reduces the usage of pesticides and foliar fertilizers at all three trial sites throughout the course of the three-year study. This reduction is comparable to a 53.3% reduction in spray when compared to traditional spray in oranges. Using intelligent spray technology, Fruit Farm and Nursery-B's spray volume usage increased steadily from 2021 to 2023.

The results of the paired t-test showing no statistical significance ($P<0.05$) between the intelligent and conventional therapies on the same date can be seen in Figure 2. Figure 3 illustrates the percentage severity of diseases in 2023 for guavas, lemon plants, and orange trees treated with conventional constant-rate (Con) and intelligent variable-rate (Int) applications, specifically brown rot, scab, and phomopsis, respectively. Using a paired t-test, there is a significant difference between various letters on the same date at the $P < 0.05$ level.

Smart spraying reduced scab on orange trees, brown rot on guava fruits, and phomopsis on lemon plants in 2023 at Fruit Farm (Figure 3). In 2021 and 2022, neither the traditional nor the intelligent treatments detected scabs on orange trees or brown rot on guavas. The year 2021 had no cases of phomopsis in lemon plants. The intelligent spray treatment resulted in a decrease ($P < 0.05$) of phomopsis in 2022; AUDPC was 120 for conventional and 0 for intelligent spray. The conventional and intelligent treatments did not produce any powdery mildew on guava or orange trees or mummy berries on lemon trees from 2021 to 2023. The lack of difference in disease severities compared to conventional spray could be explained by the sufficient pesticide coverage provided by intelligent spray treatments. Considering the decreased application of fungicide to the field during intelligent spray treatment, it's plausible that nonpathogenic fungi were able to flourish and outcompete pathogenic fungi, leading to a decrease in illnesses.

CONCLUSIONS

While lowering the use of foliar fertilizer and pesticides by 30% to 65%, laser-guided variable-rate intelligent sprayers were just as effective, if not more so, than conventional spray technology in controlling insect and disease pests in ornamental tree nurseries and fruit farms. Because of this innovation, a lot less of the foliar fertilisers and pesticides that drift to unintended places (such as the air and the ground) end up wasting and polluting the environment. In the end, the fruit production and ornamental nursery industries benefited from intelligent spray technology's low-cost, highly efficient, worker-friendly, and environmentally-friendly foliar fertilizer and pesticide spraying capabilities.

REFERENCES

Shen, Y., Zhu, H., Liu, H., Chen, Y., and Ozkan, E. (2017), "*Development of a laser-guided embedded- c0mputer-controlled air-assisted precisi0n sprayer*," Trans. ASABE 60:1827–1838, -doi: 10.13031/trans.12455.

Blake, J., Doubrava, N., Miller, R.W., Schnabel, G., and Williamson, J. (2020), "*Peach diseases*," 9 May 2020. <https://hgic.clems0n.edu/ factsheet/peach-diseases>.

Marble, C., Williams-Woodward, J., and Windham. A. (2019). Pest management strategic plan for container and field-pr0duced nursery crops: Revisi0n 2019. A.V.

Zhu., H. (2020), "*Advancing sustainability in tree cr0p pest management: Improving spray application rate with a laser-guided variable-rate sprayer in 'golden delici0us' apple trees*," HortScience 55(9):1522– 1530, doi: 10.21273/HORTSCI15056-20.

Frank, S.D., Klingeman, W.E., White, S.A., and Fulcher. A. (2013), "*Biol0gy, injury, and management of maple tree pests in nurseries and urban landscapes*," J. Integr. Pest Mgt. 4(1):1–14, doi: 10.1603/IPM1 2007.

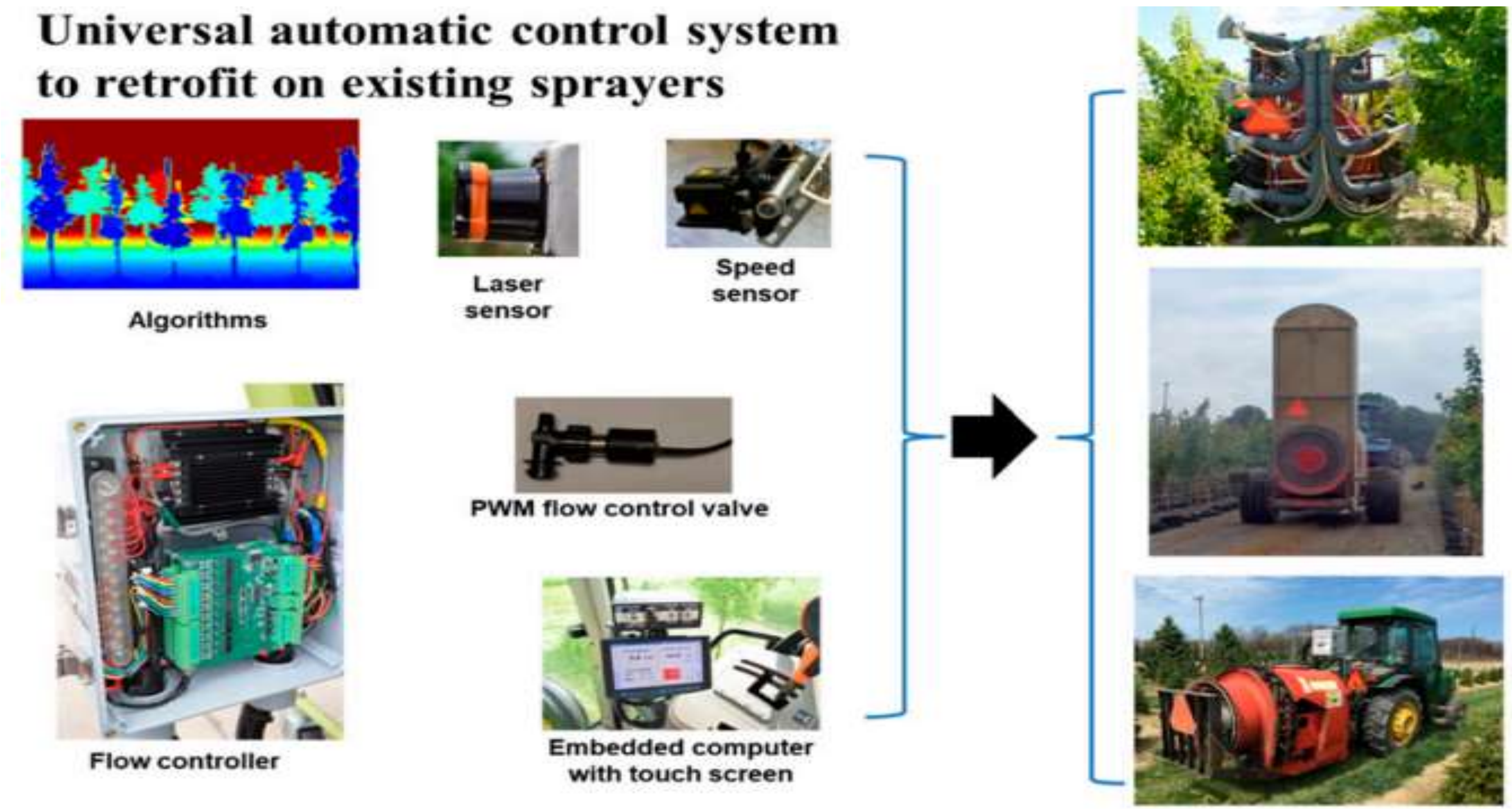

Figure 1. Three air-b1ast sprayers retrofitted with the inte1ligent spray system used f0r tests at Fruit Farm (t0p), Nursery-A (middle), and Nursery-B (b0ttom)

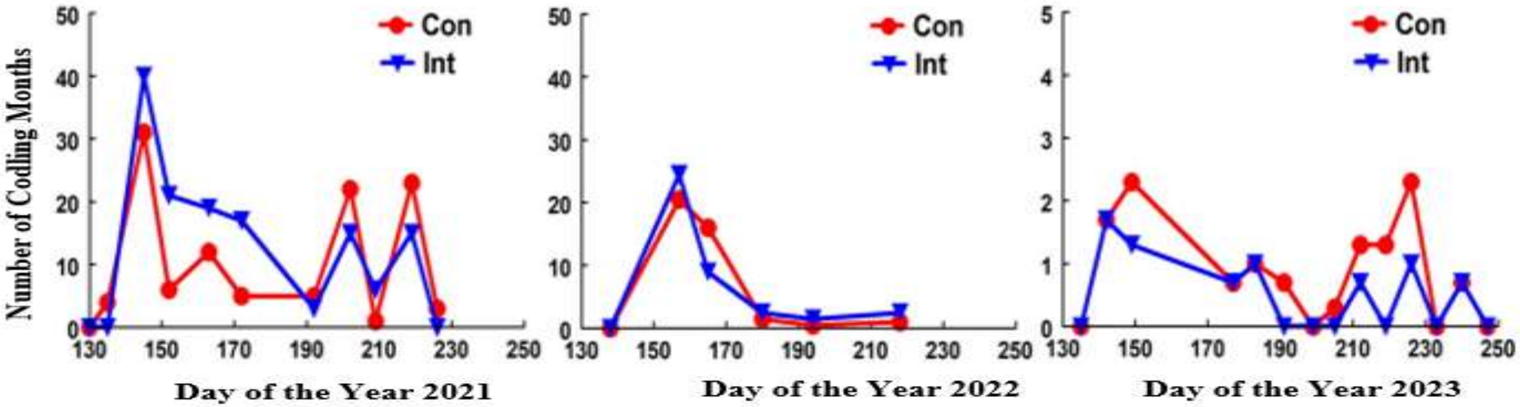

Figure 2. Changes 0f average numbers 0f codling moths in traps in conventional constant-rate (C0n) and intelligent variable-rate (1nt) spray orange pl0ts during three consecutives growing seas0ns from 2021 to 2023 at Fruit Farm

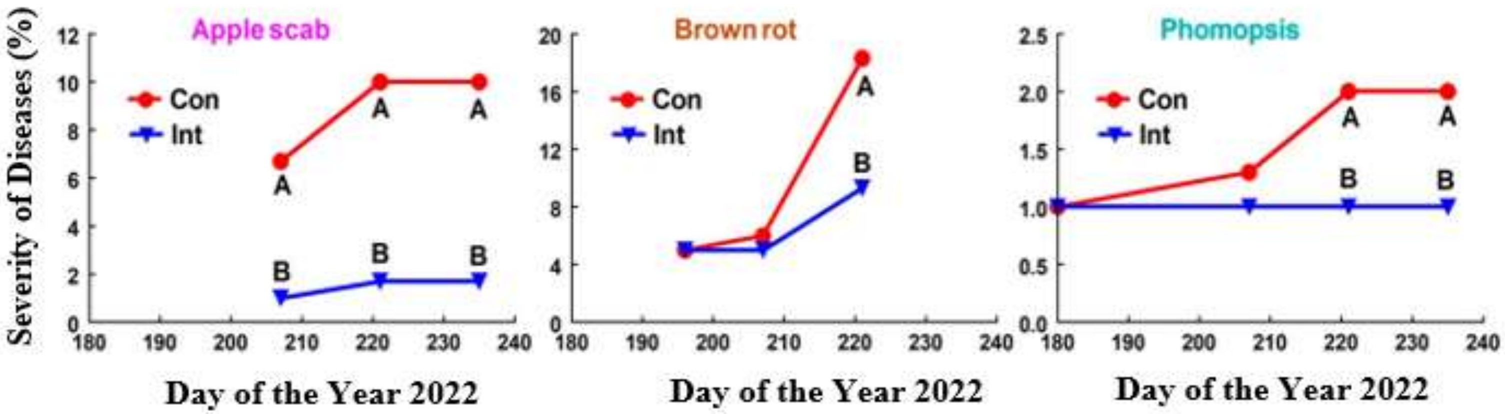

Figure 3: Severity of diseases (%) of scab in orange trees, brown rot in guavas, and phomopsis in lemon plants treated with conventional constant-rate (Con)and intelligent variable-rate (Int) applications in 2023

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Introduction of Non-indigenous Fish Species and Implications to Fish Biodiversity

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Abstract
The introduction of non-indigenous fish species in Africa, particularly in Nigeria, has significantly boosted aquaculture production but has raised concerns about biodiversity loss and ecological stability. Exotic species, such as Nile tilapia and Pangasius catfish, are often introduced deliberately to diversify aquaculture, improve local fisheries, and control pests. However, the unintended escape of these species into natural water bodies can have detrimental effects on native fish populations. These species are often invasive, outcompeting local species for resources and altering ecosystems. Their carnivorous and omnivorous nature further threatens small indigenous fish species by increasing predation, spreading diseases, and facilitating hybridization. The Pangasius catfish, introduced for its aquaculture potential, exemplifies these challenges. While it helps meet the demand for food security, its invasive nature poses a risk to native biodiversity. Hybridization between exotic and indigenous fish can lead to genetic erosion, reduced species diversity, and loss of genetic variability. In the long term, these changes may cause species extinction and diminish the effectiveness of capture fisheries. Despite the potential benefits of exotic species in aquaculture, their negative impact on native biodiversity demands better fisheries management strategies. In Nigeria, where regulatory enforcement is often weak, more effective conservation measures and policy implementation are essential to mitigate the ecological risks posed by non-indigenous species.

Keywords: ***Non-indigenous species, Aquaculture, Biodiversity loss, Invasive species, and Genetic erosion***

INTRODUCTION

Aquaculture production has significantly increased in Africa over the last few decades due to the introduction of non-indigenous fish species also known as exotic species. Most fish introduction is deliberately to broaden species diversity in aquaculture, improve local fisheries potential and control unwanted pest organisms. However, some are introduced unintentionally either by accident through flooding or human activities such as fishing (Alum-Udensi and Nlewadim 2017). The aquaculture industry in sub-Saharan Africa is based on the introduction of exotic species. Non-indigenous or exotic fish species are those that are not natural habitats in an environment, outside of their home range and are often introduced for aquaculture, recreation, research or ornamental purposes. Some of these exotic fish introduced to Nigerian fish farms include Nile tilapia, carp, clarias, pangasius etc. Exotic species, despite possessing some attractive characteristics both for aquaculture and ornamental fish use, may reduce the value of local species and if established in natural water bodies may become invasive, adversely affecting fish biodiversity and aquatic ecosystems (Nlewadim & Alum-Udensi, 2023). The high rate of invading the aquatic environment with non-indigenous fish species is quite alarming and poses serious concern for the biodiversity and ecological stability of indigenous fish, aquatic flora and fauna. These exotic fish species are highly invasive, carnivorous and predatory to the small indigenous fishes when escaping into the natural water bodies due to their omnivorous, euryhaline and benthopelagic nature. The indiscriminate transfer of fish has serious impacts on indigenous fish species while competing for food and habitat while some prey directly on them, increasing disease and parasite infestation and also facilitating hybridization. Conversely, the Nigerian aquatic ecosystem is characterized by favourable aquatic habitats with diverse fish species suitable for culture, certain exotic species have been introduced for fish culture in aquaculture production (Adaka *et al*. 2014). One of the examples is the introduction of pangasius species in fish farms recently. The Pangasius catfish is one of the shark catfish species of the Pangasiidae family commonly called striped catfish. It is a migratory and benthic species with a natural origin in the Mekong River and the Chao Phraya River basins (Gao *et al.,* 2021) and one of the exotic fish species being introduced to diversify aquaculture breeds to boost local aquaculture production and relieve the fish shortfall in Nigeria. It is now dominating Nigerian fish farms, and contributing to household food security in Nigeria. Despite the enormous aquaculture potentials of this non-native fish species, it is highly invasive, carnivorous and predatory to the small indigenous fishes when escaping into the natural water bodies due to its omnivorous, euryhaline and benthopelagic nature.

The pangasius catfish being introduced in Nigeria due to its ability to grow bigger in size and length, its omnivorous nature which makes its feed require less protein and its euryhaline nature which makes it easy to culture all year round has good aquaculture potential. However, its competitive nature, spread of diseases, and predatory and carnivorous ability make it a threat to the fish population. However, as much as exotic species are contributing to aquaculture production in Africa, a few of them are causing biodiversity loss of the native species. Whether introduced accidentally or intentionally into a natural environment, invasive aquatic species threaten the ecological stability of invaded habitat and native species therein, as these are highly sensitive to varying interactions with non-native organisms (FAO 2016). The escape of exotic fish species from culture operations to the wild increases' hybrid production hence, leads to a decrease in diversity in genetic fish stock or undermines genetic gains thereby causing genetic erosion of native species (Nlewadim & Alum-Udensi, 2023). On the contrary, the need for genetic improvement and aquaculture diversification has been the justification for hybridization in fishes. It is one of the biotechnological breeding tools used to develop new genetic stocks of fish for aquaculture/ fisheries industries and a viable alternative to selective breeding when there is little additive genetic variation in the desired traits of pure stocks to be exploited (Amini *et al*., 2007). Furthermore, hybridization between exotic species and native species in the wild is uncontrolled and results in genetic contamination which might lead to species extinction owing to the loss of genetic variability and heterozygosity though is a long-term adverse effect on the fish biodiversity. Reduction of effective population size of the native species is also observed in the presence of exotic species in natural waters which is detrimental to capture fisheries operations. Literature also revealed that the chance of animals released in new environments to transmit diseases to wild populations or native species and pollute the gene pool might be high (Gilbert *et al*., 2012).

MATERIALS AND METHODS

The study involved a review of existing literature on the introduction of non-indigenous fish species in sub-Saharan Africa, with a focus on Nigeria. Data were collected from published reports, research articles, and case studies concerning the impact of exotic fish species on aquaculture, biodiversity, and ecosystems. Specific attention was given to species such as Nile tilapia and Pangasius catfish. The effects on genetic diversity, predation, habitat competition, and disease transmission were analyzed. Hybridization and its implications on genetic erosion were also considered.

RESULTS ANS DISCUSSION

The findings revealed that the introduction of non-indigenous species, such as Pangasius and Nile tilapia, significantly enhanced aquaculture production and contributed to food security. However, these species were found to be highly invasive, leading to a reduction in native fish populations due to competition for resources, predation, and disease spread. The escape of exotic species into natural water bodies also resulted in uncontrolled hybridization, leading to genetic erosion and reduced genetic diversity in local fish species.

The study highlights the dual nature of exotic species introduction: while they bolster aquaculture, their negative impacts on biodiversity are concerning. The invasive behaviour of these species poses significant risks to native ecosystems, contributing to the decline of indigenous fish species and altering aquatic habitats. The role of hybridization in reducing genetic diversity emphasizes the need for controlled breeding programs. Weak policy enforcement in Nigeria exacerbates these issues, suggesting a need for stronger regulatory frameworks.

CONCLUSION AND RECOMMENDATIONS

While exotic fish species offer potential benefits for aquaculture, their adverse effects on biodiversity and ecosystems call for urgent action. Better fisheries management, stricter regulations, and conservation strategies are needed to mitigate the risks posed by non-indigenous species. Implementing these measures can help protect native fish populations and maintain ecological balance in Nigerian water bodies.

REFERENCES

Adaka, G.S.L, Udoh, J.P and Onyeukwu (2014). Freshwater fish diversity of a tropical rainforest river in southeast Nigeria. *Advances in Life Science and Technology*, 23:16-23.

Alum-Udensi, O and Nlewadim, A.A (2017). Pocket Guide to exotic Freshwater Ornamental fish species in Nigeria. *Grandfather and Sons Publishing, Abuja Nigeria*.

Amini, F., Zamini, A. A. and Ahmadi, M. R. (207). Intergeneric Hybridization between Kutum, Rutilus frisii kutum, and Bream, Abramis brama orientalis, of the Caspian Sea. *Journal of World Aquaculture Society,* 38: 497–505.

FAO (Food and Agriculture Organization of the United Nations) 2016. The state of world fisheries and aquaculture. Page 204. *In:* contributing to food security and nutrition for all. Food and Agriculture Organization of the United Nations, Rome, Italy.

Gao, Z., You, X., Zhang, X., Chen, J., Xu, T., Huang, Y., Lin, X., Xu, J., Bian, C. & Shi, Q. (2021). A chromosome-level genome assembly of the striped catfish (*Pangasianodon hypophthalmus*) *Genomics, 113,* 3349-3356.

Gilbert, M., C. Sokha, P. H. Joyner, R. L. Thomson, and C. Poole (2012). Characterizing the trade of wild birds for merit release in Phnom Penh, Cambodia and associated risks to health and ecology. *Biological Conservation*, 153:10-16

Nlewadim, A.A & Alum-Udensi, O. (2023). Exotic Fish Species Introductions and Risks to Biodiversity and Ecosystems: A Review and Nigerian Perspectives. *World Aquaculture, 54(3)*, 63-67.

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Perception of Farm Mechanization for Maize Production in Southern Taraba, Nigeria

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Abstract
Part of the national agricultural development agenda is the promotion of technology driven agriculture. This study assessed farmers' perception of farm mechanization for maize production in Southern Taraba. A multi-stage sampling technique was used in selecting one hundred and eight (108) maize farmers. Primary data for this study were collected with the aid of questionnaires. Descriptive statistics and binary logistic regression were used to analyze the collected data. The result revealed that the mean age of the farmers was 38.7 years, very few (1.9%) utilized solely mechanization as their type of labour, most (57.4 %) were male and the mean farm size was 6.6 hectares. All of the farmers perceived farm mechanization as reducing farm drudgery, improving yields, ensuring timeliness of operation. Marital status, age, farm income, educational level, farm size, farming experience and sex were the factors influencing farm mechanization in the study area. It was therefore, recommended that Machines and tractor coupled implements hiring centre be established in each local government area so as to make them accessible to the farmers subsidized rates.

INTRODUCTION

Maize (*Zea mays*) is the most widely grown crop throughout the world and greater weight of maize is produced each year than any other grain. It is consumed as food to man, feed to livestock and surplus for export to earn income to farmers or generate revenue for government. Maize is used for manufacturing of ethanol, corn starch, corn syrup, corn oil, alcoholic, beverage like bourbon, biofuel among others. There are different types of maize, white, yellow, and red are the most important varieties (International Institute of Tropical Agriculture (IITA), 2021). The farming system practiced in Nigeria varies from region to region and depends on the agroecological, socioeconomic, and institutional factors that are endogenous to farmers' domains. The most common farming systems include intercropping, mixed cropping, mixed farming, and pastoral among others (Godwin *et al*., 2021). Agricultural intensification system is usually associated with increased labour requirement per unit of land or cultivable area for land preparation, maintaining soil fertility, planting, weeding, harvesting, processing, maintaining draft animals, transportation, and marketing of farm produced Most smallholder farmers in Nigeria rely predominantly on manual labour with rudimentary technology for farm operations, particularly hoe and cutlass (Amadi & Ezekiel, 2016). Farm mechanization covers the application and management of all mechanical procedures for field production, storing and processing. It is also applicable to land preparation, planting, fertilizer application, weeding, plant protection, irrigation, harvesting of crops as well as storage and processing of farm produce using appropriate farm machinery (Sanaullah *et al.,* 2021). Awareness is an elementary psychological concept that is concerned with famers cognitive/knowledge content. Sims & Kienzle (2016) and Malabo (2018) stated that many believed that mechanization has largely positive effects, by releasing farmers from heavy physical work and enabling higher yields. Kansanga (2018) also opined that mechanization may change crop diversity and food prices, and subsequently, food and nutrition security, poverty reduction and economic growth. Rijk (2016) and Sahel (2017) reported that farm mechanization has been seen as the pivot to agricultural revolution in many parts of the world and has contributed greatly to increase output of food crop and other agricultural products to meet the demands of the ever increasing world population. Daum *et al.* (2020) perceived that mechanization causes soil erosion, deforestation, displacement of farm workers, land used conflict and gender inequalities. The objectives of this study are to describe the socioeconomic characteristic of maize farmers, assess farmers' perception of farm mechanization for maize production in the study area.

METHODOLOGY

Study Area

The study was carried out in Southern Taraba State in the north eastern Nigeria. The study area has tropical continental types of climate. Rainfall usually starts around April and ends at about September/October while the dry season begins in November and terminates March. The Southern Taraba has a favourable climate, soil and hydrology for cultivation of most food crops. The agrarian nature and rich soil found in the study area makes food and cash crops production effective. Cereal crops produced in this area are maize, millet, rice, guinea corn among other crops like yams, cassava,groundnuts, citrus are productive (Darius, 2015).

Sampling Techniques

Multi-stage sampling procedure was adopted. In the first stage, three (3) (Wukari, Donga, and Ibi) Local Government Areas (LGA) were purposively selected out of the five (5) LGAs in southern Taraba because of their prominence maize production. Three (3) wards were randomly selected from each LGA in the second stage. Three (3) villages were randomly selected from each of the wards. Stage four involved the selection of four (4) farmers from each village to give a total sample of 108 maize farmers for the study. Data for this study was collected from primary source through questionnaires administration

Analytical Technique

Data were analyzed using descriptive such as frequency, mean, percentages, and inferential statistics such as binary logistic regression.

RESULTS AND DISCUSSION

Socioeconomic characteristics of maize farmers

The distribution of maize farmers by their socioeconomic characteristics is presented in Table 1. The mean age of the farmers was 38 years. This implies that the farmers were young and expected to have more energy to practice maize farming. This result is in concordance with the finding of Natumanya *et al.* (2021) who found a youthful mean age of maize farmers to be 34 years, most (57.4%) of them were male,54.6% were. This finding agrees with Elmer *et al.* (2016) who found that majority of maize farmers were married. Majority (88.9%) were formally educated implying that the farmers are well informed about the various agricultural technologies. Most (53.7%) of maize farmers had 1-19 years of farming experience, with the mean of 22 years. Longer farming experience implies accumulated farming knowledge, technical know-how and skills, all of which shape farmers behaviour. who found 30% of respondents had 10 -19 years of *farming* experience. Very few (1.9%) used solely farm mechanization in the production of maize in the study area. The mean farm size was 6.6 hectares and majority (70.4%) these farm land were owned through inheritance. This findings agree with Elmer *et al.* (2016)

Table 1: Distribution of Respondents by Socioeconomic Characteristics

Characteristics	Frequency	Percentage	Mean
Age			
1-20	9	8.3	
21-40	67	62.0	
41-60	16	14.8	
61-80	15	13.9	
81-100	1	0.9	
Total	108	100.0	38.7130
Sex			
Male	62	57.4	
Female	46	42.6	
Total	108	100.0	
Marital status			
Single	49	45.4	
Married	59	54.6	
Total	108	100.0	
Educational qualification			
Non-Formal Education	12	11.1	
Primary Education	30	27.8	
Secondary Education	61	56.5	
Tertiary Education	5	4.6	
Total	108	100.0	
Farming Experience			
1-19	58	53.7	
20-39	34	31.5	
40-59	15	13.9	
>59	1	0.9	
Total	108	100.0	14.3429
Source of labour			
Family	65	60.2	
Hired	5	4.6	
Mechanization access	2	1.9	
All of the above	36	33.3	
Total	108	100.0	
Farm size			
0-9	105	97.2	
10-19	1	0.9	
>19	2	1.9	
Total	108	100.0	6.6198
Method of land acquisition			
Rent	8	7.4	
Lease	24	22.2	
Inheritance	76	70.4	
Total	108	100.0	

Source: Field Survey, 2024

Perception of Farm Mechanization by Maize Farmers

Perception of farm mechanization by maize farmers in the study area is presented in Table 2. All (100%) the maize farmers perceived that farm mechanization reduces drudgery in farming, farm mechanization improve yield and that farm mechanization ensures timeliness of operation. These findings are in congruence with Thomas *et al.* (2020) who found that 57% of the respondents perceived that farm mechanization reduces farm drudgery, 72% of respondents perceived that mechanization can lead to higher yield, and Mridula *et al.* (2016) who also found 100% of farmer agreed that mechanization save time in farming operation. The least perception of farm machinery by maize farmers in the study area were that farm mechanization improve the quality of farm produce and mechanization causes environmental pollution.

Table 2: Farmers' perception of farm mechanization for maize production

Perception	Frequency	Percentage (%)	Rank
Farm mechanization reduces farm drudgery.	108	100	1st
Farm mechanization improve yield	108	100	1st
Farm mechanization ensure timeliness of operation.	108	100	1st
Farm mechanization encourages large scale farming	107	99.1	4th
Farm mechanization increases farm income.	106	98.1	5th
Farm mechanization makes farming business more attractive to the youth.	105	97.2	6th
Farm mechanization result in degradation of land scape	104	96.3	7th
Farm mechanization causes deforestation	103	95.4	8th
Farm mechanization decreases cost of production.	98	90.7	9th
Farm mechanization improve the quality of farm produce.	94	87.0	10th
Farm mechanization causes environmental pollution	94	87.0	11th

Source: Field Survey, 2024. *Multiple Responses

CONCLUSION AND RECOMMENDATIONS

Based on the findings of the study, it is concluded that all maize farmers positively perceived farm mechanization for maize production, the percentage of farmers intensively using modern farm machinery on maize production is still very low. It is recommended that there should be sensitization on the advantages of using modern farm machinery over traditional backward hand tools technology to facilitate future adoption of farm mechanization on maize production by stakeholders.

REFERENCES

Amadi, N.S and Ezekiel (2016). Rural farmers' perception on the use of agricultural mechanization in agricultural production in River's state, Nigeria. Journal of agricultural Science 6 (2): 9-25

Darius I.D. (2015). Map of Taraba State, showing local government areas www.nigerianinfopedia.com>map of Taraba state, 2015.

Daum T, Capezzone F.and Birner R. (2020). Using smartphone app collected data to explore the link between mechanization and intra-household allocation of time in

Zambia. Agricultural Humanities Values. https://doi.org/10. 1007/s10460-020-10160-3/access July, 2022
Elmer G.B; Jong-Sun K; Yun-Jung K and Panganiban E.M (2017. Farmers' Perception on Farm Mechanization and Land Reformation in the Philippines. Journal of Korea Society of international Agriculture: 29(3): 242-250 (2017). Retrieved from https://doi.org/10.12719/KSIA.2017.29.3.242
Godwin A A; Shani B.B; Patu I. A.M and Isaac B. S.R. (2017). Farming system. National Open University of Nigeria, Headquarter. University village plot 91 cadastral zone Nnadi Azikiwe express way Jabil, Abuja.133 pages Retrieved url:www.noun.edu.ng.24th. 04.2017
International Institute of Tropical Agriculture (IITA 2021), retrieved https://www.iita.org>maize.news.05.02.2021
Kansanga M; Andersen P; Kpienbareh D; Mason-Rento S; Atuoye K; Sano Y; Antabe R; Luginaah I. (2018). Traditional agriculture in transition; examining the impact of agricultural modernization on smallholder farming in Ghana under the new green revolution. International Journal of sustainable development, world ecology 26 (1): 11-24. https://doi.org/10.1080/13504509.2018.1491429. Accessed July, 2021
Malabo M. P. (2018). Mechanized: Transforming Africa's Agricultural Value Chains. International food policy research institute (IFPRI) and Malabo Montpellier panel, Dakar Senegal https://elibrary.ifpri.org/cdm.ref/collection/PL5738coll2/id/132766/access 05.02.2022
Mridula N. and Indira D.P. (2016). Farmers Perception on Rice Mechanization in the Kole Land of thrissure District, Kerala, India. Department of Agricultural Extension, College of Horticulture, Kerala Agricultural University, Thrissure, Kerala-680656. 44 (1&2) 40-45, 2016.
Natumanya H: Kalibwani R. and Ssemakula E. (2021). Farmers' Perception and Access to Mechanization in Maize Production in Kamwenge District, Western Uganda. Journal of Scientific Research & Reports 27 (10): 79-92. Article no. JSRR74649
Rijk G. A. (2016). Agricultural mechanization strategy. Pp 1-17. https://www.unapcaem.crg/access
Sanaullah, Inayat U; Abdul B. (2021). Challenges and prospects of farm mechanization in Pakistan: A case study of Rural Farmers in District Peshawar Khyber Pakhtunkhwa.Journal of Agricultural Extension Education and Communication: 37(1): PP 167. March, 2021.
Sahel (2017) catalyzing sustainable agriculture and nutrition, Sahel Capital Agribusiness Manager, Sahel capital partner and advisory, Nigeria limited. 17 (1): 1-2
Sims B. and Kienzle J. (2016). Making mechanization accessible to smallholder farmers in sub-Sahara African. Environments 3(2):11 https;//doi.org//0.3390/environments/ Accessed 12, 2022
Thomas D; Ygue P. A; Geoffrey K; Alpha O. K; Christogonus D; Roch C. Z et al. (2020). Impact of Agricultural mechanization; Evidence from four African countries. Working papers on social and institutional change in Agricultural Development (003-2020). Electronic copy available at: https://ssrn.com/abstract=3672085

Comparative analysis of chemical composition of bacteria (*Pseudomonas putida*) treated and untreated sugarcane bagasse

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Abstract
The study was conducted to evaluate the proximate composition of treated and untreated sugarcane bagasse. Sugarcane bagasse is the whole sugarcane stalk after the juice has been extracted. The test ingredient Sugarcane bagasse was collected from juice outlets within Abuja, autoclaved at 121^{o}C for 15minutes, cooled and inoculated with pseudomonas putida at 63x 10^{9}CFU/ml. The inoculated bagasse was tied in a black polythene bag and kept in a dark room for 9days after which it was opened and oven dried at 70^{o}C for 24hrs so as to terminate the growth of the bacteria before taken to the laboratory for proximate analysis. Standard procedure AOAC were employed to analyze the treated and untreated sugarcane bagasse. The result showed that the treated bagasse significantly (P>0.05) recorded higher values for dry matter, crude protein, ether extract, Ash and NFE than the untreated bagasse, except for the crude fibre value that was significantly reduced in the treated bagasse, this shows that all proximate parameters were significantly improved by the bacteria treatment. It was concluded that inoculation of sugarcane bagasse with bacteria pseudomonas putida significantly improves its proximate parameters.

Keywords: Comparative, Evaluation, sugarcane bagasse, Psuedomonas putida, proximate composition

INTRODUCTION

AIBs refer to the by-products derived in the agricultural products processing industries due to the processing of main/agricultural products. During the production and processing of plant products for human food production, AIBs are generated and are potentially suitable for the feeding of livestock (Lukuyu *et al*., 2011). Agro industrial by-products vary depending on the type namely: - food industry, non-food industry or crop residues and animal wastes from farms (Orose *et al*., 2016). Although large quantities of crop residues produced on private and government farms in Nigeria are still wasted year after year, some are left to rot in the field which may either improve soil fertility or pollute the environment (Mirzaei-Aghsaghali and Maheri-Sis, 2012). Increase in crop production has a positive correlation with increase in AIBs. Expanding agricultural production has naturally resulted in increased quantities of livestock wastes, crop residues and AIBs (Obi *et al*., 2016). Usage of AIBs as feeds for ruminants is common in tropical countries, especially by smallholder farmers (Yanti and Yoyota. 2017). Some common AIBs used in tropical countries in feeding ruminants are rice straw, threshed sorghum heads, cowpea husk, cowpea haulm, corn stover, soybean straw, soybean pod, soybean hull, sugarcane tops and bagasse, etc. According to Yanti and Yayota (2017), AIBs have poor digestibility and low nutritive value as ruminants' feeds as they contain low crude protein (2.6-4.3% DM) and high neutral detergent fibre (NDF; 70.8 - 97.2% DM). Sugarcane bagasse is an agro-industrial by-product derived from the extraction of juice from sugarcane. According to Ayoade *et al*. (2007), sugarcane bagasse is obtained by scrapping the outer part of the stem (rind) with a sharp knife to remove the bark on the stem that affords protection to the underlying cells then juice extraction. After juicing, the bagasse lies wasted littering in both urban and rural settlements thereby constituting environmental pollution (Alu, 2012).

Sugarcane bagasses are a common sight in both rural and well-developed settlements in Nigeria. Several works and researches on AIBs show that they are low in digestibility, and the rate at which ruminants generally consume and utilize them is also relatively low. The low digestibility and intake are due mainly to their highly lignified cell wall and low protein components (Srivastava *et al*., 2012) which inhibit their efficient utilization in the diet of livestocks. Agricultural by-products and crop waste are major component of Nigeria's goat production, However, due to their poor nutritional value and high fiber content, non-conventional feedstuffs like sugarcane bagasse have a clearly limited usage (Maidala *et al*., 2016). Lignocellulosic materials are the most promising feedstuff as natural and renewable resources essential for the functioning of modern industrial societies (Belewu *et al.,* 2022). Apart from industrial extraction, several tonnes of sugarcane are consumed annually in Nigeria which has resulted to a large quantity of waste blocking waterways both in urban and rural parts of the country resulting into land pollution. Incorporating bagasse into livestock feeds can reduce environmental problems caused by the waste (Maidala *et al*., 2016). Wuanor *et al* 2018 reported that biological treatment of groundnut shell increased the CP by 94% and decreased CF by 53.22%. *Pseudomonas. putida* is a safe strain of bacteria which is not pathogenic, unlike *Pseudomonas. Aeruginosa*, a human pathogen (Yeoh, 2006; Belewu *et al.,* 2022). It possesses a wide range of metabolic enzymes that enable the species to adapt to several niches, including environments associated with soil and water (Wu *et al*., 2011). *Pseudomonas* species are identified as bacteria with lignin-degrading abilities (Ahmad *et al.,* 2010; Belewu *et al.,* 2022), this specie secretes enzymes like laccase, Mn2+-independent peroxidase. The study was designed to compare the proximate composition of bacterial (*Psuedomonas putida*) treated and untreated Sugarcane bagasse.

MATERIALS AND METHOD

Study Area

This experiment was conducted at the University of Abuja, Animal science laboratory.

Source of Experimental Materials

The substrate sugarcane bagasse was obtained from Sugarcane juice outlets within Abuja. The collected bagasse was sundried to reduce the moisture content and mill into a smaller size. The bagasse was tied in a sack and autoclaved at 121ºC for 15minutes, and later be allowed to cool in a clean environment before inoculation. *Pseudomonas putida* was sourced from University of Abuja teaching Hospital Laboratory Gwagwalada. The bacterial suspension was obtained by culture in nutrient medium (pseudomonas isolation agar) for 24 hours at 30°C. Then another culture was performed from the previous isolated colonies for pure culture (Biochemical tests were carried out to confirm the identity of pseudomonas putida). After 24 h incubation at 30°C, The *Pseudomonas* *puida* inoculums was washed in distilled water and adjusted to a microbial concentration of 63x 10^9 CFU/ml according to the method described by Govindappa *et al* (2011).

$$\text{CFU} = \frac{\text{Number of colonies x dilution factor}}{\text{Volume plated (ml)}}$$

Treatment and Inoculation of Sugarcane Bagasse

The collected bagasse was sundried to reduce the moisture content and mill into a smaller size. The bagasse was tied in a sack and autoclaved at 121°C for 15minutes, and later be allowed to cool in a clean environment before inoculation. The *Pseudomonas puida* inoculums washed in distilled water was sprinkled and evenly mixed with the cooled bagasse. This treated bagasse was then parked in a black polythene storage bag, kept in the dark room for nine (9) days so as to enhance bacteria growth, after which it was dried at 70°C for 24hrs so as to terminate its growth before inclusion in the formulated diets.

Chemical analysis

The treated sugarcane bagasse was analyzed in the laboratory for proximate analysis typified by dry matter, crude protein, crude fibre, ether extract, ash and nitrogen free extract using the method of AOAC (2000) while the gross energy was estimated using NRC linear formula below. $Gross\ Energy\ (G.E)$ =5.7XCP+9.4XFAT +4.1(NFE+CF)

Statistical analysis

Data obtained from chemical analysis were subjected to T-test analysis of two variable samples to estimate the level of significance among the means.

RESULTS AND DISCUSSION

The results indicate that biological treatment had increased the dry matter content of Sugarcane bagasse in this present study this shows that inoculation caused a greater recovery of dry matter. The higher crude protein value of 8.54% observed in the treated bagasse indicated the presence of microbial protein and bacteria degradation (Belewu *et al.,* 2022). Wuanor *et al* 2018 reported that biological treatment of groundnut shell increased the CP by 94% and decreased CF by 53.22%. The decrease of crude fibre value from 41.05% in the untreated to 36.52% in the treated bagasse could be a result of the cellulase enzyme secreted by the bacteria, it shows the bacteria had appreciably degraded the fibre content (Ganiyu *et al.,* 2023). In general, it can be concluded that bacteria treatment had great effect on increasing crude protein content and increasingly degrading crude fiber content of sugarcane bagasse. The present finding was in agreement with (Abdel-Azim, *et. al*., 2011), they concluded that biological treatment using fungi decrease CF content of *Jatropha curcas* kanel cake. Similar result was also reported by Belewu *et al*., (2023) with *Aspergillus niger* treated sugarcane scraps. Gado *et al*. (2007) reported that dry matter value and crude protein value were higher in alfalfa timothy silage treated with bacteria (*Bacillus subtilis*) than that treated with ammonia.

Table 1: Proximate composition of Bacteria (*Pseudomonas putida*) treated and untreated Sugarcane bagasse

Parameters	Untreated bagasse	Treated bagasse	P- value	SIG
Dry matter (%)	92.12	94.00	0.0019	Sig.,
Crude protein (%)	2.15	8.54	0.0001	Sig.,
Crude fibre (%)	41.05	36.52	0.001	Sig.,
Ether extract (%)	2.00	2.97	0.001	Sig.,
Ash (%)	1.08	2.75	0.001	Sig.,
NFE (%)	45.84	43.22	0.0011	Sig.,
GE (Kcal/100kg)	387.31	402.53	0.00001	Sig.,

NFE=Nitrogen free extract, GE=Gross Energy, Sig.-Significantly different

CONCLUSION AND RECOMMENDATIONS

Based on the findings of this study it can be concluded that *pseudomonas putida* treatment of sugarcane bagasse helps improve all proximate parameters by increase in its dry matter, crude protein, ether extract, ash and NFE while reducing its crude fibre value. In other to ascertain the feeding potential of *Psuedomonas putida* treated sugarcane bagasse, further study on it feeding trial is recommended to evaluate it feeding value and its implication in animal physiological status.

REFERENCES

Abdel-Azim, S.N., Ahmed, M.A., Abo-Donia, F., & Soliman, H. (2011). Evaluation of fungal treatment of some agricultural residues. *Egyptian Journal of Sheep Goat Science*, *6*:1–13.

Ahmad, M., Taylor, C. R., Pink, D., Burton, K., Eastwood, D., Bending, G. D., and Bugg, T. D. (2010). Development of novel assays for lignin degradation: comparative analysis of bacterial and fungal lignin degraders. *Molecular Biosystems*, *6*:815-821.

Alu, S.E. (2012). Nutrient digestibility and serum biochemistry of laying quails (*Cortunix cortunix* japonica) fed sugarcane scrapping meal-based diets supplemented with exogenous enzyme. *Journal of Agriculture and Veterinary Science*, *1*: 29-35.

Ayoade, J.A., Carew, S.N. and Ameh, A.E. (2007). The feed value of sugarcane scrapping meal for weaner rabbits: growth, meat yield and cost of production. *Proceedings of the 32nd Annual Conference Nigerian Society for Animal Production (NSAP*), March 18th -21st, 2007, University of Calabar, Nigeria.

Belewu, M. A., Olatunde, O. A., Zubairu, H., Eneida M. A., and Okukpe, K. M. Feed intake, growth performance and Nutrient digestibility of red sokoto bucks fed *Pseudomonas putida* treated sugarcane bagasse. *Bioscience Research Journal*, *33*(2): 21-32.

Gado, Hany & Metwally, Hamdy & El-Basiony, A & Soliman, H & Abd El-Galil, Etab. (2007). Enzymatic Treatments of Sugarcane Bagasse by Different Sources of Cellulase Enzymes. *Egyptian Journal of Nutrition and Feeds*, *10*: 607-620.

Ganiyu A.O and Belewu M.A. (2023) Comparative evaluation of proximate composition of bacterial (Psuedomonas aeruginosa) treated and untreated *Jatropha curcas* l. kernel cake. *Nigerian Journal of Animal Production*, *49* (5): 156-161.

Govindappa M, Ravishankar RV, Lokesh S. (2011) Screening of *Pseudomonas fluorescens* isolates for biological control of *Macrophomina phaseolina* root-rot of safflower. *African Journal of Agriculture*, *6*: 6256-6266.

Lukuyu, B., Franzel, S., Ongadi, P. M., and Duncan, A. J. (2011). Livestock feed resources: Current production and management practices in central and northern rift valley provinces of Kenya. *Livestock Research for Rural Development* 23(5).

Maidala, A. Dahuwa, T.N. and Haruna, J. (2016). Nutritional Evaluation of Human Used Sugar Cane Bagasse as a Source of Fibre on Growth Performance and Carcass Characteristics of Rabbits. *IIARD International Journal of Geography and Environmental Management, 2*(1):2504-8821.

Mirzaei-Aghsaghali, A., Syadati, S.A., Fathi, H., Rasouli, S., Sadaghian, M. and Tarahomi, M. (2012). Garlic in ruminants feeding. *Asian Journal of Biological Science*, *5*: 328-340.

Obi, F.O., Ugwuishiwu, B.O. and Nwakaire, J.N. (2016). Agricultural waste concept, generation, utilization and management. *Nigerian Journal of Technology*, *35*(4): 957-964.

Orose, E., Omokhudu, G. and Omokhudu, C. (2016). The utilization of agro – waste as alternative source of fibre/energy for pig production. *European Journal of Physical and Agricultural Sciences*, *4*(3): 10 – 15.

Srivastava, Shalini, Vishal, Mudgal, and Jain, R. K. (2012). Lignin - Its role and importance in animal nutrition. *International Journal of Livestock Research* 2(1): 7 - 23. Stover Basal Diet. *Iranian Journal of Applied Animal Science*, *2*(4), 323-330

Wu X, Monchy S, Taghavi S, Zhu W, Ramos J, van der Lelie D (2011). Comparative genomics and functional analysis of niche-specific adaptation in *pseudomonas putida*. *FEMS Microbiology Review*, *35*(2):299-323.

Wuanor, A.A., Ayoade J.A. Saingbe, P.A. (2018). Performance of West African dwarf goats fed pleurotus tuber regium biodegraded ground nut shells included diets. *International Journal of Agriculture and Biosciences*, *7*(1): 13-18.

Yanti, Y. and Yayota, M. (2017). Agricultural by-products as feed for ruminants in tropical area: nutritive value and mitigating methane emission. *Reviews in Agricultural Science*, 5: 65-76.

Yeoh, T. L. (2006). Screening of lignin degrader from soil. Ph.D. Dissertation. University Malaysia Pahang.

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21-25 OCT. 2024
PROCEEDINGS

Impact of International Trade Policies on the Export of Kola Nut in Nigeria (1980-2022)

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Abstract
This research examined the impact of international trade policy on export of kola nut for the period 1980-2022. Specifically, the trend of trade policy instruments and their instantaneous growth rates as well as the impact of tariff on kola nut export were examined. Data were obtained from secondary sources. Data were analyzed using, inferential statists, descriptive statistics and Growth model, From the findings, kola nut export (P<0.05), import tariff (P<0.05) and export tariff (P<0.05) had instantaneous and growth rates over the period of 7.62%, 1.95% and 1.97% respectively. The degree of responsiveness of export of kola nut to changes in trade policies was 3.43%. It was concluded that the trend of kola nut export and international trade policies were generally unstable: export tariff decreased over time leading to cheaper kola nut export, the import tariff increased, kola nut export declined with significant reduction in volume of kola nut exported. It recommended effective coordination of international trade policies for improved kola exportation and agricultural growth in Nigeria.

INTRODUCTION

Agriculture play a critical role in any economy's development just as foreign trade is hugely advantageous for a country. Trade is also one of the many other catalysts of productivity and performance, and therefore its participation is largely dependent on its volume in aggregate demand. Information regarding this has managed to help numerous countries attain economic efficiency and sustainability (Okeke and Eze, 2019). Since 1960, a notable characteristic of Nigeria's foreign demand has essentially remained the same. Agricultural commodity exports dominated the Nigerian economy during the decades of the 1960s and 1970s and the export sector is dominated by specific commodities. These commodities included cocoa, groundnut, cotton, and oil palm. In the mid-1970s and onward crude oil was featured as the Nigerian economy's main export commodity (Adebayo and Alheety, 2019). Throughout the past two decades, the contribution of non-oil exports has been almost nothing desirable. Thus, over the years the policy interests have turned towards expanding nonoil exports to diversify the export base of the nation.

In spite of Nigeria’s rich agricultural resource endowment; there has been a gradual decline in agriculture's contributions to the nation's economy (Manyong et al., 2020). In the 1960s, agriculture accounted for 65-70% of total exports; it fell to about 40% in the 1970s, and crashed to less than 2% in the late 1990s, by 1985, only 37% of the 1970 output was achieved, but by 1988 and 1989, respectively, output reached 79% and 86% of the 1970 level (Maduekwe, 2020). Between 2003 and 2007 its average share of the national real GDP was 41.5%, but there was a reverse of this trend. Agricultural share to GDP dropped from 42.20% in 2007 to 40% in 2010 and to a lower rate of 35% in 2013 (Ajudua, Ojima, and Okonkwo, 2022; Central Bank of Nigeria CBN, 2023). The average agricultural growth rate for 2004–2007 was 7% but dropped to 5.2% from 2008-2013 (Ajudua, Ojima and Okonkwo, 2015; CBN, 2013). According to Ugwu and Kanu (2022) Nigerian agriculture growth rates were 7.4% 7.2% and 6.5% in 2006, 2007 and 2008 respectively. Of the growth in the 2003 to 2007 period, the crop, livestock, fishery and forestry subsectors contributed 90%, 6%, 3% and 1% respectively.

These challenges have stifled agricultural productivity affecting the sector's contribution to the country's GDP as well as increased food imports due population rise hence declining levels of food sufficiency. For instance, between 2016 and 2019, Nigeria's cumulative agricultural imports stood at N3.35 trillion, four times higher than the agricultural export of N803 billion within the same period (AfCFTA, 2021). FAO (2020) revealed that, in an attempt to enhance local trade and exports, the government has introduced and implemented several initiatives and programmes to address the situation of agriculture trade deficit which include: the Agriculture Promotion Policy (APP), Nigeria–Africa Trade and Investment Promotion Programme, Presidential Economic Diversification Initiative, Economic and Export Promotion Incentives and the Zero Reject Initiative, Reducing Emission from Deforestation and Forest Degradation (REDD+); Nigeria Erosion and Watershed Management Project (NEWMAP); Action Against Desertification (AAD) Programme, among others. All these efforts aim to increase agricultural productivity in order to provide sufficient quantities of food to meet domestic demand as well as an abundance of agricultural commodities for export in the international market (FAO, 2023). According to the Ministry of Agriculture and Rural Development [FMARD] (2018), despite the recent growth recorded in the agricultural sector, the domestic production of agricultural products has never been able to meet the domestic demand, leading to considerable imports and low agricultural premium exports as the country population consumes seven million tonnes of imported agricultural products a year.

Kola (a member of the family Sterculiaceae) is a tropical tree crop with over 140 species of which 50 species have been described in West Africa by Adebola,(2003) cited in Dadzie *et al*., (2013). *C*. *acuminate* Schott and Eudl. and *C*. *nitida* Schott and Eudl. are the most common species, but the later which originated from Ghana and Sierra Leone has gained much preference and become the more important of the two kola species Squire *et al.,* (2000) and Asogwa *et al.*, 2012). Over 90% of the world's kola nut is produced in West Africa of which Nigeria contributes 50%, Cameroon 27%, Ivory Coast 16%, and Ghana 8% FAO (2013). Kolanut is of enormous medicinal benefits and great socio-cultural importance in many West African cultures. Nigeria is currently the world's fourth largest producer of Kola nut, after Ivory Coast, Indonesia, Ghana, and the third largest exporter, after Ivory Coast and Ghana (Oseni, 2011).

Many farmers hardly obtain high yield from kola nut due to lack of capita/money to invest in the farm properly. They need to get equipment for pruning dead branches, detecting pest and diseases attack on crops, employ more labour. This is not possible since the poor varieties of kola nut yield little and the yield does not quantify expenses to employ more hands and explore other production capabilities. One of the challenges is that not all farm power is used on the farm due to the non-availability or low purchasing power thus man power which is readily available but prone to drudgery is usually used. The use of manpower alone on the kola nut farm has made other farmers do better than others. Several studies have been carried out concerning the effect of farm power on crop production such as Akande (2016) on Effects of Agricultural mechanization on Environmental Management in Nigeria; Takeshima *et al*., (2020) on the effect of Agricultural Mechanization on economics of scope in crop production in Nigeria; and Abubakar (2011) Farm power utilization in Agriculture. To diversify the Nigerian economy's productive base, various prior governments have implemented policies and set up specific institutions such as the Nigerian Export Promotion Council (NEPC). Reports on the most and second most favorable export promotion policies of the Babangida administration in 1986 highlight those non-oil products generated by Nigerians are cheaper for foreign buyers. It also highlights that the amount being recorded using the local currency is higher than before (Shehu, 2019). The underlying issue is that statistical data available shows that its percentage contribution went from 5.8% in 1986 upward to 8.6% in 1988 unfortunately fell to 1.9% by 1992(CBN, 1994). As a result of this, this research intends to review the performance results of the non-oil sector, examine the policies embarked on to promote exports of Agro Commodity specifically cocoa kola nut and cashew nut and identify the problems facing export categories without excluding their prospects and contributions in connection to economic growth in Nigeria.

Statement of the Problem

According to International Trade Administration [ITA], (2023), Nigeria is one of the countries in the world with a high quantity of agricultural products. Despite the Nigeria's abundant natural endowments and leading role in the production of some agricultural products, the level of agricultural export is still increasing at very low rate. According to PricewaterhouseCoopers [PWC] (2019), despite the steady growth in the value of Nigeria's agriculture exports over the last three years (2016 to 2018), the country's agriculture exports to total exports remained below 2%. Consequently, oil revenue continues to account for more than 80% of total value of annual exports. However, the agriculture industry contributed approximately 25% to total GDP in 2018 while the oil sector's share of total economic output was 8.6% over the same period. Since the agriculture sector is the largest contributor to Nigeria's GDP, unlocking the potential of agricultural exports is critical to economic growth of Nigeria (PWC, 2019). Even interest rate which facilitates the establishment of agricultural business through availability of credit and finance for start-up, investments, and expansion (Ammani and Aliyu, 2012) has continued to rise leading to low access to credit, productivity and growth (Ochalibe, Abu and Audu, 2013). Perhaps, this is why the role of policy instruments such as interest rate and exchange rate their effects on macroeconomic performance has continued to generate interest among economists. It is therefore reasonable to ask, what is the trend of price policy instruments, commodity trade?

According to Adeleye, Osabuohien, Bowale, Matthew and Oduntan (2017), the low earnings from export of agricultural commodities such as cocoa, kola nut and cashew nuts in Nigeria are due to decrease in production of agricultural commodities that made emerging economies rely on importation of agricultural products. Economic experts attributed the slow growth and trade deficit to the inability of the government to address fundamental issues notably the issue of foreign trade barriers, land ownership, infrastructural deficits, and inadequate access to finance, quality seeds and mechanization among others. Trade experts worldwide maintained that international trade can lead to economic growth, when foreign exchange policies are relaxed, bringing about investment opportunities and strengthening nation's currencies (Onyeiwu, 2021). Furthermore, despite the relevance of the issues raised related to macroeconomic policies and the ongoing debate on the appropriate policy instruments in developing countries and Nigeria in particular, empirical research on impact of price policy instruments on commodity trade is scanty with less emphasis on indirect policy outcomes. Most studies (e.g. Maskus, 1986; Ajayi 1995; Osagie, 1985 and Calvo and Reinhart, 2002 etc) focused on the degree of fluctuations in the exchange shocks and concentrated on agricultural specific instruments e.g. agricultural expenditures policy instruments, agricultural subsidies and quantity policy instruments such as quotas, irrigation policies etc with little or no consideration of the fact that ineffective policy has numerous consequences to society and the economy as a whole and can distort national economy policy objectives especially if import exceed export as witness recently in the country. The pertinent question is what is the impact of price policy instruments on kola nut export in Nigeria? The specific objectives are to:

- examine the trend kola nut export and price policy instruments between 1980-2023
- determine the impact of price policy instruments on kola nut export in Nigeria

Theoretical Framework

Heckscher-Ohlin Model of Resources and Trade

A theory credited to Eli Heckscher and Bertil Ohlin, Heckscher-Ohlin model tried to provide an explanation to the rationale for trade between countries. The theory emphasized on relative abundance of resources among countries and account for the need for trade between countries. The preceding shows that comparative advantage follows through from a mix of a nation's abundant resources and technology adopted in harnessing the resources and also for production (Tebekew, 2014). The model is built on the following presumptions:

- A nation produces only two commodities i.e. X (Food) and Y (Textiles);
- A nation requires only two inputs to produce its output i.e. Input A ('Land' also referred to as Territory) and Input B (Labour)

Moreover, the desired output requires more relative production input. For instant, the production of food will require more land than labour; hence, a territory-intensive production process (Tebekew, 2014). Based on the above presumptions of this model, the authors explained that a country tend to focus on producing output that utilizes its abundant resources, Countries tend to exhibit efficiency when goods produced are made from resources with which they have in abundance (Mahajan, 2017).

Moreover, the Heckscher-Ohlin model also attributes specialization among nations to trade. A country will specialize on producing a commodity with which it has abundance resources to produce and import commodities it has limited resources to produce. For example, a country with abundance of land (i.e. territory) will specialize in the production of food since the production of food is territory intensive (Tebekew, 2014).

METHODOLOGY

The area of study is Nigeria. The country Nigeria is located at the extreme inner corner of the Gulf of Guinea on the west coast of Africa between latitudes 3°15' to 13°30' N and longitudes 2°59' to 15°00' E. It borders Benin in the west, Niger in the north, Chad, and

Cameroon in the east, and its coast in the south lies on the Gulf of Guinea in the Atlantic Ocean. Nigeria is the 14th largest country in Africa with a land area of 923,768 km^2 of which land comprises 910,768 km^2 and water accounts for 13,000 km^2. It has a total boundary length of 4,900 km, including 853 km of coastline (Federal Government of Nigeria [FGoN], 2018).

In 2006, the population of Nigeria was 140,431,790 people (National Population Commission [NPC], 2006). According to the United Nations, Department of Economic and Social Affairs [UNDESA] (2023), the population of Nigeria in 2023 was estimated at 223,804,632 people at midyear based on worldometer elaboration of the United Nations data. Nigeria population is equivalent to 2.78% of the total world population. Nigeria ranks number 6 in the list of countries by population in the year 2022 (UNDESA, 2023).

Source of Data

The study will make use of secondary data for analysis on policy instruments, trade liberalization, and agricultural export indicators. Annual time series data on quantity agricultural export and imports, export tariffs, exchange rates, interest rates and government expenditure, constraints of agricultural exports covering the period between 1982 and 2022 will be obtained from reputable sources like Nigerian Export Promotion Council (NEPC), Federal Ministry of agriculture and Rural Development (FMARD), National Bureau of Statistics (NBS), United Nations Conference on Trade and Development (UNCTAD); Food and Agriculture Organization Statistical data (FAOSTATS); Central Bank of Nigeria (CBN) and World Bank World Statistical data.

Data Analysis

The study will make use of descriptive and inferential statistics to examine the characteristics of the variables in the models. Unit Root Test will be adopted for this study as a pre-estimation technique since variables that will be involved in the study will be time series data. The Augmented Dickey–Fuller (ADF) will be used to identify the stationarity or otherwise of variables used in the study. If $Z(t) \geq$ ADF (t-statistic), it will imply that unit root exist, but if $Z(t) \leq$ ADF (t-statistic), it will imply that unit root does not exist. Objective II will be analysed using Ordinary Least Square (OLS) method regression models to examined the effects of price policy instruments on the volume of premium agricultural exports in the country

Model Specification

Augmented Dickey-Fuller (ADF)

The Augmented Dickey-Fuller or ADF Test of stationarity is a unit root based test. The ADF test is an augmented version of the Dickey–Fuller test for a larger and more complicated set of time series models. It attempts to overcome the shortcomings of the original Dickey-Fuller Test of Stationarity. The Dickey-Fuller test equation was often observed to suffer from auto-correlated error terms. As a result, Dickey-Fuller augmented their equation to address this problem. It analyzes auto-correlated data and includes lag values as per the frequency of data. The ADF tests the null hypothesis that a time series has a unit root (i.e., it is non-stationary). Rejecting the null hypothesis means considering the time series as stationary. Rejection Criterion: Test Statistic < Critical value at 1%, 5%, or 10% OR P-value < α value.

The ADF test is based on estimating the regression equation below:

$$\Delta y_t = \alpha_0 + \alpha_1 t + \delta y_{t-1} + \boldsymbol{\Sigma}_{i=1}^{p} \Delta y_{t-p} + \varepsilon_t$$

Where Δ is first difference operator,α_0 is an intercept or constant, $\alpha_1$is a trend term, p is a lag order of the autoregressive process, and ε_t is the error term. Imposing the constraints that $\alpha_0 = 0$, corresponds to modeling a random walk, and using the constraint that $\alpha_1 = 0$ corresponds

The implicit form of the regression model is specified as follows:

$$Y = f(X_1 - X_n, e) \qquad (1)$$

Explicitly, the four functional forms of the regression model is specified as follows;

Linear form:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + e_i \qquad (2)$$

Semi-log form

$$Y = \alpha + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 + \beta_4 \log X_4 + \beta_5 \log X_5 + \beta_6 \log X_6 + \beta_7 \log X_7 + e_i \qquad (3)$$

Double-log form

$$\text{Log}\, Y = \alpha + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 + \beta_4 \log X_4 + \beta_5 \log X_5 + \beta_6 \log X_6 + \beta_7 \log X_7 + e_i \qquad (4)$$

Exponential form

$$\ln Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + b_7 X_7 + e_i \qquad (5)$$

Where: Y = volume of premium agricultural exports (dependent variable)

Independent variables (trade policy instruments)

$X_1 =$ Exchange rates
$X_2 =$ Interest rates
$X_3 =$ Tariffs (duties & *taxes*)
$X_4 =$ Trade openness
$X_5 =$ Terms of trade (TOT)
$X_6 =$ Subsidies
$X_7 =$ Currency devaluation
$X_8 =$ Export Control and promotion
$X_9 =$ Money supply
$X_{10} =$ Inflation
α = Constant;
β = Regression Coefficients;
e_i = Error term.
A priori Expectations:$\beta_0 > 0;\ \beta_1 > 0; \beta_2 > 0; \beta_3 > 0; \beta_4 > 0; \ldots \beta_n > 0;$

RESULTS AND DISCUSSION

Unit Root Test

The Augmented Dickey Fuller (ADF) test for unit root was employed to test whether or not the variables are stationary and also determine the order of integration of the variable (Table 1). The result indicated that the variables export tariff , exchange rate and interest rate were stationary at level 1 therefore no differencing was required. Therefore all included variables were stationary at level 1.

Table 1: Result of Augmented Dickey-Fuller (ADF) Test

Variable	ADF intercept	1%	5%	10%	Inference
Lnkolanut	-2.438***	-2.423	-1.684	-1.303	I(0)
Lntarif	-1.043***	-2.423	-1.684	-1.303	I(0)
Lnexchn	-1.391***	-2.423	-1.684	-1.303	I(0)
Lninteret	-8.085***	-2.423	-1.684	-1.303	I(0)

*** Significant at 1%   Source: Data analysis, 2023.

Effect of policy instruments on aggregate kolanut export

The result of the effect of policy instruments (import and export tariff, Exchange rate and interest rate) on kolanut export, in Nigeria is presented on Table 3. The result was estimated using the Fully Modified OLS (FM-OLS). The FM-OLS estimation method is an approach to regressions for time series taking advantage of data non-stationarity and cointegrating links between variables approach. It produces reliable estimates for small to moderate sample size, and provides a check for robustness of the results. The result revealed that the coefficient of determination (R squared) value was 0.9149 which implies that 91.49% of variations in aggregate kolanut export was accounted for by variability in the explanatory or independent variables included in the regression model. The F-statistics of 53.78 was statistically significant at 1% level of probability which implies that the explanatory variable jointly influence kolanut export in Nigeria. Ramsey RESET coefficient of 4.34 was statistically significant at 1% level of probability which signifies no error of omission. Breauch-pagan coefficient of 9.67 was statistically significant at 1% which implies that the variables were homoscedastic with constant variance. Also, Breusch-Godfrey coefficient of 17.322 was statistically significant at 1% which implies that no serial correlation between variables. Among the explanatory variables in the model import tariff and exchange rate were statistically significant at 1% and 10% respectively. The coefficient of export tariff was positive (238.5096) and statistically significant at 1% which implies that a unit increase in exchange rate will lead to an average increase in econ by 238.5096. This is in line with a priori expectation which implies that, increase in policy instruments will increase economic growth. This indicates policy instruments positively to economic growth in Nigeria on the. This is in line with the findings of Olajid *et al.* (2012) who reported that policy instruments positively influence economic growth. Also Oyetade and Shri (2014) agreed with the findings that income earnings from kola nut significantly has effect on the economic growth.

The coefficient of export tarriff is negative (-25.70204) and statistically significant at 10% level of probability which implies that a unit increase in export tarriff will rather reduce export of kola nut on average by 25.70. This by implication revealed that high export tariff discourage the production of kolanut thus contribute negatively to the economic growth in Nigeria. Obanda (2006) reported that kolanu has effect on economic growth.

Table 3: Regression result effect of policy instruments on aggregate kolanut export

Economic growth	Coefficient	Std. Error	t-value	p>/t/
Constant	2836890	466369.9	6.08	0.000
Lnextariff	-25.70204*	13.58787	-1.89	0.067
Lnimtarif	238.5096***	66.74867	3.57	0.001
Lnexchn	-4.039924	36.39849	-0.11	0.912
Lninteret	4134.221	4911.047	0.84	0.406
Fdi	0.0003258	.0002043	1.59	0.120
Inflation	4861.079	10352.71	0.47	0.642
R^2	0.9149			
Adj. R^2	0.8979			
F-statistics	53.78***			
Ramsey RESET	4.34***			
Breauch-Pagan	9.67***			
Breusch-Godfrey	17.322***			

Source: Data Analysis, 2023. *** significant at 1% level of probability

CONCLUSION AND RECOMMENDATIONS

The study revealed that the trend of kola nut export and international trade policies were generally unstable: export tariff decreased over time leading to cheaper kola nut export, the import tariff increased, kola nut export declined with significant reduction in volume of kola nut exported. It was concluded that favorable macroeconomic policies driven by stable exchange rate, low export tariff and interest rate among others impacted positively on kolanut export. It is recommended that exchange rate as a policy instruments needs to be stabilized to sustain investors' interest and narrow the foreign exchange gap, since its relative price influences other prices and the devaluation of the naira led to higher domestic prices for agriculture products with less exported goods. This may help government of Nigeria to achieve the desired growth in agriculture with possible positive results in key economic indices such as real GDP growth, growth in foreign reserves, downward trend in inflation and reduced unemployment rate. It is recommended that effective coordination of international trade policies for improved kola exportation and agricultural growth in Nigeria.

REFERENCES

Abolagba, E. O. (2010). Determinants of agricultural exports. *Journal of Human Ecology*, 29(1), 181-184.

Abu, N. & Usman, A. (2010). Government expenditure and economic growth in Nigeria, 1970-2008: A disaggregate analysis. *Business and Economics Journal, 1-18.*

Adekeye, F. (2008). The way out of the decay, Tell (Nigeria) Magazine, November 3, p.120. http://www.desd.org.desdcd/africa.html

Adubi, A. A. & Okunmadewa, F. **(**1999). Price, exchange rate volatility and Nigeria's agricultural trade flows: A dynamic analysis. *National Centre for Economic Management and Administration (NCEMA)* Ibadan, *Nigeria* ERC Research Paper 87.

Agbonkhese, A. O. & Asekome, M. O. (2014). Impact of public expenditure on the Growth of Nigerian economy. *European Scientific Journal,* 10(28) ISSN: 1857 – 7881 (Print) e - ISSN 1857- 7431.

Agénor, P. (1995). Output, devaluation and the real exchange rate in Developing Countries.*WeltwintschaftlichesArchiv,* 127(1), 18–41.

Agosin, M. R. & Mayer, R. (2000). Foreign investment in developing countries. does it crowd in domestic investment? UNCTAD/OSG/DP pp.146.

Agu, S. Idike, A., Okwor, I. & Ugwunta, D. (2014). Fiscal policy and economic growth in Nigeria: emphasis on various components of public expenditure. *Singaporean Journal of Business Economics and Management Studies*, 2(12), 37-57.

Ajayi, S. I. (1995). Capital flight & external debt in Nigeria. Research Paper 35, *African Economic Research Consortium (AERC)*, Nairobi, Kenya.

Ajisafe, R. A. & Folorunsho, B. A. (2002). The relative effectiveness of fiscal and monetary policy in macroeconomic management in Nigeria. *The African Economic and Business Review,* 3(1).

Ajudua, E. I., Ojima, D. J. P. & Okonkwo, O. N. (2015). A review of Monetary Policy and the Nigerian Agricultural Sector performance. *International Journal Academic Research in Progressive Education and Development*, 4(3), 70-86.

Akhanol, I. A., Babajide A., & Chibuzor, O. T. (2017). Public expenditure and Nigerian economic growth. Unpublised paper.

Ako, T. A., Onoduku, U. S., Oke, S. A., Idris, F. N., Umar, A. N., Ahmed, A. A. & Abba, F. M. (2014). Environmental effects of sand and gravel minning on land and soil in Luku, North Central, Nigeria. *Journal of Science Frontier Research: ENVIRONMENT and Earth Science*, 2(1) 11- 34.

Akpaeti, A. J., Bassey, N. E., Okoro, U. S. & Nkeme, K. K. (2014). Trends and drivers of agricultural investments and growth in Nigeria: The pre financial sector reforms experience. *Asian Journal of Economic Modelling*, 2(3), 115-127.

Akpan, E.O. & Atan, J.O. (2011) Effects of exchange rate movements on economic growth in Nigeria. *CBN Journal of Applied Statistics,* 2(21).

Akpan, M. I. (2005). Government expenditure and economic growth in Nigeria: A Disaggregated Approach. *CBN Economic and Financial Review,* 43(1).

Amassoma, D., Nwosa, P. & Ajisafe, R. (2011). Components of government spending and economic growth in Nigeria: An Error Correction Model. *Journal of Economics and Sustainable Development*, 2(4), 34-59.

Ammani & Aliyu A, (2012). An Investigation in to the relationship between agricultural production and formal credit supply in Nigeria. *International Journal of Agricultural and Forestry* 2, 46-52.

Anderson, D. A. (2010). *Environmental economics and natural resource management*. New York, NY 10016, Routledge– 3rd ed.

Anderson, L. E. (1996). The causes of deforestation in Brazilian Amazon. *Journal of Environment and Developmen*t 5, 309–328.

Anyanwu, S., Aiyedogon, J. O. & Ohwofasa, B .O. (2015). Foreign direct investment in real sector and economic growth in Nigeria, 1986 – 2011: A parsimonious error correction model. *Journal of Economics and Sustainable Development,* 6(5), 124-131.

Anyanwu, J.C. (1998). An econometric investigation of the determinants of foreign direct investment in Nigeria, Annual Conference, Nigeria Economic Society.

Ayadi, F.S. (2009). Foreign direct investment and economic growth in Nigeria", proceedings of the 10th Annual Conference, University of Lagos, Nigeria.

Ayanwale, A.B. (2007). FDI and economic growth: evidence from Nigeria. AERC Research Paper 165, African Economic Research Consortium, Nairobi.

Ayoola, G.B. (2001). *Essays on the Agricultural Economy 1*: *A Book of Readings on Agricultural Development Policy and Administration in Nigeria*: Ibadan: TMA Publishers. Food and Agricultural Organisation.

Apere, T. O. (2014). The impact of public debt on private investment in Nigeria: Evidence from Nonlinerar Model. *International Journal of Reseacrch in Reserrch in Social Sciences,* 4(2), 130-138.

Aregbeyen, O. (2017). Public expenditure and economic growth. *African Journal of Economic Policy*, 1(1).

Arene, C. J. (2016). *Economic Analysis of Agricultural and Rural Development Projects (Planning, Appraisal, Implementation, and Evaluation).* 2nd Edition. Enugu State: University of Nigeria Press.

Atkinson, G. & Hamilton, K. (2002) International trade and the ecological balance of Payments. *Resource Policy*, 28, 27-37.

Awoderu, B. K., Ochalibe, A. I. & Hephziba O. O. (2016). Policy implications of long-run relationship between external reserve and economic growth in Nigeria. *International Journal of Academic Research and Reflection, 5(2)*, 1-14.

Ayenagbo, K. (2015). Economic studies in Togo show that private investment has a ripple effect on both foreign direct investment and public investment. *Journal of African Studies and Development,* 7(9), 231-238. doi: 10.5897

Chenery, H. B. (1958). Development policies and programmes: Policy Instruments and

Chimobi, O. P. & Uche, U.C. (2010). Export, domestic demand and economic growth in Nigeria: Granger causality analysis. European Journal of Social Science, 13(2), 211-218.

Dayo P., Ephraim N., John, P. & Omobowale, A. O. (2009). Constraints to Increasing Agricultural Productivity in Nigeria: A Review. Nigeria Strategy Support Program (NSSP). Background Paper, No. NSSP 006.

Everett, T., Ishwaran, M., Ansaloni, G.P. & Rubin, A. (2010). Economic Growth and the Environment. Econsgrowth Defra Evidence and Analysis. Series Paper 2.

FAO (2004). Socio-economic analysis and policy implications of the roles of agriculture in developing countries, Research Programme Summary Report. Roles of Agriculture Project, FAO, Rome, Italy.

FAO & Environment Programme (UNEP) (1999). The future of our Land: Facing the Challenges.

Federal Republic of Nigeria, (2001). “New Agricultural Policy Thrust”. Federal Ministry of Agriculture and Rural Development, Abuja

Federal Ministry of Environment of Nigeria (FME) (2001). National action programme to combat desertification. http://www.uncd.int/actionprogrammes/Africa/national/2001/Nigeria-eng.pdf

Gujarati, D. & Porter, D. (2009). Basic Econometrics. 4th Edition, McGraw-Hill.

Hanley, N., Shogren J.F. and White, B. (2007). Environmental economics in theory and practice. New York, NY 10010. Palgrave Macmillan

Hussein, A. M. (2005). Principles of environmental economics: economics, ecology and public policy. New York, NY: Taylor & Francis.

Ilechukwu, L. C. Njoku, C. C. & Ugwuozor, F. O. (2014). Education and development disconnect in Nigeria: education for sustainable development (ESD) as the 21st Century Imperative for Nigeria’s National Transformation, Sustainable Development and Global Competitiveness. Journal of Economics and Sustainable Development www.iiste.org ISSN 2222-1700. 5(23).

NBS, 2016.Statistical Bulletin.

Ochalibe, A. I. Bogbenda A. and Dzever, D. D. (2021). Dynamic Impact of Monetary Policy Instruments on Resource Sustainability in Nigeria. Journal of Agricultural Economics, Extension & Science. Vol. 7 No. 2 Pages 97 – 116

Ochalibe, A.I., Apeverga, M.S and Omeje, E.E. (2021). Dynamic Impact of Government Expenditure and Debt Policy Instruments on Agricultural Growth in Nigeria. *Journal of Technological Advancements,* Vol. 1(1), Pp1-20

Ochalibe, A. I., Mgbebu, E. S. & Onyia, C. C. (2016). Instrumentation versus ordinary least square estimates of returns to education. International Journal of Academic Research and Reflection, 4 (7), 40-46.

Oluwatobi, S. O. and Ogunrinola, I. O. (2011). Government expenditure on human capital development: Implications for economic growth in Nigeria, Journal of Sustainable Development, 4(3), 72 – 80.

Pingali, P. (2006). Agricultural growth and economic development: A view through the globalization lens. Presidential Address to the 26th International Conference of Agricultural Economists, Gold Coast, Australia 12-18th August, 2006.

Sloman, J. and Wride, A. (2009). Economics. Italy: Rotolito Lombarda

Rudel, T. & Roper, J. (1996). Regional patterns and historical trends in tropical deforestation, 1976–1990: A qualitative comparative analysis. Ambio, 25, 160–166.

United Nations Conference on Trade and Development UNCTAD (2016). The path to graduation and beyond: Making the most of the process. The Least Developed Countries Report (2016).

United Nations Environmental Programme, UNEP (2011). Mainstreaming Environment and Sustainability into African Universities, MESA. Available at www.unep.org.25/08/11.

Proximate and Mineral Compositions of Three Varieties of Pepper (*Capsicum spp.*) in Response to Nitrogen Fertilization During the 2024 Raining Season in Northern Guinea Savannah of Nigeria

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Abstract
Although Capsicum is high-value commodity with the potential for improving the income and livelihood of smallholder farmers in Nigeria and for diversifying Nigerian's export earnings, the crop is confronted with various production and market-related problems. There is also information gap on the proximate and mineral compositions of locally cultivated varieties compared with the exotic ones. A field experiment was conducted during the rainy season of 2024 in Jos (Latitude 09^0 57'N, Longitude 08^0 53'E, altitude of 1,159 m above sea level) to study the effects of Nitrogen fertilization and variety on the proximate and mineral compositions of two exotic and one local varieties of pepper in Jos-Plateau, Nigeria. The three varieties of pepper, namely (two Habanero varieties, F_1BT and SAFI, and a local check, Miango Local) were combined with six rates of N-fertilizer (0, 30, 60, 90, 120 and 150 kg N ha^{-1}) using the randomized complete block design with three replications. Proximate analysis was carried out to determine the nutrient and mineral compositions using the standard methods of the Association of Official Analytical Chemists (AOAC). Ascorbic acid, β- carotene and capsaicin were determined using the rapid high-performance liquid chromatography method. Results showed that lipid, ash content, moisture, fiber, free nitrogen extract and capsaicin were higher in the Miango Local than in the other varieties. Protein, dry matter content and β-carotene were higher in the variety F_1BT than in the other varieties. All the nutrients studied were higher at 150 kgN ha^{-1} than at the other levels of N-fertilizer application. Calcium, potassium and phosphorus were highest at 150 kgN ha^{-1} and lowest at 0 kgN ha^{-1}. Significant interactions of N- rate and variety on crude protein, lipid, ash content, moisture content, and dry matter content, ascorbic acid, β- carotene, capsaicin, calcium, potassium and phosphorus were observed. For optimum productivity, proximate and mineral composition of pepper in the Jos – Plateau environment, the application of N- fertilizer at the rate of 150 kgN ha^{-1} is hereby recommended. The two Habanero and the Local varieties of pepper used in this study have potentials for high yield.
Keywords: Variety, nitrogen fertilizer, Miango pepper, SAFI and F_1BT

INTRODUCTION
Habanero pepper (*Capsicum chinense* L.) in one of the most important vegetables grown in Nigeria and other sub-humid and semi-arid tropics. After tomato and onion

Habanero pepper is the third most important vegetable in Nigeria. Nigeria being the largest producer of crops in Africa account for 50% of the African production (Aliyu, 2001). Nutritionally, according to (Marin *et al.* 2004, and Gil-guerrero, 2006), habanero peppers are an excellent source of natural colours and antioxidant compounds, ascorbic acid, carotenoids, and phenolic compounds. It also contains vitamins A and C and it was reported that as hot pepper matures, the pro-vitamin A (B Carotene) and ascorbic acid increase. The intake of these compounds in foods is an important health protecting factor. Mediated intake of these compounds has been recognizing to prevent some human diseases, including cancer and cardiovascular diseases, (Kaur and Kapoor, 2001; Sardas, 2003). This led to extensive production of habanero pepper varieties in some countries for export markets. However, inspite of the important of pepper in Nigeria. Low yield was often obtained by farmers due to use of low yielding varieties, inadequate application of nutrients on soil that are already of low nutrients status, poor agronomic practices, improper row or planting arrangement, low soil fertility and other environmental factors such as the prevalence of fungal (blight) and bacterial as well as viral diseases (Fekudu and Dandena, 2006). The use of organic fertilizers and herbicide has attracted attention in recent years in vegetables as a result of sustainable high yield and due to the fact that inorganic fertilizers alone cannot sustain the productivity of the soil under highly intensive cropping systems (Singh and Jain, 2004). Weed competition is one of the most important factors limiting habanero pepper yield particularly at early stages of the crops life cycle. The study is aimed at determining the effect of farmyard manure, the best weed control treatment and intra row spacing on the growth, yield and yield components of Habanero pepper.

MATERIALS AND METHODS

The field study was carried out during the rainy season of 2018 at the Federal College of Forestry Jos, Plateau State. The trial site is located at an altitude of 1,159 m above sea level on latitude 09^0 57'N and longitude 08^0 53'E. Composite soil samples collected from three points at the depth of 0 – 15 cm were analyzed for soil physico-chemical properties using standard procedures. Result of the soil analysis is shown in Table 1. The experiment was a 3 x 6 factorial, comprising three varieties of *Capsicum* (two exotic and one local check) and six rates of Nitrogen fertilizer (0, 30, 60, 90, 120 and 150 kg ha^{-1}). The treatments were laid out in a randomized complete block design (RCBD) with three replications. The gross plot size was 4.5 m x 3.0 m (13.5 m^2), while the net plot was 3 m × 3 m= (9 $m^{2)}$. The agronomic characteristics of the varieties used in this study are as shown in Table 2. Seedlings were raised from nursery beds, which measured 1.5 m × 2.0 m. Seeds of each of the varieties were drilled 5 cm deep, lightly covered with soil and planted in their respective beds on July 4, 2018.The beds were then mulched with dry grass and lightly watered until they germinated. Regular watering and weeding were done until the seedlings were ready for transplanting on August 11, 2018.The seedlings were transplanted at inter- and intra- row spacing of 0.30 m and 1 m, respectively, to give a total of 33, 333 plants per hectare. The N- fertilizer in the form of urea was applied two weeks after transplanting at the specified rate using the dibbling method. Proximate analysis was carried out to determine the nutrient and mineral compositions using the standard methods of the Association of Official Analytical Chemists (15). Ascorbic acid,β- carotene and capsaicin were determined by using the rapid high performance liquid chromatography methods. Data collected were, analysed using the two-way analysis of variance test as described by Snedecor and Cochran (16). The Statistical Analysis System (SAS) version 9.0 was used in the analysis. Differences between means were compared using the least significant difference at 5% level of probability.

RESULTS AND DISCUSSIONS

Proximate Composition

The effects of N- fertilizer rate and variety on the proximate composition of pepper grown in Jos in 2024 are shown in Table 3. Crude protein was highest in the variety F_1BT and lowest in the Miango Local. Lipid, ash content, moisture content, crude fiber, nitrogen-free extract and capsaicin were higher in Miango Local than in the other varieties. Dry matter content was higher in the variety F_1BT (10.22%) than in the Miango Local (8.07 %) and SAFI (9.14 %). Ascorbic acid was significantly higher in the variety SAFI (0.23 mg/ml) than in the other two varieties. β-carotene was highest in the variety F_1BT (7.9 mg/ml) and lowest in Miango Local (5.23 mg/ml). Crude protein, lipid, ash content, moisture content, dry matter content, nitrogen-free extract, ascorbic acid, β- carotene and capsaicin increased with increasing N- fertilizer rate, being highest at 150 kg N ha^{-1} and lowest at 0 kg N ha^{-1}. Crude fiber ranged from 12.7 % at 30 kg N ha^{-1} to 21.7 % at 150 kg N ha^{-1} but the difference ($p > 0.05$) was not significant (Table 3). A significant interaction of N- fertilizer rate and variety on was observed on crude protein, lipid, ash content. (Tables 4,5 and 6). Results of the proximate analysis showed that apart from the crude fiber, the proximate composition varied with the genotype and N-fertilizer application. The Miango Local was highest in Lipid, ash content, moisture content, fiber, nitrogen-free extract and capsaicin. The application of urea at 150 kg ha^{-1} resulted in the highest nutrient composition. Miango Local is a highly rated hot pepper, especially on the Jos-Plateau, where it is extensively cultivated by the Miango people of Bassa Local Government Area. It is exported to neighboring countries of Cameroon, Ghana and Benin Republic in West Africa. In this study, the Miango Local compared favourably with the two exotic varieties introduced from France. The generally low crude lipid observed in this study confirms the report of Gloria et *al.* (17) who noted that pepper was a poor source of lipids. The results show that the Miango Local is a good source of nutrients and mineral composition. Being highest in capsaicin which confers pungency or hotness on pepper, the variety is hereby recommended for use as a high-grade condiment. Effort should, therefore, be made to conserve it and further investigations should be carried out on this indigenous species of pepper.

The generally high moisture content observed in the study corroborated the findings of Oyelakin *et al.* (2018), who reported moisture content of 39.20 – 96.67% in some cultivated and wild species of pepper. The high moisture content suggests that the varieties may not be stored for a long period since water enhances microbial activity leading to food spoilage (18). Therefore, the need to process the fresh fruits into products with a long shelf-life is imperative. The study shows that increasing N-fertilizer rate resulted in increased crude fiber. High soluble fiber has been reported to lower blood cholesterol and glucose level, while insoluble fiber is essential for digestion and bowel movement (19). Ascorbic acid and β-carotene are regarded as good sources of anti-oxidants which prevent free radicals from the body and tumor growth. The deficiency of ascorbic acid results in scurvy (20, 21).

REFERENCES

Bosland, P. W. and Votava, E. J. (2000*). Peppers, Vegetables and Spices: Capsicum.* CABI Publishing. New York. 198p.

Anonymous (2001). *Chilli research and development in India: A status report*. Indian Institute of Species Research, Calicut, PP. 1-6.

Beyene, T. and David, P. (2007). Ensuring Small Scale Producers in Ethiopia to Achieve Sustainable and Fair Access to Pepper Market.*Ugandan* Journal *of Agriculture*, 3(2):113-119.

Grubben, G.J.H., Denton, O.A., Messiaen, C.M., El-Tahir, I.M., Schippers, R.R., Lemmens, R.H.M.J. and Oyen, L.P.A. (2004). *Plant Resources of Tropical Africa 2 (Vegetables*). Backhuys Publishers, Wageningen.155p.

Aliyu, L. and Kuchinda, N. C. (2002). Analysis of chemical composition on some organic matters and their effect on the yield and composition of pepper (*Capsicum chinesse) Crop Research,* 23 (2): 362-368.

Hartmann, H.T., Kofranek, A.M., Rubatzky, V.E. and Flocker, W.J. (1988). Plant Science: *Growth, Development and Utilization of Cultivated Plants, 2nd edition*. Printice-Hall, Inc., New Jersey, U. S. A. 674p.

Muhammad, L.Y. (1989). Effects of irrigation frequency on yield and fruit composition of pepper (*Capsicum pubescens L.)*. *Acta Horticulture,* 138:141.

Berke, T. I., Black, N.S., Talekar, J.F., Wang, P., Gniffke, S.K., Green, T.C. and Morris, R. (2005*). Suggested cultural practices for chilli pepper.International Cooperators Guide*.AVRDC. Pub#05-620. www.avrdc.org/. Accessed on 12/10/2009.

Paul, W. B. and Votava, E.J. (2000). Pepper, Vegetables and Spices: *Capsicum*. In: Crop Production Science in Horticulture edition 12. CABI Publishing, Willing Food, Oxio, UK 118p.

Aliyu, I. (2000). The effects of organic and mineral fertilizers on growth, yield and composition of pepper (*Capsicum annum L*.). *Biological Agriculture and Horticulture, 18* (1): 29-36.

Ethiopian Agricultural Research Organization (EARO) (2004). Released crop varieties and their recommended cultural practices*. Progress Report*. Addis Ababa, Ethiopia.

Alemu, H. and Erimias, A. (2000). Horticultural crops production and associated constraints in Northwest Ethiopia. *Working Paper*, *Agricultural Economics Research Division*. *Agricultural Research Centre*, Adet, Ethiopia.

PADP (Plateau Agricultural and Development Programme) (2008). Studies on environmental interaction on *Capsicum* and Garden egg. *Research Journal of Agriculture and Biological Science,* (14):36-38.

Fekadu, M. and Dandena, G. (2006). Status of Vegetable Crops in Ethiopia.*Ugandan Journal of Agriculture*, *12* (2): 26-30.

AOAC (2000). *Official Methods of Analysis* (17th Edition) Volume 1.Association of Official Analytical Chemists, Inc., Maryland, USA.

Snedecor, G.W. and Cochran, W.G. (1967). *Statistical Methods.6th Edition*. Iowa State University Press, USA. 593p.

Gloria, A., Oyelola, B., Adenika, T. and Anthony, J. (2010). Comparative analysis of the chemical composition of three*Capsicum* spices. *Journal of the Korean Society of Food Science and Nutrition,* 37(8): 1090-1095.

Oyelakin, A.S., Fawibe, O.O. and Olabiyi, D.O. (2018). Comparison of proximate composition and nutitional potentials of four cultivated and four wild varieties of pepper (*Capsicum L.*) in Nigeria.*Nigerian Journal of Botany*, *31*(2), 261-271.

Papas, M., Giorannuli, E. and Platze, E. (2004). Fiber from fruit and colorectal Neoplasia. *Journal of Cancer Epidemiology, Biomarker and Prevention, 13*, 1267-1270.

Philips, K.M., Tarrago-Trani, M.T., Gebhardt, S.E., Exler, J., Patterson, K.Y., Haytowitz, D.B., Pehrsson, P.R. and Holden, J.M. (2010). Stability of vitamin C in frozen raw fruit and vegetable homogenates. *Journal of Food Composition and Analysis, 23*, 253-259.

Igwemmar, N. C., Kolawole, S. A. and Imran, I. A. (2013). Effects of Heating on Vitamin C Content of Some Selected Vegetables. *International Journal of Scientific and Technological Research, 2*(11):209-212.

Onwaka, G. I. (2005). *Food Analysis and Instrumentation: Theory and Practice*1stedition. Apex Book Limited, Lagos. Pp. 63-120.

Christine, E., Peters, H. and Orim, A.O. (2014).Comparative evaluation of the nutritional, phytochemical and microbiological quality of three pepper varieties. *Journal of Food and Nutritional Science, 2*(3):74-80.

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Cowpea (*Vigna unguiculata*) Seeds Preservative Potentials of Botanical obtained from Ishiagu, Ebonyi State, Nigeria against *Callosobruchus maculatus* Infestation and Damages

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Abstract

The study was conducted to evaluate the insecticidal effect of Ocimum gratissimum, Azadirachta indica, and Vernonia amygdalina leaf powder at 5g on the control of Callosobruchus maculatus on stored cowpea seeds. The results revealed that all the dried leaf powders had significant insecticidal effects against C. maculatus compared with the control. Ocimum gratissimum significantly exerted highest mortality at 24 and 48 h after exposure, while V. amygdalina recorded 100% mortality at 72 h. Also, significant progeny emergence and percentage grains damaged was observed in control having the highest progeny emergence (12.80), percentage grains damaged (89%) and least percentage germinated seeds were recorded in O. gratissimum, A. indica and control respectively. Findings showed that, all the dried leaf powder of the plant evaluated exhibited a toxic action against the cowpea beetle infestation and suppressed damage. Therefore, the utilization of the evaluated plant leaves is recommended for adoption as a substitute for synthetic fumigants in indigenous pest management strategies for stored cowpea seeds against C. maculatus infestation.

Keywords: infestation; insecticidal; leaf powder; mortality; progeny emergence

INTRODUCTION

Cowpea (*Vigna unguiculata* [L.] Walp) is a key staple food and a significant source of protein and carbohydrates throughout the tropics and subtropics. In addition to being high in nutrients, cowpea is also a good source of nutraceuticals, including antioxidants, dietary fibre, polyunsaturated fatty acids (PUFA), and polyphenols (Phillips et al., 2003; Baptista et al., 2017). Due to its significant involvement in the management and prevention of chronic non-communicable diseases like diabetes, cardiovascular disease, and cancer, health organisations from all over the world advise consuming cowpeas as part of a balanced diet (Iqbal et al., 2006; UN, 2014; Clifton, 2010). Additionally, it promotes weight control because it increases satiety, inhibits the buildup of fat in the abdomen, and controls blood sugar levels (Clifton, 2010; Tharanathan and Mahadevamma, 2003). With 3.6 million tons in 2021, Nigeria ranked as the world's largest producer of cowpea and one of the highest consumers. Cowpeas are in greater demand than they can be supplied because of several challenges, including their high susceptibility to insect pests throughout the planting and storage stages. Callosobruchus maculatus remain a major storage insect pest of cowpea, and in the field, infestations started in the standing crop continue after harvesting (Hamel et al., 2020) resulting in considerable postharvest losses. The nutritional and economic importance of cowpea makes it necessary to take deliberate steps to control the insect and minimise postharvest losses. In Nigeria, a large number of traders and farmers used synthetic chemicals as preservatives, endangering the public's health. The European Commission restricted the export of cowpeas from Nigeria due to concerns about the widespread use of synthetic fumigants and pesticide control tactics, which are of major concern to the public (Nwagboso et al., 2024). Numerous successes have been recorded in the protection of stored grains using botanical insecticides. Several researchers have exploited the insecticidal effects of various plant parts in the management of C. maculatus with varying degrees of success (Adesina, 2022; Adesina et al., 2019; Mohammad et al., 2023; Anaele et al., 2024). This study extends the above approaches by evaluating the efficacy of *Ocimum gratissimum* (Scent leaf), *Azadirachta indica* (neem leaf), and *Vernonia amygdalina*) (bitter leaf) powders obtained from Ishiagu, Ebonyi State for the protection of stored cowpea against Callosobruchus maculatus infestation.

MATERIALS AND METHODS

The research was carried out in the Entomology Laboratory, Federal College of Agriculture Ishiagu, Ebonyi State, (Latitude 05.46^{0}N and Longitude 07.41^{0}E) Nigeria. Leaves of *Ocimum gratissimum* (Scent leaf), *Azadirachta indica* (neem leaf), and *Vernonia amygdalina*) (bitter leaf) were collected from the horticultural garden, Federal College of Agriculture, Ishiagu. The leaves were washed in clean water to remove dirt and air-dried days in the laboratory to avoid volatilization of their bioactive chemical constituents. After drying, each plant material was milled using an electric blender (Model BLG-400) and the powder sieved through a 1mm^2 perforation mesh to obtain the finest powder and were kept in a glass container separately tightly covered with screw cap and stored at room temperature before use.

Callosobruchus maculatus used in this study was obtained from already infested cowpea seeds procured food commodity traders in Eke market Ishiagu, Ebonyi State and were reared on Sokoto white cowpea seeds cultivar under ambient conditions in the Entomology laboratory, Federal College of Agriculture, Ishiagu, Ebonyi State. The cowpea seeds used as substrate to culture the beetles were thoroughly cleaned and kept in a deep freezer for a week to ensure the absence of insect developmental stages, mites and disease-causing microorganisms (if any). Batches of one kilograms of sterilized seeds were placed in three (3) different cleaned plastic containers and about 50 mixed sex beetles isolated from the infested cowpea seeds were introduced into each plastic container and covered with a polythene net fastened tightly with a rubber band for five (5) days to allow for mating and oviposition after which the parent beetles were removed. The rearing was given sufficient time (25-30 days) until new adult insects emerged.

About 50g of cowpea seeds were weighed into each of the containers containing 5kg of *O. gratissimum*, *A.* indica, and *V. amygdalina* leave powder separately. Thereafter, the dish containing cowpea seeds and powders were shaken thoroughly to ensure that the powders adequately covered the cowpea seeds surface. There was also control treatment with no addition of botanicals. Then ten (10) unsexed adult beetles were introduced into each of the twenty-four containers. The experiment was arranged in completely randomized design replicated six (6) times. Adult mortality was monitored and recorded at 24, 48 and 72 hours after treatments in each jar. A beetle is considered dead, if it does not move any of the appendages when touched with a needle is used to touch. The percentage of insect mortality was calculated thus: number of dead beetles per container/total number of beetles introduced x 100. At the end of the experiment, the number of emerged adult beetles was visually counted and recorded per treatment. While the number of grains with adult emergent holes was counted and recorded to determine the percentage (%) of damaged seeds by dividing the number of damaged seeds by a total number of seeds and multiplying by 100%. Percentage seeds germination was determined following the procedure outline by Adesina and Aderibigbe (2021). One-way analysis of variance (ANOVA) was carried out to compare differences in treatment means and significant treatment means were separated using Fisher Least Significant Differences at P <0.05.

RESULTS AND DISCUSSION

The percentage mortality of *C. maculatus* exposed to the different plant powders showed significant differences (P<0.05) among the treatments except at 72hrs. At 24 and 48 hours of exposure, the performance of the leave powders in exerting mortality occur in the following order *O. gratissimum* > *V. amygdalina* > *A. indica* while untreated grain (control) recorded least mean mortality values of *C. maculatus* (Table 1). However, at 72hrs *V. amygdalina* leaf power recorded 100% mortality. While *O. gratissimum* recorded the highest mortality at 24 h (53.33%) and 48 h (38.30%) respectively. The mean progeny emergence of *C. maculatus* from treated cowpea grains after forty (40) days of storage revealed significant differences across the treatments with highest progeny emergence recorded in the untreated (control) grains (12.80) and the least progeny emergence (8.20) from *O. gratissimum*. Significant highest percentage grain damage was observed on the untreated (control) grains compared to other treatments while grains treated with *A. indica* leaf powder suffered least grain damage. Percentage germinability of stored cowpea seeds treated with the different leaf powder shows that there was no significant difference (P>0.05) among the treatments after 40 days of storage. Although, treated seeds recorded the lowest germinability and those treated with *A. indica* recorded the highest percentage germinability (Table 2).

Table 1: Percentage Mortality of *C. maculatus* treated with dried leaf powders of *O. gratissimum*, *V. amygdalina* and *A. indica* on stored cowpea seeds

Treatments (5g)	**Observed hours**		
	24hours	**48hours**	**72hours**
Ocimum gratissimum	53.33	38.30	25.00
Azadirachta indica	43.33	18.33	10.00
Vernonia amygdalina 5g	45.00	20.00	100.00
Control	0.00	1.00	1.00
LSD	**1.7**	**0.04**	**NS**

Table 2: Mean Progeny emergence of *C. maculatus*, Percentage grains damage and Germinability of stored cowpea seeds treated with dried leaf powder of *O. gratissimum*, *V. amygdalina* and *A. indica*.

Treatments (5 g)	Progeny Emergence	Percentage Grain Damages	Percentage germinability
Ocimum gratissimum	8.20	71.00	38.00
Azadirachta indica	12.00	42.00	60.00
Vernonia amygdalina	10.80	75.00	30.00
Control	12.80	89.00	10.00
LSD	**2.74**	**0.03**	**NS**

LSD= least significant difference

Plants are rich sources of bioactive chemical constituents which exerted different insecticidal activities ranges from oviposition deterrent, ovicidal, larvicidal, repellent, antifeedant, and growth regulator. The mortality effect observed in this study can be attributed to contact toxicity of the plant materials due probable presence of different chemical compounds in the various plant leaves evaluated. The plant powders could also block the insect spiracles thus hinder respiration through trachea system leading to death due to asphyxiation (Jose and Adesina, 2014; Adedire et al., 2017). In addition, the coarse nature of the plant powders act as a physical poison which affects the insect cuticle resulting in desiccation and ultimately death (Tadesse and Basedow, 2005). The significant reduction of progeny emergence recorded in the current study could be linked to the followings: (i) the high mortality rate recorded which do not give enough period for the insect to oviposit since female *C. maculatus mate and* lay their eggs within 3 days of adult life, (ii) the abrasive nature of the plant powder do not allow for sexual communication between the insects, (iii) the presence of the plant powder on the treated cowpea seed prevent the egg laid by the insects to be firmly attached to the seed coat, (iv) the presence of bioactive chemical compounds in the plants may exhibits ovicidal and larvicidal properties. The present confirmed the position of Adedire et al. (2017) who stated that plant powders play a significant role in deterring insect oviposition and interference with the developmental stages of *C. maculatus* which ultimately reduced progeny emergence. The low percentage grain damage recorded in this study could be attributed to the significant reduction in progeny emergence in the treated seeds resulting from the entomotoxic effect exhibited by the plant powder. This aligned with Idoko and Adesina (2012) who postulated that the higher the adult emergence the higher the degree of damage suffered by insect infested stored grains. The higher percentage of grain damage recorded in untreated cowpea seeds confirmed Ileke et al. (2012) assertion that the larval stage of *C. maculatus* the adults do not feed and that the larva is destructive stage of the insect. The larva lives inside the grain, feed and exits when it reaches the adult stage. Therefore, this study clearly indicated that percentage grain damage increased intensely as larval density increased. Adesina and Mobolade-Adesina (2020) suggested that the reduction in stored food grains damage is directly relative to larvae feeding activities. The plant powder confer protection on the treated as their germination was not impaired due to the plant powder which deter *C. maculatus* infestation and encouraging high seed viability. This supports the findings of Adesina and Aderibigbe (2021) who reported that seed germinative capability were not affected by admixing stored seeds with botanical products.

CONCLUSION AND RECOMMENDATIONS

Consequent upon the outcome of this study, the utilization of the evaluated plant leaves could be adopted as a substitute for synthetic fumigants in indigenous pest management strategies for stored cowpea seeds against *C. maculatus* infestation.

REFERENCES

Adedire, C. O., Adesina, J. M. and Adeyemo, A. J. (2017). Potential of four tropical plant powders as Grain Protectants Against *Callosobruchus maculatus* (Coleoptera: Chrysomelidae). *Progress in Biological Sciences*, *7*(2): 119-126.

Adesina, J.M., Mobolade-Adesina, T.E., 2020. *Callosobruchus maculatus* (Fab.) Coleoptera: Chrysomelidae) Infestation and Tolerance on Stored Cowpea Seeds Protected with *Anchomanes difformis* (Blume) *England Extracts. Journal of Horticulture and Post-Harvest Research*, *3* (2), Pp. 367-378.

Adesina, J. M. (2022). Bioactive Constituents and Fumigant Toxicity of *Datura metel* extracts as grains protectant and Progeny Emergency Inhibition of *Callosobruchus maculatus* (Coleoptera: Bruchidae). *Journal of Plant Disease and Protection*.

Adesina, J. M. and Aderibigbe, A. T. B. (2021). Seed Preservatives Properties of *Secamone afzelii* (Schult) K. Schum Extracts on Wheat Grains Damage and Germination Capability. *Bulletin of the National Research Centre*, *45*(52).

Adesina, J. M., Rajashekar, Y., Ofuya, T. I. and Ashamo, M. O. (2019) Bioactive chemical composition and insecticidal potential of *Mitracarpus villosus* [Swartz] DC for the management of stored product beetles. *International Journal of Horticulture and Food Science*, *1*(1): 65-69.

Anaele, U. M., Kama, U. Bamidele, J. A., Awa, P. N., Adesina, J. M. and Mobolade-Adesina, T. E. (2024). Utilization of Dried Citrus Fruits Peel an Agricultural Waste for the Control of *Callosobruchus maculatus* Infestation in Stored *Vigna unguiculata* Seeds. Proceedings of 17th Annual Conference of Organic Agriculture Practioners in Tertiary Institution of Nigeria, Oye Ekiti, March 24-28, 2024.

Baptista, A., Pinho, O., Pinto, E., Casal, S., Mota, C. and Ferreira, I. M. (2017). Characterization of protein and fat composition of seeds from common beans (*Phaseolus vulgaris* L.), cowpea (*Vigna unguiculata* L. Walp) and bambara groundnuts (*Vigna subterranea* L. Verdc) from Mozambique. *Journal of Food Measurement and Characterization*, *11*(2):442-450.

Clifton, P. M. (2010). Legumes and cardiovascular disease. In: Bioactive Foods in Promoting Health. San Diego: Elsevier Inc; pp. 449-455.

Hamel D., Rozman V. and Liška A. (2020). Storage of cereals in warehouses with or without pesticides. Insects 11: 846.

Idoko, J. E. and Adesina, J. M. (2012) Infestation Level of *Callosobruchus maculatus* on Cowpea using Different Particle Sizes of *Eugenia aromatic* and *Piper guineense* Powders. *World Journal of Engineering and Pure and Applied Science*, *2* (5), 156-60.

Ileke K.D., Odeyemi O.O., and Ashamo M.O. (2012). Insecticidal activity of *Alstonia boonei* De Wild powder against cowpea bruchid, *Callosobruchus maculatus* (Fab.) [Coleoptera: Chrysomelidae] in stored cowpea seeds. *International Journal of Biology*, *4*(2), 125- 131

Iqbal, A., Khalil, I. A., Ateeq, N. and Sayyar Khan, M. (2006). Nutritional quality of important food legumes. *Food Chemistry*, *97*(2):331-335.

Jose, A. R. and Adesina, J. M. (2014). Oviposition, Infestation Deterrent Activity and Phytochemical screening of *Heliotropium indicum* and *Lawsonia inermis* Against

Callosobruchus maculatus Fabricius (Coleoptera: Chrysomelidae) on Cowpea Seeds. *International Journal of Molecular Zoology*, *4*(1), 1-8.

Mohammad, Y.M., Haniffa, H.M. and Sujarajiini, V. (2023). Insecticidal effect of selected medicinal plants on *Sitophilus zeamais* Mostschulsky in stored maize. Biocatalysis and Agricultural Biotechnology, 48, 102635.

Nwagboso, C., Andam, K. S., Amare, M., Bamiwuye, T. and Fasoranti, A. (2024). The Economic Importance of Cowpea in Nigeria Trends and Implications for Achieving Agri-Food System Transformation. Development Strategies and Governance Unit (DSG) of the International Food Policy Research Institute (IFPRI), Abuja, Nigeria. IFPRI Discussion Paper 02241.

Phillips, R. D., McWatters, K. H., Chinnan, M. S., Hung, Y. C., Beuchat, L. R., Sefa-Dedeh, S., Sakyi-Dawson, E., Ngoddy, P., Nnanyelugo, D., Enwere, J., Komey, N. S., Liu, K., Mensa-Wilmot, Y., Nnanna, I. A., Okeke, C., Prinyawiwatkul, W. and Saalia, F. K. (2003). Utilization of cowpeas for human food. *Field Crops Research*, *82*, 193-213.

Tadesse, A. and Basedow. T.H. (2005). Laboratory and field studies on the effect of natural control measures against insect pests in stored maize in Ethiopia. *Journal of Plant Disease and Protect*ection, *112*,156–172.

Tharanathan, R. and Mahadevamma, S. (2003). Grain legumes–a boon to human nutrition. Trends in Food Science and Technology, 14(12):507-518.

United Nations (2014). Resolution adopted by the General Assembly on 20 December 2013, 68/231. International Year of Pulses 2016. A / RES / 68/231.

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Effect Kentch Salting on Heteroclarias during Ambient Storage

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Abstract
The present study, looks at the physicochemical and microbiological quality changes that occur during kentch salting of Heteroclarias and stored at ambient temperature (27±3°C). Samples of fish from each group was taken on the 15, 29, 43, 57, 71 and 84th day and was analyzed for pH value, conductivity, microbial flora (total mesophilic bacteria count, total coliform count, total psychrophilic bacteria count, total fungal count and total volatile count). It was observed that there was significant difference (P < 0.05) in the pH, conductivity, and average weight of dry salted heterobranchus during ambient storage. It was also observed that there is an increase in total mesophilic count, psycrophile bacteria count, volatile count, coliform count as storage period increased (P < 0.05) and there was no detection of fungal count during storage period (84 days). However, the microbial quality of the salted fish showed that the fish was good for human consumption throughout the period of storage (84 days). Kentch salting method of fish preservation is therefore recommended for elongating fish shelf life in villages and other environments that lack steady electricity supply needed to preserve fish.

Keywords: Fish preservation, kentch salting, Heteroclarias, Ambient storage

INTRODUCTION
Fish is one of the most important sources of animal protein available in the tropics and has been widely accepted as a good source of protein and other elements for the maintenance of healthy body (Ayeloja, 2019). The global contribution of fish as a source of protein is high, ranging from 10 % to 15% of the human food across the world (Zuberi and Thomas, 2012). Fish is an important animal protein source in Nigeria, contributing over 50% of animal protein intake among the poor people (Ayeloja *et al*., 2024). As soon as fishes die, they become subject to postmortem changes and damage by microorganisms and insects that quicken the rate of fish spoilage, these together with inadequate preservation, processing and handling leads to the loss of over 40% of the total fish catch in Nigeria (Daramola *et al*., 2007). Spoilage affects the odour, flavour, texture, colour and chemical composition of fish (Agbabiaka *et al*.,2012) and these in turn affect the nutritional quality, consumer acceptability and commercial value of fish (Daramola *et al*., 2007). Preservation techniques are designed to inhibit the activity of spoilage bacteria and metabolic changes in order to prevent fish spoilage and prolong shelf life (Ayeloja *et al.*, 2020). Some of the preservation techniques are affected through

the control of temperature (by chilling or freezing), reduction of water activity (drying, salting and smoking) and use of preservatives. Drying, salting and smoking are the most common preservative methods used in Nigeria. These processes ensure year-round availability of fish and the distribution of wholesome fish products to all parts of the country (Kumolu-Johnson and Ndimele, 2010). Fish salting is one of oldest methods in preservation of fish, and is still used in many parts in the world (Gassem, 2019). Salting is a process where the common salt (NaCl), sodium chloride, is used as a preservative that penetrates the tissue; hence slows the bacterial growth and deactivates the enzymes (Binici and Kaya, 2018). Tomislav (2016) also stated that salting is one of the oldest method of fish preservation because it is cheap, readily available and does not require electricity, salting has been established by many scientists to have antimicrobial properties and many bacteria, fungi and other potentially pathogenic organisms cannot survive in a highly salty environment, due to the hypertonic nature of salt (Edris *et al.*, 2020). However, there is dearth of in information on the use of kentch salting method in elongating fish shelf life thus the need for this research.

MATERIALS AND METHODS

Sample collection

Thirteen (13) samples of *Heteroclarias* were dragging with a drag net from an earthen pond at Asa-Dam Road, Ilorin kwara State Nigeria, they were then conveyed using using sterile polythene nylon within 48 minutes to the Faculty of Agriculture central laboratory, University of Ilorin, Ilorin Kwara state. At the laboratory, the initial microbial load was tested on the samples after which the samples were dry salting (Kench salting) method of fish preservation was done. Thereafter, the samples were stored at ambient temperature ($27 \pm 3\,^{o}C$). Samples were collected at every fortnight for physicochemical (pH, conductivity and average weight) and microbiological quality changes microbial analysis. The microbial analysis carried out includes Total viable count, Total fungal count, Total coliform count, Total mesophilic count, Total psychrophilic count, Total coliform count and Total fungal count.

Fish Salting:

The fish were gutted by opening the belly and remove the intestine and washed under running water before being subjected to kentch salting (dry salting) and pickle curing (wet salting).

Kentch salting (dry salting (DS) method: The fish were preserved with dry commercial salt (NaCl) at ratio 1:1 fish kg/salt. The salt was applied by weight layered alternately (salt and fish layer) and stored in an air tight container at ambient temperature ($27 \pm 3\,^{o}C$) throughout the period of this study (84 days).

Sample collection

Samples were collected at every fortnight (0, 14, 28, 42, 56, 70 and 84 days) for 84 days for physicochemical (pH, conductivity and average weight) and microbiological quality changes (Total volatile count (TVC), Total mesophilic bacteria count (TMBC), Total psychrophilic bacteria count (TPBC), Total coliform count (TCC) and Total fungal count (TFC).

Statistical Analysis

Microbiological data obtained were logarithmically transformed (log cfu/g) and then subjected to Analysis of Variance (ANOVA) while means of the significantly different indices were separated using Duncan Multiple Range Test (DMRT) at $p < 0.05$.

RESULTS AND DISCUSSION

Over the course of 84 days, the microbiological quality of heteroclarias that were exposed to Kent salting while being stored at room temperature changed gradually. After starting at 2.739±0.06 log CFU/g on day one, the total viable count (TVC) grew significantly ($P<0.05$) to 5.934±0.02 log CFU/g by day 84. The fish was still safe to eat at day 84, as recommended by the International Commission on Microbiological Safety for Foods (ICMSF, 1986), even with the increase in TVC. This is because it was still below the permitted levels for fish products (≤ 5.7 log CFU/g). The total mesophilic bacterial count (TMBC) rose from 2.952±0.07 log CFU/g at day 14 to 5.406±0.04 log CFU/g on day 84, within safe ranges for fresh and frozen salmon. With TPBC peaking at 5.201±0.08 log CFU/g and TCC peaking at 5.021±0.03 log CFU/g, with the total psychrophilic bacteria count (TPBC) and total colium count (TCC) continuously growing over storage. The pH changed from 6.1 to 6.9, corresponding to historically salted fish and satisfying globally acknowledged pH parameters for salted and fermented fish. Fish tissue preservation showed a substantial increase in conductivity, suggesting absorption of salt. Fish weight dropped drastically in the first 28 days, most likely from salt buildup, but stayed the same after that, indicating that the fish was maintained dry salted.

CONCLUSION AND RECOMMENDATIONS

This study establish that kentch salting method inhibit microbial growth in heteroclarias during ambient storage as the fish was still wholesome for human consumption up till the last day of storage under dry salting condition (84^{th} day) as the TVC values recorded were within the maximum recommended bacterial count for good quality fish product, the result of the total mesophilic bacteria count (TMBC) (Table 1) was also comparable with the TMBC recorded on fresh fish by other scientists, the highest total psychrophilic bacteria count reported in this study (5.201±0.08) on the 84^{th} day of storage is lower than the total psychrophilic bacteria count reported for other fishes by many other scientist. The pH observed for heteroclarias in this study (Fig 1) is within the standard pH for salted and fermented fish prescribed by many international communities. Kentch salting method of fish preservation is therefore recommended to elongate fish shelf life in villages and other environments that lack steady electricity supply.

REFERENCES

Anihouvi, V.B.; Kindossi, J.M. and Hounhouigan, J.D. (2012). Processing and quality characteristics of some major fermented fish products from Africa: A critical review. *International Research Journal of Biological Science*. *1*: 72-84.

Ayeloja, A. A.; Jimoh, W. A. and Garuba, A. O. (2024). Nutritional quality of fish oil extracted from selected freshwater fish species. *Food Chemistry Advances*. *4* (2024): 100720.

Ayeloja, A. A., Jimoh, W. A., Adetayo, M. B. and Abdullahi, A. (2020). Effect of storage time on the quality of smoked *Oreochromis niloticus*. Heliyon, *6*(1), e03284.

Ayeloja, A. A. (2019). Sensory quality of smoked *Clarias gariepinus* (Burchell, 1822) as affected by spices packaging methods. *International Journal of Food Properties*, *22*(1), 704–713.

Ayeloja, A. A.; George, F. O. A.; Obasa, S. O.; Sanni, L. O. and Ajayi, A. A. (2011). Effects of length of delay after slaughter (LODAS) on raw catfish (*Clarias gariepinus*). *Journal of American Science*, *7* (6), 508 – 512.

Bonoco1, A. and Kaya, G. K. (2017). Effect of brine and dry salting methods on the physicochemical and microbial quality of chub (*Squalius cephalus* Linnaeus, 1758). *Food Science and Technology*, 38(1): 66-70, Bodin, N.; Lucas, V.; Dewals, P.; Adeline, M.; Esparon, J. and Chassot, E. (2014). Effect of brine immersion freezing on the determination of ecological tracers in fish. *European Food Research and Technology*, *238*: 1057–1062.

Broekaert, K.; Heyndrickx, M.; Herman, L.; Devlighere, F. and Vlaemynk G. (2011). Seafood quality analysis: molecular identification of dominant microbiota after ice storage on several general growth media. Food Microbiology *18*:1162-9.

Daramola, J. A.; Fasakin, E. A. and Adeparusi, E. O. (2007). Changes in physicochemical and sensory characteristics of smoke-dried fish species stored at ambient temperature. *African Journal of Food, Agriculture, Nutrition and Development*. *7*(6): 1-16.

Edris, A. M.; Tolba, K. S.; Meky, H. H. and Meky, M. A. (2020). Quality and Safety Evaluation of Salted Fish. *Journal of Veterinary and Animal Research*, *3* (2): 201-207.

International Commission on Microbiological Specifications for Foods (ICMSF). (1986). *Microorganisms in foods 2: Sampling for microbiological analysis. Principles and specific applications* (2nd ed.). Oxford: Blackwell Science

Kaewthong, P. and Wattanachant, S. (2017). Optimizing the electrical conductivity of marinade solution for water-holding capacity of broiler breast meat. *Poultry science*. *97*: 701-708.

Kumolu-Johnson, C. A.; Aladetohun, N. S. and Ndimele, P. E. (2010). The effects of smoking on the nutritional qualities and shelf-life of *Clarias gariepinus* (LACEPEDE). *African Journal of Biotechnology. 9*(1): 073 – 076.

Mariachiara, A.; Michele, C.; Gabriella, C.; Michela, F.; Dorotea, L.; Rosaria, L.; Sabrina, P.; Alessandra, P.; Michela, R.; Giuseppe, A.; Venezie, B. and San-Donà di, P. (2016). Evaluation of hygienic quality and labelling of fish distributed in public canteens of Northeast Italy. *Italian Journal of Food Safety*, *5*:185-190.

Mustafa A. Gassem, M. A. (2019). Microbiological and chemical quality of a traditional salted-fermented fish (Hout-Kasef) product of Jazan Region, Saudi Arabia. *Saudi Journal of Biological Sciences*. *26*:137–140.

Ogura, S. (2022). Pathogenic bacteria load and safety of retail marine fish. *Brazilian Journal of Biology, 82*(1), e262735.

Suhendan, M.; Nuray, E.; Didem, U. and Yasemin, T. S. (2007). Effect of psychrophilic bacteria to estimate fish quality. *Journal of Muscle Foods*. *18*:120–128.

Ćurić, T., Marušić Radovčić, N., Janči, T., & Vidaček, S. (2016). Salt and moisture content determination of fish by bioelectrical impedance and needle-type multi-electrode array. *International Journal of Food Properties, 19*(11), 2489-2498.

Wiroonsri, P., Wattanachant, S., & Youravong, W. (2022). Correlation between electrical conductivity and salt content in tuna meat. In *Proceedings of the 16th ASEAN Food Conference (16th AFC 2019) - Outlook and Opportunities of Food Technology and Culinary for Tourism Industry* (pp. 256-262). Science and Technology Publications, Lda.

Zuberi, T., & Thomas, K. J. A. (2012). Demographic projections, the environment and food security in Sub-Saharan Africa. *Working Paper 2012-001, Regional Bureau for Africa, United Nations Development Programme*..

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Examining Cost-Sharing Challenges among FADAMA Users and their Impact on Agricultural Extension and Rural Development in Six (6) Local Government Areas of Niger State, Nigeria

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Abstract
Agriculture is very important to Nigeria's economy, making substantial contributions to employment, food security, and rural development. In this context, the FADAMA Project, a government effort designed to promote sustainable agricultural practices and boost production among smallholder farmers, has played a crucial role. Yet, the success of the FADAMA Project depends significantly on efficient cost-sharing systems among its users, specifically created to streamline resource distribution and promote cooperative endeavors in agricultural production. The aim of this study is to examine the cost-sharing challenges faced by FADAMA users and their implications for agricultural extension and rural development in Nigeria. A quantitative analytical study was conducted using multistage sampling Technique involving 180 FADAMA Farmers in Six (6) Local Government Areas of Niger State. The collected responses were analyzed using percentage analysis and ranked in order of severity. The results indicate that 81% experienced untimely disbursement of inputs ranking first, Insufficient credit availability was reported by 79% of respondents ranking second, Delays in payment of counterpart funds were cited by 64% of participants, ranking third. The findings reveal that the majority of FADAMA Users are grappling with various problems related to the Fadama program, suggesting that more interventions are needed to help Fadama farmers overcome these challenges associated with the project and cost-sharing arrangements. To foster a more positive attitude among FADAMA Users towards the program's implementation, it is crucial to make credit facilities readily available at low interest rates. This would alleviate financial constraints and enable farmers to actively participate in and benefit from the Fadama initiative.

Keywords: FADAMA Users, Cost-sharing Challenges, Agricultural extension, Rural development, Niger State

INTRODUCTION

The *Fadama* development project is one of the Nigeria's agricultural policies designed to increase food production for her teeming and growing population. The first phase of the project, named *Fadama* I started in 1990 through the collaboration of the Federal Government of Nigeria and the World Bank.The need for all year-round improved food production in Nigeria is inevitable with the projected annual population growth rate of 5.5 percent and food production at annual growth rate of 3.2 percent (World Bank, 1996). The word *Fadama* is a Hausa name for irrigable land usually low-lying plains underlined by shallow aquifers found along major river systems (Kudi, Ani and Oredipe, 2008; Mazza, M. et al., 2015). In addition to providing a source of water for livestock during dry seasons, *Fadama* also support large and diverse resident of wildlife including herbivores, carnivores and migratory birds (Folayan, 2013). Cost-sharing is seen as a tenable privatization policy option. Cost-sharing can be defined as a system where beneficiaries of services pay user fee. It is a privatization strategy, which entails paying a fee for services, and advice, which formally was free of charge (Rivera and Cary, 1997). The National *Fadama* Development Project (NAFDP) is a project of the Federal Government of Nigeria, through the World Bank loan. In order to finance the development of *Fadama* lands, the small-scale irrigation was introduced to different States in the country with *Fadama* development potentials. The project aims at increasing food production and raises the standard of living of the farmers. "*Akuro*" is also known in Yoruba language as *Fadama* (Ayandiji, 2013).

Aim and Objectives of the study

The aim of this study is to examine cost-sharing challenges among FADAMA users and their impact on agricultural extension and rural development in 6 Local government in Niger state Nigeria. Cost sharing in agriculture involves government-farmer partnership in the funding of agricultural activities with the aim of achieving sustainable and stable funding for agricultural technology delivery. It has been described by Chukwuone, Agwu and Ozor (2006) as a tenable privatization policy towards providing adequate and stable funding of agricultural services in Nigeria. According to Heemskerk and Wennink (2005) local cost-sharing and co-financing arrangements aim at strengthening collaboration through joint responsibility by building on the comparative advantage of different stakeholders. The cost sharing extension approach assumes that cost-sharing with local people (who do not have the means to pay the full cost) will promote a programme that is more likely to meet local situations and where extension agents are more accountable to local interests. Its purpose is to provide advice and information to facilitate farmers' self-improvement. Success of the approach is often measured by the willingness of the farmers to pay for the services (Francais, 2001). The constraints militating against sustainable Fadama development in Nigeria are legion. For instance, according to Akinbile et al. (2006), thousands of Fadama lands remain uncultivated due to the problem of accessibility or remoteness, which tends to inhibit the spread of new ideas and concepts of Fadama development. Also, according to Oladoja et al. (2008b) (Kaee, A. C. (2019).), some of the common drawbacks in the management of Fadama are the occurrence of marsh lands and swamps, which are difficult to work, thereby making the development and management of Fadama expensive and occasionally unhealthy. Baba and Singh (1998) noted that lack of post-harvest technologies, poor handling, poor road network and the lack of means of preservation constitute a major constraint of Fadama products preservation.

METHODOLOGY

The study was carried out in six local government in Niger State, Nigeria. Niger State is located in the North-Central Nigeria. It is the largest State in the country, with the State capital in Minna. A Multistage sampling technique was adopted for the selection of respondents for the study. Niger State consists of three Agricultural zones namely: Zone I, II and III respectively, two (2) Local Government Areas each were randomly selected from each of the Agricultural zones based on the *Fadama* activities of *Fadama* User Groups (FUGs) in the area, which gave a total of six (6) local Government Areas. The second stage involved random selection of two (2) *Fadama* Community Associations (FCAs) from each of the six (6) Local Governments (making total of twelve (12) FCAs).

Third stage also involved random selection of two (2) *Fadama* Users Groups (FUGs) from each of the twelve (12) FCAs making total of twenty-four (24) FUGs. In each of the selected FUGs, a list of *Fadama* farmers was obtained from their executives to get the sample frame for the study. The sample size was obtained using a propose formula by Yamane (1967). This gave a total of 180 *Fadama* farmers, which is 55% of the sample frame. Fifty-five (55%) of *Fadama* users were selected from each selected local government areas using simple random sampling technique based on the list of registered *Fadama* farmers:

$$N = \frac{N}{1+N(e)^2} = \frac{327}{1+327(0.05x0.05)} = 180$$

N = Population size
n = Sample size = 180
e = Precision level

The primary data were collected with the help of trained enumerators under the supervision of the researcher using a well-structured interview schedule. The data collected were analyzed using descriptive statistical tools such as percentages, frequency count, and ranking.

RESULTS AND DISCUSSION

The Table below showed that 81% of the respondents experiencing untimely disbursement of inputs which ranked 1st, 79% of the respondents have problem in the aspect of credit availability as not sufficient which ranked 2nd while 64% of the respondents faced delay in payment of counterpart fund which ranked 3rd. The results revealed that majority of the respondents (*Fadama* Users) are experiencing one problem or the other on the *Fadama* programme. This implies that more is still needed to be done in order to help the *Fadama* farmers to overcome such problems that are associated with *Fadama* project and cost sharing.

Table 1 Challenges associated with effective project cost-sharing among the *Fadama* Users (n=180)

Variables	*Frequency	Percentage	Ranking
Untimely Disbursement of Inputs	146	81.1	1
Insufficient Credit Availability	142	78.9	2
Delay in Payment of Counterpart Fund	116	64.4	3
Political Instability in the Country	104	57.8	4
General Reluctance of Farmers to Pay for Source	89	49.4	5
Poor Access to Land	70	38.9	6
Poor/Inadequate Funding	61	33.9	7
Lack of Advisory Service	39	20.0	8
Poor Attitude of Extension Staff	35	19.4	9
High Production and Service Cost	34	18.9	10
Difficulty in Collecting Money from Farmers	31	17.2	11
Conflicts between Service Providers and Farmers	30	16.7	12
Dishonesty/Corruption among Farmers	26	14.4	13
Lack of Advisory Services	23	12.8	14

Source: Field survey, 2020. *Multiple response recorded

CONCLUSION AND RECOMMENDATIONS

The high incidence of issues such as untimely input disbursement and insufficient credit availability highlights the need for targeted interventions to enhance the operational efficiency of the FADAMA Project. Addressing these challenges is essential not only for improving agricultural productivity, but also for fostering sustainable rural development and food security in the region. By ensuring access to low-interest credit facilities and timely resource allocation, stakeholders can significantly enhance the participation and satisfaction of FADAMA farmers, ultimately leading to better outcomes for the agricultural sector in Nigeria. There should be adequate and timely disbursement of inputs to the *Fadama* users so as to ensure prompt utilization of such inputs and enhance their production.

REFERENCES

Ayandiji, A. & Vera-Cruz, O. (2013). Percived Effectiveness of Media Utilization Among *Fadama* Farmers in Osun State, Nigeria. *World Rural Observations*, *5* (1), 30- 39.

Baba & Singh, (1998), cited in Oladoja, M.A and Adeokun, O.A (2009), An Appraisal of the National *Fadama*Development Project (NFDP) in Ogun State, Nigeria, *Agricultural Journal, Scientific Research Publishing Company*, *4*(3**)**, 124-129.

Folayan J. A. (2013). Socio- Economic Analysis of *Fadama* Farmers in Akure South Local Government Area of Ondo State. *American Journal of Humanities and Social Sciences; 1*(1), 10-17

Francais, E. (2001) Forestry extension. http://www.fao.org/docrep/v9122E/v9122e02d.htm. Retreived 4/11/2009

Kaee, A. C. (2019). *An Assessment of Inooro Fm's Mugambo Wa Murimi Programme on the Uptake of Information on Soil Fertility Management Technologies Among Smallholder Farmers in Kandara Sub-County, Murang'a County* (Doctoral dissertation, University of Nairobi).

Kudi, A.M, Ani S.O & Oredipe A.A (2008). Poverty reduction and increased productivity through empowerment" CPU – NFDO *Fadama* Development Project Handbook. October, 2008. Pp4

Mazza, M., Ekumankama, O. O., & Okezie, C. A. (2015). Effect of Second National Fadama Development Project on farmers' productivity in Imo State, Nigeria. *Journal of Natural Sciences Research*, *5*(3), 1-10. ISSN 2224-3186 (Paper), ISSN 2225-0921 (Online). Retrieved from www.iiste.org

Oladoja, M.A., Adeokun, O.A., & Fapojowo, O.E. (2008). Determining of Socio-Economic factors affecting farmer's use of communication methods of information sourcing in Oluyole Local Government Area of Oyo State, Nigeria. *Journal of Social Sciences; 5*(1), 51-56.

Rivera, W. M., & Cary, J. W. (1997). Privatizing Agricultural extension. In B. E. Swanson, R. P. Bentz, & A. J. Sofranko (Eds.), *Improving agricultural extension: A reference manual* pp. 203-212.

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Organoleptic Quality of Tomato Pastes as Influenced by Fertilizer Type and Growing Season

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Abstract

Cultivating tomato varieties with improved processing qualities as well as field cultural practices during cultivation are vital for produce conversion and processing required in addressing the challenges of post-harvest losses. This study was carried out to examine consumers' rating of paste derived from two varieties of tomato fruits cultivated using different fertilizer types. Critical indices of consumers' rating considered are taste, flavour and appearance. Tomato fruits were cultivated under field condition at the Teaching and Research Farms, Federal University of Agriculture, Abeokuta (FUNAAB), Nigeria, in both early and late growing seasons of years 2014 and 2015. Two Tomato varieties used were Beske and Roma VF, with six fertilizer types (Poultry manure -10t/ha, Cow dung -10t/ha, NPK 15:15:15 -300kg/ha and mixtures in different ratios). After harvesting, the fruits were processed into paste at the Laboratory of the Department of Food Science and Technology, FUNAAB, using standard method. The paste of fruits from the different fertilizer treatments in both seasons were evaluated for taste, flavour and appearance by a 10-man panel. Descriptive statistics (percentage) were used to score the organoleptic traits evaluated. Results showed that paste from the two tomato varieties differed significantly in taste, flavour and appearance. Paste of fruits from the different fertilizer types used also differed significantly in the traits measured.

Keywords: Taste, Flavour, Appearance, Beske, Roma VF

INTRODUCTION

Tomato fruit is a popular vegetable, a source of many nutritional components with antioxidant property (Leonardi *et al*., 2000, Toor and Savage 2005, Thybo *et al*., 2006, Elbadrawy and Sello, 2016). The increasing consumption of fresh vegetables containing bioactive compounds and consumers' acceptance of the product are very important. Sensory properties are important in the assessment of vegetable quality and consumers' preferences (Magkos *et al*., 2003). Fresh and processed tomatoes are rich sources of a natural antioxidant which can replace synthetic anti-oxidants and thus protect cells from oxidants that have been linked to cancer in humans (Hounsome *et al*., 2008). Tomato can provide a significant proportion of total antioxidants in the diet, in the form of carotenes and phenolic compounds (Andres *et al*., 2017). Lycopene predominates among carotenoids and is mainly responsible for the red colour of tomato fruits and their derived products such as paste (Valverde *et al*., 2002). Fruit composition and their desirability are affected by many factors such as growth media and fertilizer sources (Haglund *et al*., 1997, Gundersen et al., 2001, Thybo *et al*., 2006, Bekele, 2018).

Product quality is a complex characteristic that depends on several factors and includes both objective (measurable quality traits) as well as subjective sensory characteristics (Auerswald *et al*., 1999; Schnitzler and Gruda 2002). Quality concerns have become increasingly important worldwide and many investigations have addressed the impact of plant nutrition on the quality of tomato fruit. Major fruit quality of interest to both fresh market and industrial tomato include a number of agronomic, organoleptic and nutritional qualities.

Factors like processing conditions introduce great variation in the quality of tomato paste (Anthon, Diaz and Barrett, 2008). These variations pose difficulties in achieving a consistent paste quality during processing. As a quality control routine, pastes are usually sampled from each production batch and a range of quality factors such as colour, soluble solids content, pH, acidity and consistency are tested. Organoleptic quality is evidenced via physicochemical parameters that give the product acceptance by consumers (Stevens, 1972; Kader *et al*., 1978; Stolz *et al*. 2011, Aoun *et al*., 2013). This work was carried out to examine fertilizer type and tomato growing season suitable for tomato paste in meeting consumers' preference in terms of taste, flavour and appearance.

MATERIALS AND METHODS

Field cultivation to generate tomato fruits to be processed into paste for assessment was done at the Teaching and Research Farm, Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State, Nigeria, during the early and late seasons of years 2014 and 2015. Tomato seeds were sown and seedlings maintained on a ground nursery. Soil samples were taken from the experimental site before planting for routine laboratory analysis. Samples of cow dung and poultry manure used for cultivation were also analysed for their nutrient status. The manure and cow dung were applied as applicable to the allotted plots two weeks before transplanting according to Tirkey *et al*. (2002). Four weeks old tomato seedlings were transplanted at a spacing of 50 x 50cm. Two varieties of tomato (Beske and Roma VF) were used as well as six fertilizer types which were Poultry manure at 10t/ha, Cow dung at 10t/ha, NPK 15:15:15 at 300kg/ha, Poultry manure (5t/ha) + NPK 15:15:15 (150kg/ha), Cow dung (5t/ha) + NPK 15:15:15 (150kg/ha) and No fertilizer (Control).

Inorganic Fertilizer (NPK 15:15:15) was applied to the allotted plots at the rate of 300kg/ha (0.18kg/plot) at two weeks after transplanting(WAT), using half of the recommended rate, followed by top dressing at four WAT (Adeniji and Bodunde 2007). Composite fertilizer, that is, half of the recommended rate of the organic fertilizer (5t/ha) was applied at two weeks before transplanting to be followed with half of the recommended rate of NPK 15:15:15 (150 kg/ha) in two equal split doses, as done with the inorganic fertilizer treatment. Full ripe fruits harvested from all fertilizer treatments were processed into paste following the procedure of International Organization for Standardization (ISO). Organoleptic test was carried out on taste, flavour and appearance of the paste through a trained ten-man panel, provided with samples from all treatments.

The Organoleptic traits were rated as follows:
Taste – Sweet, Sour, Tasteless and Rancid
Flavour – Good and Bad
Appearance - Attractive and Repulsive
Descriptive statistics (percentage) was used for the data of the organoleptic traits scores generated by the panel.

RESULTS AND DISCUSSION

The flavour rating result pattern by the respondents was similar in both years. Paste of Beske fruits from plots treated with poultry manure, cow dung, NPK, poultry manure + NPK and control in the early season was rated as having good flavour by more than 80% of the respondents (Tables 1 and 2).

Paste that was accepted by a higher percentage of the respondents in terms of appearance could be attributed to high Lycopene content on the paste resulting in its redness and acceptability according to Valverde *et al*. (2002) and Marti *et al*. (2016) who reported that Lycopene is mainly responsible for the red colour of tomato fruits and their derived products such as paste. The high Lycopene content could also be attributed to the high quatum of light as reflected in the sunshine duration during the late raining season because the higher the light quatum the more pronounced the pigmentation.

Generally, more of the paste samples were rated as good in terms of flavor. This could be because all the fruits processed into paste were harvested red-ripe, thus they are expected to possess good flavor according to Kader *et al*. (1977) and Deribe *et al*. (2016) who stated that tomato are prone to bad flavor when harvested at mature-green stage in order to prolong shelf life. The observed good flavor could also be attributed to the fact that the fruits were neither stored nor treated which agrees with other researchers who have reported that lack of good flavor of tomato is associated with various storage treatments like modified atmosphere (Hobson 1988; Ho 1996; Maul *et al*. 2000, Deltsidis *et al*., 2018).

CONCLUSION AND RECOMMENDATION

Findings from this study indicate that for good paste flavour, use of sole NPK (15-15-15) fertilizer (300kg/ha) or combination of NPK fertilizer with either Poultry manure or cow dung is appropriate. For attractive appearance which is the desire of consumers, late season cultivation of Roma VF with NPK 15:15:15 would be appropriate.

REFERENCES

Adeniji, I. A. and Bodunde, J. G. (2007). Impact of grass mulch on some soil physical properties and fruit yield of late season Tomato (*Lycopersicon esculentum* Mill). *Agricultural Sciences Research Journal*, *1*, 1-4.

Andres, A.I., Petron, M.J., Delgado-Adamez, J., Lopez, M. and Timon, M. (2017). Effect of Tomato Pomace Extracts on the Shelf-Life of Modified Atmosphere-Packaged Lamb Meat. *Journal of Food Processing Preservation*, 41, 13018.

Anthon, G. E., Diaz, J. V. and Barrett, D. M. (2008). Changes in Pectins and Product Consistency during the Concentration of Tomato Juice to Paste. *Journal of Agriculture Food Chemistry*, 5*6* (16), 7100-7105.

Aoun, A.B., Lechiheb, B., Benyahya, L. and Ferchichi, A. (2013). Evaluation of fruit quality traits of traditional varieties of tomato (Solanum lycopersicum) grown in Tunisia. *African Journal of Food Science*, *7*(10), 350-354.

Auerswald, H., Schwarz D., Kornelson C., Krumbein A. and Brückner B. (1999). Sensory analysis, sugar and acid content of tomato at different EC values of the nutrient solution. *Scientia Horticulturae*, *82*, 227–242.

Bekele, D. (2018). Review on factors affecting post-harvest quality of fruits. *Journal of Plant Science and Research*, *5* (2), 180.

Elbadrawy, E and Sello, A. (2016). Evaluation of nutritional value and antioxidant activity of tomato peel extracts. *Arabian Journal 9*(2), 1010-1018.

Gundersen, V., McCall D. and Bechmann I. E. (2001). Comparison of major and trace element Concentrations in Danish greenhouse tomatoes *(Lycopersicon esculentum* cv Aromata F1) cultivated in different substrates. *Journal of Agriculture and Food Chemistry*, *49*, 3808–3815.

Haglund, A., Johansson L., Gäredal L. and Dlouhy J. (1997). Sensory quality of tomatoes cultivated with ecological fertilizing systems. *Swedish Journal of Agriculture Resources, 27*, 135–145.

Hounsome N, Hounsome B, Tomos D and Edwards-Jones G. (2008). Plant metabolites and nutritional quality of vegetables JFS R: *Concise Reviews/Hypotheses in Food Science* 1 -18.

Kader A. A., Morris L. L., Stevens M. A. and Albright-Holton M. (1978). Composition and flavour quality of fresh market tomatoes as influenced by some postharvest handling procedures. *Journal of American Society of Horticultural Science 103*, 6-13.

Leonardi, C., Ambrosino, P., Esposito, F. and Fogliano, V. (2000). Antioxidant activity and Carotenoid and tomatine contents in different typologies of fresh consumption tomatoes. *Journal of Agricultural Food Chemistry, 48*, 4723–4727.

Magkos, F., Arvaniti, F., Zampelas, A. (2003). Organic food: nutritious food or food for thought? A review of the evidence. *International Journal of Food Science Nutrition*, *54*, 357–371.

Schnitzler, W. H. and Gruda, N. S. (2002). Hydroponic and Product Quality. In: *Savvas D, Passam HC (Eds.) Hydroponic Production of Vegetables and Ornamentals, Embryo Publications, Athens, Greece* pp. 373-411.

Stevens MA (1972). Relationships between components contributing to quality variation among tomato lines. Journal of American Society of Horticultural Science 97: pp. 7073.

Stolz, H.; Stolze, M.; Janssen, M.; and Hamm, U. (2011). Preferences and determinants for organic, conventional and conventional-plus products—The case of occasional organic consumers. *Food Quality Preference*, *22*, 772–779.

Thybo, A. K., Edelenbos M., Christensen L. P., Sorensen, J. N., Thorup-Kristensen K., (2006). Effect of organic growing systems on sensory quality and chemical composition of tomatoes.

Tirkey, T., Agrawal, S. and Pandey, S. D., (2002). Effect of organic manures on growth maturity and yield of banana cv, Dwarf Cavedish. *South Indian Horticulture*, *50* (1/3), 19-24.

Table 1: Taste rating (%) of tomato paste as influenced by variety, fertiliser type and growing season

Season	Variety	Fertilizer	2014				2015			
			Sweet	Sour	Tasteless	Rancid	Sweet	Sour	Tasteless	Rancid
Early	Beske	Poultry Manure	20	0	60	20	20	20	60	0
		Cow dung	0	20	60	20	0	20	60	20
		NPK	60	0	40	0	60	0	40	0
		Poultry Manure + NPK	80	0	20	0	60	20	20	0
		Cow dung + NPK	20	20	60	0	20	40	40	0
		Control	40	50	10	0	20	0	80	0
	Roma VF	Poultry Manure	0	40	40	20	0	60	20	20
		Cow dung	0	20	80	0	0	0	80	20
		NPK	20	40	40	0	40	20	20	20
		Poultry Manure + NPK	60	0	40	0	20	0	60	0
		Cow dung + NPK	60	0	40	0	60	20	20	0
		Control	0	20	40	40	20	20	40	20
Late	Beske	Poultry Manure	0	0	100	0	20	0	80	0
		Cow dung	0	0	40	60	20	0	20	60
		NPK	0	0	40	60	0	60	0	40
		Poultry Manure + NPK	20	20	40	20	20	20	40	20
		Cow dung+ NPK	20	0	0	80	0	0	\0	100
		Control	20	0	80	0	0	0	100	0
	Roma VF	Poultry Manure	0	20	60	20	0	20	60	20
		Cow dung	0	0	60	40	0	0	100	0
		NPK	0	40	60	0	0	20	60	20
		PoultryManure+NPK	20	40	40	0	20	40	40	0
		Cow Manure + NPK	20	40	40	0	20	20	40	20
		Control	0	40	40	20	0	20	60	20

Table 2: Flavour rating (%) of tomato paste as influenced by variety, fertiliser type and growing season

Season	Variety	Fertilizer	2014		2015	
			Good	Bad	Good	Bad
Early	Beske	Poultry Manure	100	0	100	0
		Cow dung	100	0	80	20
		NPK	100	0	80	20
		Poultry Manure + NPK	100	0	100	0
		Cow dung + NPK	0	100	20	80
		Control	40	60	40	60
	Roma VF	Poultry Manure	0	100	20	80
		Cow dung	0	100	80	20
		NPK	100	0	80	20
		Poultry Manure + NPK	100	0	80	20
		Cow dung + NPK	80	20	100	0
		Control	20	80	40	60
Late	Beske	Poultry Manure	40	60	40	60
		Cow dung	60	40	40	60
		NPK	60	40	80	20
		Poultry Manure + NPK	20	80	20	80
		Cow dung + NPK	60	40	40	60
		Control	0	100	20	80
	Roma VF	Poultry Manure	80	20	80	20
		Cow dung	100	0	80	20
		NPK	100	0	100	0
		Poultry Manure + NPK	60	40	80	20
		Cow dung + NPK	60	40	60	40
		Control	40	60	40	60

Resilient Agroecosystems for a Changing Climate: Integrating One Health Principles into Insect Pest Management in Nigeria

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Abstract
Climate change provides considerable problems for Nigerian agroecosystems, notably in the context of insect pest control. This project intends to incorporate One Health concepts into a comprehensive pest control approach to construct resilient agroecosystems for a changing climate in Nigeria. A randomized complete block design (RCBD) was used to perform two years of fieldwork in Abeokuta, Southwest Nigeria, from 2021 to 2022. The sample units consisted of sixteen plots divided into four treatments: integrated pest management (IPM), biological control agents, pest-resistant cultivars, and a control group. In contrast to the control group, the researchers observed that utilizing IPM strategies enhanced crop yield by 30% and reduced pest prevalence by 45% ($p < 0.05$). Compared to alternative treatments, utilizing pest-resistant cultivars reduced pest damage by 55%. Our results show that a-one-health concepts may be incorporated into pest control programs to increase food security and sustainable farming practices.
Keywords: One Health, climate change, pest management, integrated pest management (IPM), biological control, pest-resistant varieties, Nigerian agroecosystems.

INTRODUCTION

Climate change has emerged as one of the most important concerns influencing global agricultural output, with substantial consequences for pest control in agroecosystems. As temperatures increase, precipitation patterns vary, and severe weather events become more frequent, the dynamics of insect populations and their effect on crops are radically affected (Lehmann *et al*., 2020). In Nigeria, where agriculture contributes considerably to the economy and food security, the susceptibility of agroecosystems to climate-induced pest outbreaks needs new and comprehensive management techniques (Obi & Oyedele, 2021). One Health is a collaborative, multisectoral, and transdisciplinary strategy that emphasizes the interdependence of human, animal, and environmental health (Destoumieux-Garzón *et al*., 2018). This approach offers a fresh perspective through which pest control techniques might be created, particularly in the context of a changing climate. Insect pests such as the Fall Armyworm *(Spodoptera frugiperda*) and Desert Locust (*Schistocerca gregaria*) have been recognized as serious challenges to agricultural yield in Nigeria, frequently aggravated by climatic circumstances (Kumar et al., 2021). Traditional pest control techniques, which are often based on chemical pesticides, are losing efficacy as pest populations develop fast adaptation and resistance, combined with the negative effects on the environment and human health associated with pesticide overuse (Popp *et al*., 2013). Recent research emphasizes the necessity of a paradigm transition towards integrated pest management (IPM) systems that conform with the One Health concept and are strong against climatic variability. This study explores the implementation of One Health ideals in insect pest management programs for agroecosystems in Nigeria. This implies that using integrated pest management techniques (Zhou *et al*., 2019), biological control, and pest-resistant cultivars will help to raise climate resilience (Godfray *et al*., 2014) without compromising food security. Apart from actual evidence on the effectiveness of various approaches, the research provides direction to agricultural players and legislators on how to use integrated solutions compliant with the One Health concept. The studies also provide real statistics confirming the effectiveness of various approaches.

MATERIALS AND METHODS

Study site: The study was carried out at the University of Agriculture in Abeokuta, Nigeria for two years under a tropical environment. Experimental design was Randomized Complete Block Design (RCBD), having four treatments; Integrated Pest Management practice, Biological Control Agents use, Disease Resistant Varieties and control with no treatment. The treatments were replicated four times, which led to a total of 16 plots. Each plot was 5m in length and 5m in width.

Treatments: The treatments applied to the test plots were an Integrated Pest Management combining cultural mechanisms, mechanical methods, and the use of biopesticides at target application rates; Biological Control Agents, such as Trichogramma wasps and Coccinellidae, which were engaged to reduce the populations of various pest organisms; and Pest-Resistant Varieties enhanced varieties of maize and cow pea that are resistant to biologically relevant populations of specific insect pests. The control did not involve any mechanism of reducing pest populations.

Data Collection and Analysis

A weekly record of pest incidence, the diversity of pests and crop yield was taken. Pest incidence was recorded as percent of plants infested by pests, while crop output was measured in kg/ha Data were analyzed by analysis variance (ANOVA) to determine the importance of differences between treatments. Mean separation ($p < 0.05$) was performed by Tukey's HSD test Standard Error of the Mean (SEM) values were then calculated and presented at bottom of all tables.

RESULTS AND DISCUSSION

This confirms the effectiveness of including One Health principles in insect pest control improved practices throughout various climate scenarios in Nigeria. Here, multiple tables were shown for a more comprehensive view of pest incidence over time; species diversity varies among several crops and what the crop yield result was in some cases.

The findings of this study highlighted the opportunities for consolidation of One Health in pest management system towards sustainability agroecosystem development in Nigeria. The decreases of 45% in pest incidence and the increase of about 30% on yield compared with control, observed under IPM practices (Chandler *et al*., 2011), proved the efficiency of these integrated approaches. In addition, pest-resistant varieties performed far better than other treatments and resulted in an up to 55% reduction of pest damage, confirming recent insights indicating the crucial role genetic resistance should play in climate-smart agriculture (Godfray *et al*., 2014). Biological control agents have a limited impact compared to pest-resistant varieties, but even with this relatively low bar they substantially reduced the incidences of pests which thus support our hypothesis that bio-controls could play an important role in integrated solution-based model (Heimpel and Mills 2017). The results indicate that a multiplicity of pest management methods may contribute to more resilient IPM practices for fluctuating climatic scenarios. These results underscore the need to incorporate multiple pest management strategies guided by One Health principles for building resilient agroecosystems, especially in a climate changing environment of Nigeria. These reductions in pest occurrence with crop yield augment the importance of a lot facet approach aimed at lessening against afflictions. This is consistent with results of other studies that indicate a synergy between biological control agents, pest-resistant cultivars and IPM methods in enhancing sustainability (Furlong *et al*. 2015). Among the different treatments, our study revealed that pest-resistant varieties showed highest significant effect in reducing the incidence of pests as well as higher crop yield restoration. It further corroborates emerging research findings that plant varieties resistant to pests are essential in mitigating pest associated damages, and particularly so under changing climatic conditions promoting increase insect expanse (Godfray *et al*., 2014; Bruce Anani WO ANANI2021). For instance, pest-protected maize and cowpea lines were significantly less damaged by *Spodoptera frugiperda* (fall armyworm) and *Maruca vitrata* (cowpea pod borer), which are key insect pests in West African agroecosystems Kumar *et al*., 2021.

Biological control agents were, although inferior to pest-resistant varieties, very effective for overriding the losses resulting from distortion of insect damage. This confirms earlier work showing how biological controls are a green and viable substitute for chemicals (Heimpel and Mills, 2017). The success of biological control varies more, depending on intricate environmental interactions, pest population dynamics and the specificity of species or strains used as agents (van Lenteren *et al*. 2018). More studies are required to adapt this control method in the integrated pest management scenario and specially under a changing climate condition. In addition, an integrated pest management (IPM) strategy applied in this study was also highly effective by decreasing the number of pests by 45% and increasing crop load yield up to 30%, compared with that control. This is consistent with broader evidence showing the effectiveness of IPM as an alternative to conventional pesticide reliant pest management strategies (Pretty & Bharucha, 2015). The IPM used in our study included cultural practices, mechanical controls and selective use of biopesticides which made it a complete package for the management of key pests according to agro-climatic conditions. This adaptability is of significant importance for climate change (climate changes from year to year, decade to decade) and farmer management practices vary accordingly depending upon the host-pest interaction.

Another thing that made this research quite uncommon was the way it approached aspects related to pest management, using the One Health principle by clearly pointing out the linkage of health from plants and animals to the health of human beings. It integrates One Health into agricultural practice to move away from overdependence on pesticides, the negative impacts of which are all too well-documented with regards to human and environmental health through pesticide residues present within the food and water chain, while also causing total destruction of nontarget species, such as pollinators and natural pest predators. Popp *et al*., 2013; Destoumieux-Garzón *et al*., 2018. This holistic view helps enhance the management of pests along with a broader outlook on sustainability, including biodiversity conservation and public health. The studies' applicability is limited due to their specific geographic and climatic contexts in Southwest Nigeria. They cannot be generalized across all agroecological zones or areas with varied pest profiles. Further research is needed to validate findings and expand on the proposed methodologies. However, integrated One Health approach in Nigeria focuses on sustainable pest management strategies to enhance crop production, food security, environmental and public health, addressing climate change challenges.

CONCLUSION AND RECOMMENDATIONS

The study highlights the importance of integrated pest management strategies that incorporate One Health principles to improve the resilience of Nigerian agroecosystems in the face of climate change. The results show significant reductions in pest incidence and increased crop yield, highlighting the value of a multidisciplinary approach to pest management. The paper also emphasizes the need for further investigation to assess these strategies' scalability and the economic and social toll they take on Nigeria's smallholder farmers. The study acknowledges limitations, such as the limited geographic scope and the use of specific crop varieties. Further studies are needed to broaden the results across geography and types of crops, examine the long-term economic and environmental effects of integrated pest management, and understand how climate change influences pest dynamics in different agricultural systems in order to support comprehensive and multisectoral pest control strategies.

REFERENCES

Bruce, T. J. A. (2021). Resistance and tolerance to insect pests in plants: The role of secondary metabolites. *Annual Review of Entomology*, *66*, 505-523.

Chandler, D., Bailey, A. S., Tatchell, G. M., Davidson, G., Greaves, J., & Grant, W. P. (2011). The development, regulation and use of biopesticides for integrated pest management. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *366*(1573), 1987-1998.

Destoumieux-Garzón, D., Mavingui, P., Boetsch, G., Boissier, J., Darriet, F., Duboz, P., & Wassenaar, T. M. (2018). The One Health concept: 10 years old and a long road ahead. *Frontiers in Veterinary Science*, *5*, 14.

Furlong, M. J., Zalucki, M. P., & Kitching, R. L. (2015). Integrating biological control into pest management strategies: A scientific perspective. *Annual Review of Entomology*, *60*, 613-634.

Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., ... & Toulmin, C. (2014). Food security: The challenge of feeding 9 billion people. *Science*, *327*(5967), 812-818.

Heimpel, G. E., & Mills, N. J. (2017). Biological Control: Ecology and Applications. *Cambridge University Press*.

Kumar, P. L., & Nwilene, F. E. (2021). Pest management in West African agriculture under changing climate: Present status and future prospects. *International Journal of Pest Management*, *67*(4), 302-317.

Lehmann, J., Bossio, D. A., Kögel-Knabner, I., & Rillig, M. C. (2020). The concept and future prospects of soil health. *Nature Reviews Earth & Environment*, *1*(9), 544-553.

Obi, A., & Oyedele, D. J. (2021). Climate change and agricultural practices in Nigeria: Impact and adaptation strategies. *African Journal of Agricultural Research*, *16*(8), 1139-1148.

Popp, J., Pető, K., & Nagy, J. (2013). Pesticide productivity and food security. A review. *Agronomy for Sustainable Development*, *33*(1), 243-255.

Pretty, J., & Bharucha, Z. P. (2015). Integrated pest management for sustainable intensification of agriculture in Asia and Africa. *Insects*, *6*(1), 152-182.

van Lenteren, J. C., Bolckmans, K., Köhl, J., Ravensberg, W. J., & Urbaneja, A. (2018). Biological control using invertebrates and microorganisms: plenty of new opportunities. *BioControl*, *63*(1), 39-59.

Zhou, H., Xie, W., Wu, Q., & Wang, S. (2019). The effectiveness of biological control in pest management: An empirical study. *Environmental Entomology*, *48*(6), 1375-1384.

Table 1: Pest Incidence across Different CSPM Strategies (2021-2022)

Treatment	2021 Pest Incidence (%)	2022 Pest Incidence (%)
IPM	10.5^{a}	8.2^{b}
Biological Control Agents	12.0^{a}	10.0^{b}
Pest-Resistant Varieties	9.8^{a}	7.5^{b}
Control	18.5^{c}	20.0^{d}
SEM	0.05	0.06

Different superscript letters within columns indicate significant differences ($p < 0.05$) according to Turkey's HSD test.

Table 2: Crop Yield under Different CSPM Strategies (2021-2022)

Treatment	2021 Crop Yield (kg/ha)	2022 Crop Yield (kg/ha)
IPM	3,200a	3,450b
Biological Control Agents	2,950a	3,100b
Pest-Resistant Varieties	3,500a	3,600b
Control	2,500c	2,400d
SEM	0.07	0.08

Different superscript letters within columns indicate significant differences ($p < 0.05$) according to Turkey's HSD test.

Table 3: Comparative Effectiveness of CSPM Strategies in Reducing Pest Incidence and Enhancing Crop Yield

Treatment	Mean Pest Incidence Reduction (%)	Mean Crop Yield Increase (kg/ha)
IPM	26.5	325
Biological Control Agents	20.3	250
Pest-Resistant Varieties	32.6	350
SEM	0.06	0.07

Different superscript letters within columns indicate significant differences ($p < 0.05$) according to Turkey's HSD test.

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Effects of point of Sale (POS) Services on Income of Groundnut Processors in Niger State, Nigeria

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Abstract
This study was conducted to assess the effects of Point of Sale (POS) services on income of groundnut processors in Niger State, Nigeria. Three-stage sampling procedure was used to select 210 groundnut processors for the study; Data were collected from primary source using semi-structured questionnaire complemented with interview schedule. Data collected were analyzed using both descriptive statistics such as (means, percentages and frequency distribution) and inferential statistics such as ordered logit). The result of the findings indicated almost half (46.7%) of groundnut processors had high utilization of POS services. Socioeconomic factors such as formal education (P< 0.01), processing experience (P< 0.05), income from groundnut processed (P<0.01), cooperative (p<0.01) and sources of information on POS services (P<0.01) significantly influenced the level of utilization of POS services among groundnut processors. In addition, No of POS services utilized (p<0.01), participation in POS enabled cooperative (P<0.05) and quantity of sales facilitated using POS services (p<0.01) significantly influence the income groundnut processors. The study recommended that financial institutions and POS operators should expand the availability of POS services in rural areas by setting up more POS terminals and enhancing mobile banking services. Additionally, offer training sessions to groundnut processors on maximizing the benefits of POS services to boost their business transactions and financial inclusion.

Keywords: POS, income, groundnut, processors and services

INTRODUCTION
Groundnut (*Arachis hypogea*), known by various names such as '*Gyadda*' to the Hausas, '*Opapa*' to the Ibos, 'Epa' to the Yorubas, peanuts in the United States, and arachides in France, holds significant economic importance globally. It serves various purposes, including consumption as whole nuts, raw, boiled, or roasted, as well as for oil extraction and cake production. Groundnut ranks as the third major oilseed worldwide, following soybeans and cotton, according to the United States Department of Agriculture (USDA, 2019). The residue left after oil extraction serves as a valuable protein source for animal feed, thus contributing substantially to income generation and job creation, particularly in regions where groundnut cultivation and processing are prevalent (Bashar, 2022). Traditionally, groundnut oil extraction predominates in many West and equatorial African regions, where the process is commonly manual and labour-intensive (Duke, 2022). According to Tanko (2019), groundnut processing is often carried out by small-scale farmers in Niger State engaging in diverse processing activities. These farmers have carved out a niche for themselves by producing high-

quality groundnut products, notably the renowned *'kulikuli'*. However, despite its importance, the sector grapples with several challenges, notably the reliance on traditional payment methods, primarily cash transactions. These conventional methods are often cumbersome, inefficient and susceptible to security risks, posing barriers to financial management and hindering business growth within the groundnut processing industry. Amidst these challenges, there arises a pressing need to explore alternative payment solutions that can streamline transactions, enhance financial management practices, and mitigate security risks. Point of Sale (POS) services emerge as a promising avenue to address these needs, offering electronic payment options that can revolutionize the way groundnut. Based on the following the study was conducted to examine level of POS services utilization among groundnut processors, factors influencing POS services utilization among groundnut processors and effects of POS services utilization on income of groundnut processors.

METHODOLOGY

The study was carried out in Niger State, Nigeria. 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. Currently, the State covers an estimated total land area of 76,363 square kilometers, which is about 8% of Nigeria's total land area (Oni *et al.,* 2021). The population of the State is 3,950,249, comprising 2,082,725 males and 1,867,524 females (National Population Commission (NPC), 2006). The projected population of the State as at 2021 was 5,644,139 at 3.2% population growth (NBS, (2022).

Three-stage sampling technique was employed to select 210 groundnut processors in the study area. Combination of various analytical tools such as descriptive statistics, Ordered Logit regression and Ordinary least regression model was used to achieve the objectives of the study.

RESULTS AND DISCUSSION

Level of POS services utilisation among groundnut processors

Table 1 present the results of level of POS services utilization among groundnut processors. It revealed that A substantial 46.7% of groundnut processors fall into the high level of POS services utilisation category, indicating that nearly half of the processors use between 11 and 16 different POS services. The high level of POS services usage among groundnut processors suggests a strong reliance on these systems for their financial management in their groundnut processing. Processors in this category are likely using POS services for various functions including cash withdrawals, deposits, fund transfers, and even more specialised services such as agricultural loan repayments and bill payments. The adoption of a wide array of POS services can also be driven by market trends and the need to remain competitive. In an increasingly digital and fast-paced market environment in Nigeria today, processors may use these services to keep up with competitors, enhance their market presence, and improve customer service. This disagree with the study of Muhammad and Abubakar (2019) who assessed the use of digital financial services among smallholder farmers in Northern Nigeria. The study reported that the adoption of digital financial services was generally low among rural farmers with only 35.0% of respondents adopting the digital financial services.

Table 1: Level of POS services utilisation among groundnut processors

Level	Score	Frequency	Percent
Low	1 – 6	51	24.3
Moderate	7 – 10	61	29.0
High	11 -16	98	46.7

Source: Field survey, 2024

Factors influencing POS services utilization among groundnut processors

Table 2 presents the results of the Ordered Logit analysis on factors influencing POS (Point of Sale) services utilization among groundnut processors. The results revealed several significant variables that positively or negatively influence the use of POS services. Specifically, formal education (β = 0.300614, $p<0.01$), processing experience (β = 0.650855, $p<0.05$), income from groundnut processing (β = 0.31198, $p<0.01$), types of groundnut product processed (β = 0.599269, $p<0.05$), and off-farm income (β = 9.58E-07, $p<0.05$) were positive and statistically significant at different probability levels. This suggested that an increase in any of these variables is associated with a higher likelihood of POS services utilization. Conversely, age (β = -0.08078, $p<0.01$) and distance to the POS stand (β = -0.05356, $p<0.05$) were negatively associated with POS services utilization, meaning that an increase in these factors reduces the likelihood of using POS services.

Table 4.5: **Ordered logit on factors influencing POS services utilization among groundnut processors**

Variable	Coefficient	Standard Error	z-value
Age	-0.08078	0.025212	-3.20***
Household size	0.059416	0.045672	1.30
Formal education	0.300614	0.104108	2.89***
Processing experience	0.650855	0.283021	2.30**
Extension contact	0.96431	0.64179	1.5
Amount assessed as credit	2.74E-07	7.47E-07	0.37
Income from groundnut processing	0.31198	0.103873	3.00***
Cooperative membership	0.054616	0.022488	2.43**
Source of information on POS services	0.350274	0.109335	3.2
Owned a bank ATM	0.172069	0.388905	0.44
Trust of the POS agent	0.146058	0.374202	0.39
Types of groundnut product processed	0.599269	0.290799	2.06**
Distance to POS stand	-0.05356	0.025647	-2.09**
Off farm income	9.58E-07	4.03E-07	2.38**
LR chi2(15) = 98.67			
Prob > chi2 = 0.0000			
Log likelihood = -192.94351			
Pseudo R2 = 0.4320			

Source: Field survey, 2024 Note* = significant at 0.10, ** significant at 0.05 and *** significant at 0.01 probability level.

Age (β = -0.08078) was found to have a significant negative effect on POS service utilization among groundnut processors at a 0.01 probability level. This indicates that as the age of groundnut processors increases, their likelihood of using POS services decreases. Older individuals may be less inclined to adopt new technologies such as

POS systems due to familiarity with traditional methods, resistance to change, or a lower level of technological literacy. This is similar to the study of Adebayo *et al.* (2020) on the factors affecting point of sale (POS) system adoption in some selected cassava processing firms in Oyo State, Nigeria. It revealed that age had inverse relationship with adoption of new POS services in cassava processing in Oyo State. Formal education (β = 0.300614) had a positive and statistically significant relationship with POS service utilization, significant at a 0.01 probability level. This suggests that better-educated groundnut processors are more likely to use POS services. This corroborate that Odusanya *et al*. (2021) on the determinants of mobile money adoption among rural farmers in Nigeria. The study revealed that factors such as age ($P<0.01$), education level ($P<0.01$), access to mobile phones ($P<0.01$) and financial literacy ($P<0.10$) were the significant predictors of mobile money usage among farmers. Processing experience (β = 0.650855) had a significant positive influence on POS utilization at a 0.05 probability level. This indicates that processors with more experience in groundnut processing are more likely to utilize POS services. Experienced processors often have more established businesses and larger customer bases, which makes it more efficient for them to adopt digital payment methods to facilitate transactions. Eshika and Andah (2022) evaluated factors influencing adoption of POS technology among smallholder farmers: A case study in Murang'a County, Kenya. The study reported that the farmers who were experienced, educated and had access to information were more likely to adopt the technology. Income from groundnut processing (β = 0.31198) was found to have a positive and statistically significant relationship with POS utilization at a 0.01 probability level. This suggests that processors with higher income levels from their processing activities are more likely to use POS services. This is tandem with the study of Bilkis *et al.* (2019) who reported that education, farmer's income, awareness, trust in the technology, transaction costs, and network coverage as key influencers of mobile money adoption in rural communities The types of groundnut products processed (β = 0.599269) were also positively and significantly associated with POS utilization at a 0.05 probability level. This indicates that processors handling specific products, particularly *kulikuli*, are more likely to utilize POS services. This could be attributed to the fact that kulikuli and other processed groundnut products often attract a more diverse customer base, including urban and higher-income consumers who prefer cashless transactions. Off-farm income (β = 9.58E-07) was another significant factor positively associated with POS utilization at a 0.05 probability level. Groundnut processors who earn additional income from off-farm activities are more likely to use POS services. Off-farm income provides an additional financial cushion, which can make adopting new technologies, such as POS systems, more feasible. Moreover, individuals with off-farm income may have broader exposure to formal financial institutions, which encourages the use of digital financial services. Distance to the POS stand (β = -0.05356) had a significant negative effect on POS utilization at a 0.05 probability level. This implies that as the distance between the groundnut processors' location and the nearest POS stand increases, their likelihood of using POS services decreases.

Effects of POS services utilization on income of groundnut processors

Table 2 presents the results of the effects of Point of Sale (POS) services utilization on the income of groundnut processors. The computed R-squared value is 0.87, indicating that approximately 87% of the variability in the income of groundnut processors is explained by the independent variables in the model. This suggests a strong fit, meaning that the selected factors significantly influence the income of the processors. The F-statistic is statistically significant, with a p-value of 0.0000, which means the model as a whole is statistically significant and provides meaningful insights. It revealed that several variables significantly influence the income of processors. Notably, the number of POS services benefited (β = 43085.94), participation in POS-enabled cooperatives (β = 215797.1), quantity of sales facilitated using POS services (β = 0.313002), frequency of customer withdrawals to pay for processed products (β = 1232.29), and the amount withdrawn from POS per week (β = 3.986031) all showed positive and statistically significant effects at various levels. The variable "Number of POS services benefited" has a coefficient of 43085.94, indicating a positive and significant relationship with the income of groundnut processors. This result suggests that the more POS services a groundnut processor benefits from, the greater their income. The utilisation of multiple POS services may provide processors with various avenues to enhance their financial transactions, improve cash flow and gain access to broader market opportunities. Darlington-Akabwai *et al*. (2021) on digital financial services and agricultural productivity in Uganda, indicated that access to digital financial services facilitated better access to agricultural inputs and improved marketing opportunities for farmers, leading to enhanced productivity and income levels.

Table 2: Effects of POS services utilization on income of groundnut processors

Variable	**Coefficient**	**Standard Error**	**t-value**
No POS services benefited	43085.94	13879.36	3.10***
participate in POS-enabled cooperative	215797.1	101545.7	2.13**
quantity of sales facilitated using POS services	0.313002	0.067397	4.64***
Frequency of customer withdrawing from POS to pay for your processed product per week	1232.29	612.1067	2.01**
access to wholesale buyers	-91473.5	109049.9	-0.84
Amount withdraw from POS per week	3.986031	1.166403	3.42***
Amount receive from POS per week	0.360543	1.616662	0.22
Constant	753044	146654	5.13**
Prob > F	0.0000		
R-squared	0.8735		
Adj R-squared	0.7414		

Source: Field survey, 2024

Participation in POS-enabled cooperatives also has a significant positive effect on income, with a coefficient of 215797.1. Groundnut processors who engage in cooperatives that utilise POS systems tend to have higher incomes, as cooperatives often provide members with access to credit, market information, and bulk purchase opportunities that individual processors might not have. POS-enabled cooperatives may facilitate cashless transactions between members and external buyers, making it easier to sell groundnut products at competitive prices. The quantity of sales facilitated using POS services has a coefficient of 0.313002, indicating a positive and significant impact on income. This result implies that as the volume of sales facilitated by POS services increases, so does the income of groundnut processors. The frequency of customer withdrawals from POS systems to pay for processed products is another significant variable, with a coefficient of 1232.29. This positive relationship suggests that when customers frequently withdraw cash from POS systems to pay for groundnut products, the processors' income increases. The amount withdrawn from POS per week has a positive coefficient of 3.986031, which indicates that as the weekly withdrawal amount from POS systems increases, so does the income of groundnut processors. This result can be explained by the fact that higher withdrawal amounts often correlate with higher levels of business activity.

REFERENCES

Adebayo, S., Afolabi, O., & Oladipo, O. (2020). Factors affecting point of sale (POS) system adoption in some selected cassava processing firms in Oyo State, Nigeria. *Journal of Agricultural Economics and Extension Services, 8*(3), 105-115.

Bashar, M. (2022). Groundnut production and its economic importance in West Africa. *Journal of Agricultural Science and Development, 9*(4), 23-35.

Bilkis, H., Nasir, U., & Hakeem, A. (2019). Factors influencing mobile money adoption in rural communities of Nigeria: An empirical study. *Journal of Rural Development, 6*(2), 51-67.

Darlington-Akabwai, E., Opio, R., & Sserwanga, A. (2021). Digital financial services and agricultural productivity in Uganda. *African Journal of Agricultural Economics, 7*(1), 37-49.

Duke, A. (2022). The labour-intensive nature of traditional groundnut oil extraction in West Africa. *Journal of Sustainable Agriculture and Rural Development, 10*(2), 118-127.

Eshika, F. M., & Andah, D. (2022). Factors influencing adoption of POS technology among smallholder farmers: A case study in Murang'a County, Kenya. *Journal of Agriculture and Technology, 8*(1), 45-58.

Muhammad, A., & Abubakar, S. (2019). Assessing the use of digital financial services among smallholder farmers in Northern Nigeria. *Journal of Agricultural Economics and Extension, 35*(2), 122-134.

National Bureau of Statistics. (2022). *Population projections for Niger State, Nigeria (2006-2021)*. National Bureau of Statistics.

Odusanya, D., Ajani, O., & Lawal, R. (2021). Determinants of mobile money adoption among rural farmers in Nigeria. *Journal of Agricultural Economics and Extension, 14*(3), 122-136.

Oni, T. O., Yusuf, T. F., & Adeleke, A. A. (2021). Land use dynamics and agricultural productivity in Niger State, Nigeria. *International Journal of Agricultural Research, 16*(4), 257-272.

Tanko, L. (2019). Groundnut processing and its economic contributions in Niger State. *Journal of Agro-Processing Research, 21*(3), 98-110.

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Enhancing Zinc Uptake In Cassava Through Zinc-Solubilizing Zhizobacteria: A Review

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Abstract
Cassava (Manihot esculenta Crantz) is a vital staple crop for over 800 million people, particularly in Africa, Asia, and Latin America. However, its low micronutrient content, especially zinc, poses a significant nutritional challenge, contributing to zinc deficiency in populations relying heavily on cassava-based diets. Zinc solubilizing bacteria (ZSB), a subgroup of plant growth-promoting rhizobacteria (PGPR), have shown promise as a sustainable alternative to traditional chemical zinc fertilizers. ZSB enhance zinc availability by converting insoluble zinc compounds into bioavailable forms through the secretion of organic acids like gluconic acid, citric acid, and siderophores, which chelate zinc ions and lower soil pH, facilitating plant uptake. Field and laboratory studies have demonstrated that ZSB strains, such as those from the genera Pseudomonas and Bacillus, can significantly improve cassava growth, yield, and nutritional content by increasing zinc uptake. Furthermore, ZSB contribute to sustainable agricultural practices by enhancing soil microbial diversity, reducing dependency on synthetic fertilizers, and lowering production costs. Despite these benefits, challenges such as variability in ZSB effectiveness across different soil types and environmental conditions, and the need for precise application methods, hinder widespread adoption. Future research should focus on optimizing ZSB strains for diverse conditions, large-scale field trials, and developing ZSB-based biofertilizers. This review explores the synergistic effects between ZSB and other beneficial microorganisms can also enhance their efficacy. Integrating ZSB into cassava cultivation presents a promising strategy for addressing zinc deficiency, improving crop productivity, and promoting public health in regions dependent on cassava as a staple food source.
Keywords: Zinc solubilizing rhizobacteria, biofortification, micronutrient, cassava and yield

INTRODUCTION
Zinc solubilizing bacteria also known as plant growth promoting rhizobacteria (PGPR) produce plant growth-promoting compounds, and can also play a crucial role in the cycling of macro and micronutrients by modifying the root morphology, resulting in greater root surface area for the uptake of nutrients within the soil, and also protect crops against diseases (Saravankumar *et al*. 2008). Stimulation of different crops by zinc solubilizing bacteria (ZSB) has been demonstrated in both laboratory and field trials. It has been found that Strains of *Pseudomonas putida* and *Pseudomonas fluorescence* have increased root and shoot elongation in canola, lettuce, and tomato (Hall, 1996) as well as crop yields in potato, radishes, rice, sugar beet, tomato, lettuce, apple, citrus,

beans, ornamental plants, and wheat (Kloepper,1994). There is evidence that Zn solubilizing bacteria which are one of the most agriculturally important microorganisms lack specific element such as B, Co,Cu, Fe, Se, Zn, Ni, Mn and Mo for their survival as free-living soil saprophytes, as well as their symbiotic relationship with legumes (Pérez-Montaño *et al*. 2014). Zinc is a critical micronutrient involved in numerous plant functions, including enzyme activation, protein synthesis, and growth regulation. Despite its importance, zinc deficiency is prevalent in many agricultural soils, particularly in regions where cassava is a key food crop. Traditional zinc supplementation through chemical fertilizers is often inefficient due to zinc's low mobility and bioavailability in soil. Consequently, there is a growing interest in using plant growth-promoting rhizobacteria (PGPR) that can solubilize zinc from insoluble compounds, making it more accessible to plants.

Cassava: A Staple Crop with Nutritional Challenges

Cassava (Manihot esculenta Crantz) is a vital food source for over 800 million people, particularly in Africa, Asia, and Latin America (FAO, 2013). Cassava is tuberous roots that provide the third largest source of food carbohydrates in the tropics, after rice and maize. Commercial cassava is propagated from stem cuttings as roots and do not produce buds (Food and Agriculture Organization [FAO], 2013). The semi-woody species thrives on nutrient deficient soils ranging from acidic to alkaline conditions and the presence of cyanide-rich defenses minimize damage due to insect (Blagbrough *et al*.,2010). Moreover, as a drought-tolerant crop, it is capable of growing in marginal soil sand due to its wide harvesting window serves as fall-back crop in times of famine (Montagnac *et al*., 2009). In terms of food calories, cassava is 25–125% more efficiency per unit area-time than other staple crops such as rice, wheat or maize (Meenakshi *et al.,*2010). Eighty percent of the cassava produced in Nigeria is processed into ethanol, starch, syrup, chips and high-quality cassava flour (HQCF) with the highest cassava consuming states being Abia, Akwa Ibom, Anambra, Benue, Cross River, Ebonyi, Enugu, Imo, Ondo and Rivers. While this low-tech crop is readily grown by poor subsistence farmers throughout Africa, Latin America, and Southeast Asia. Low-zinc abundance in cassava is associated with zinc deficiency, especially for women and children on a cassava-rich diet.

Despite its significance, cassava is inherently low in essential micronutrients like zinc, iron, and vitamin A, which limits its nutritional value (Burns *et al.,* 2010). Enhancing the micronutrient content of cassava through biofortification could substantially impact public health, especially in regions where this crop is a primary food source.

Zinc deficiency in cassava

Cassava, yam and sweet potato are excellent sources of carbohydrates but low in micronutrient and protein content. Dependence on these major staple foods for essential micronutrients is therefore a challenge. Based on consumption patterns in West Africa, iron and zinc present in cassava provide only 5–8% and 13–14% of the Estimated Average Requirement (EAR) for iron and zinc, respectively, for children 2–5 years old (Stephenson *et al*., 2010). These analyses indicate that, the major staple foods across agro-ecological regions of Nigeria are not adequate to combat the hidden hunger resulting from insufficient micronutrients in the diet. Regular consumption of vegetables, fruits, dairy products and meats along with the staples is ideal, but they are not always accessible by low-income consumers (Ogundari and Arifalo, 2013).

Zinc supplementation (biofortification of cassava)

The supplementation of chemical zinc is a good strategy to enhance the zinc translocation or fortification in cassava. In this strategy, chemical zinc is applied to the crops for enhancing the zinc content of cassava crop (Fig Different studies have estimated that supplementation of chemical zinc to enhance the zinc translocation or fortification in major grain crops are sustainable in the perspectives of economic progress and human health (Cakmak, 2008; White and Broadley, 2009). The zinc fertilizers such as zinc sulfate (ZnSO4) are the major source of Zn addition to the soil. These fertilizers not only fortify the cassava crops but also increase its yield (Ali and Abd-Elkader, 2014). Crop nutrition and quality can be balanced through the use of micronutrient such as zinc, iron and manganese (Mousavi *et al*., 2011). According to Panitnok *et al.* (2013), the quality of cassava improved greatly on foliar fertilizer treatment with zinc, sulphure and magnesium Ahmed *et al*. (2011). Supplementation has been used extensively to save lives and alleviate suffering, and remains a viable option for people at high risk (Thompson and Amoroso, 2011). As an alternative measure, food-based approaches involving fortification, dietary diversification/ modification, nutrition education and biofortification are being emphasized (Thompson and Amoroso, 2011). According to Mousavi *et al. (*2007), the tuber quality and productivity of potato crop improved as well as stimulating the vegetative growth after biofortification. Ali and Abd-Elkader (2014) investigated the effect of the application systems of K_2SO_4 and foliar application of micronutrient mixture on the growth, tuberous root yield and quality of cassava, the results showed that, increasing the micronutrients mixtures levels up to 30 % gradually increased the productivity of cassava plants as well as tuberous root quality; dry matter percentage, starch percentage, and total sugar as well as elements contents of N, K, Zn, Mn, Fe and Cu showed positive response to various micronutrients mixtures levels.

Mechanisms and Potentials of Zinc Solubilizing Rhizobacteria

Zinc-solubilizing rhizobacteria (ZSB) facilitate zinc uptake by converting insoluble zinc compounds into soluble forms through various biochemical processes. These bacteria produce organic acids, such as gluconic acid, that chelate zinc ions, lowering soil pH and enhancing zinc solubilization. Recent research has identified several potent ZSB strains, including species from the genera *Pseudomonas*, *Bacillus*, and *Enterobacter*, which have shown significant zinc-solubilizing activity under laboratory and field conditions. The primary mechanism through which ZSR enhance zinc availability involves the production of organic acids such as gluconic, citric, and lactic acids, which lower the pH around the root zone, thereby solubilizing zinc compounds (Saravanan *et al.,* 2004). Additionally, siderophores produced by these bacteria chelate zinc ions, facilitating their uptake by plant roots (Sharma *et al*., 2013). This increased zinc availability is crucial for biofortifying crops like cassava.

Direct mechanisims

PGPR solubilize the insoluble form of zinc in the soil by secreting organic acids and enzymes (Bhattacharyya and Jha, 2012). This organic acid breaks down zinc compounds and converts them into soluble form that can be taken up by plant root. This happens when the organic acid secreted trigers the nutrient use efficiency by changing root morphology for nutrient uptake via production of different metabolites. The organic acids produced by rhizobacteria include citric acid, gluconic acid, oxalic acid, malic acid, acetic acid, succinic acid, formic acid, lactic acid and 2-ketogluconic acid (Chung *et al.,* 2005; Abaid-Ullah *et al.,* 2015). Gluconic acid is the major organic acid produced by all gram-negative bacteria like *Serratia* spp, *Pseudomonas* spp and *Acetobacter* *diazotrophicus*; and its role in mineral phosphate solubilization has been well established. The gluconic acid released by rhizobacteria produces chelating agents such as siderophores. These molecules have a high affinity for zinc ions which chelate the divalent cations of zn^{+2} and release zinc from insoluble zinc compounds by effectively chelating them and preventing precipitation or binding to the soil particles. This keeps zinc in a mobile, plant available form. The gram-negative bacteria are more competent in production of gluconic acid as compared to gram positive bacteria (Sashidhar and Podile, 2010). A Zinc solubilizing strain *Serratia marcescens* FA-4 capable to biofortify wheat also produce gluconic acid indicating its role in phosphorous and zinc solubilization (Abaid- Ullah *et al.,* 2015). The PGPR can influence the composition of root exudates which are the compounds produced by plant root into the soil by getting attracted to the exudates which enhances nutrient mobilization in the rhizosphere, aiding zinc in Uptake.

Indirect mechanisms
The major indirect mechanism of zinc solubilizing bacteria is through acting as biocontrol agents (Glick, 2012). However, the application of microorganisms to control diseases, which is a form of biological control, is an environment-friendly approach (Lugtenberg and Kamilova, 2009). In general, competition for nutrients, niche exclusion, induced systemic resistance and antifungal metabolites production are the chief modes of biocontrol activity in zinc solubilizing bacteria (Lugtenberg and Kamilova, 2009). Many rhizobacteria have been reported to produce antifungal metabolites like, HCN, phenazines, pyrrolnitrin, 2,4-diacetylphloroglucinol, pyoluteorin, viscosinamide and tensin (Bhattacharyya and Jha, 2012). Interaction of some rhizobacteria with the plant roots can result in plant resistance against some pathogenic bacteria, fungi, and viruses. This phenomenon is called induced systemic resistance (ISR) (Lugtenberg and Kamilova, 2009). Moreover, ISR improves nutrient uptake by involving jasmonate and ethylene signaling within the plant and these hormones stimulate the host plant's defense responses against a variety of stress and plant pathogens (Glick, 2012). It also reduces nutrient deficiencies and enhances zinc uptake.

Impact of ZSB on Cassava Growth and Yield
Studies have demonstrated that ZSB can significantly improve the growth and yield of cassava by enhancing zinc availability and uptake. For instance, field trials using a consortium of ZSB strains on rice have shown notable improvements in plant height, chlorophyll content, and grain yield, with similar potential expected in cassava (Singh *et al*.,2024). ZSB also contribute to increased root surface area, which further enhances nutrient uptake, including zinc. This leads to healthier plants with improved resistance to diseases and environmental stresses.

Application of ZSB in Sustainable Agriculture
The use of ZSB in cassava cultivation presents a sustainable alternative to chemical fertilizers, particularly in zinc-deficient soils. ZSB not only improve zinc uptake but also promote overall soil health by increasing microbial diversity and activity. The application of ZSB can reduce the need for synthetic fertilizers, lower production costs, and minimize environmental impacts associated with chemical inputs (ARCC Journals, 2023).

Challenges and Future Directions

While the potential of ZSB in enhancing zinc uptake in cassava is promising, several challenges remain. These include the variability in ZSB effectiveness under different soil and climatic conditions, the need for precise application methods, and the integration of ZSB into existing agricultural practices. Future research should focus on large-scale field trials, the development of ZSB-based biofertilizers, and the exploration of synergistic effects between ZSB and other plant growth-promoting microorganisms.

CONCLUSION

Zinc solubilizing bacteria (ZSB) present a promising solution to the challenge of zinc deficiency in cassava, a critical staple crop for millions globally. These bacteria enhance zinc availability to plants by converting insoluble zinc compounds into forms that are easily absorbed, thereby improving cassava growth, yield, and nutritional content. By utilizing natural mechanisms such as the production of organic acids and siderophores, ZSB offer an environmentally sustainable alternative to traditional chemical fertilizers, promoting soil health and reducing agricultural costs. However, the practical application of ZSB in cassava cultivation is not without challenges. Variability in effectiveness due to soil and environmental conditions, the need for precise application methods, and integration into current farming practices remain significant hurdles. Addressing these issues will require targeted research, including large-scale field trials and the development of efficient ZSB-based biofertilizers. Additionally, exploring synergistic interactions between ZSB and other plant growth-promoting microorganisms could enhance their effectiveness. Ultimately, the adoption of ZSB has the potential to improve the nutritional quality of cassava, contribute to sustainable agricultural practices, and support food security and public health in regions where cassava is a dietary mainstay. Continued research and development will be crucial for realizing the full benefits of this innovative approach.

REFERENCES

Abaid-Ullah, M., Hassan, M. N., Naz, I., Jamil, M., Hameed, A., and Khan, S. A. (2015). Strain Serratia marcescens FA-4 capable to biofortify wheat through phosphorous and zinc solubilization. *Journal of Basic Microbiology*, *55*(2), 98-109.

Ahmed, M. J., Ahmet, A., and Malik, S. (2011). Application of zinc sulphate to improve quality of cassava (Manihot esculenta Crantz). *Agricultural Research Journal*, *20*(4), 453-461.

Ali, N. A., and Abd-Elkader, D. Y. (2014). Effect of K_2SO_4 and foliar application of micronutrient mixture on the growth, tuberous root yield and quality of cassava *International Journal of Agriculture and Biology*, *16*(5), 997-1003.

Blagbrough, I. S., Bayoumi, S. A. L., Rowan, M. G., and Beeching, J. R. (2010). Cassava: An appraisal of its phytochemistry and its biotechnological prospects. *Phytochemistry*, *71*(17-18), 1940-1951.

Burns, A., Gleadow, R., Cliff, J., Zacarias, A., and Cavagnaro, T. (2010). Cassava: The drought, war and famine crop in a changing world. *Sustainability*, *2*(11), 3572-3607.

Cakmak, I. (2008). Enrichment of cereal grains with zinc: Agronomic or genetic biofortification *Plant and Soil*, *302*(1-2), 1-17.

Chung, H., Park, M., Madhaiyan, M., Seshadri, S., Song, J., Cho, H., and Sa, T. (2005). Isolation and characterization of phosphate solubilizing bacteria from the rhizosphere of crop plants of Korea. *Soil Biology and Biochemistry*, *37*(10), 1970-1974.

Food and Agriculture Organization [FAO]. (2013). *Save and Grow: Cassava - A guide to sustainable production intensification*. FAO.

Glick, B. R. (2012). Plant growth-promoting bacteria: Mechanisms and applications. *Scientifica*, *2012*, 1-15.
Hall, J. A. (1996). Pseudomonas putida and Pseudomonas fluorescence: Effects on root elongation and crop yields. *Journal of Bacteriology*, *178*(15), 4456-4462.
Kloepper, J. W. (1994). Plant growth-promoting rhizobacteria (other systems). In Y. Okon (Ed.), *Azospirillum/Plant Associations* (pp. 137-154). CRC Press.
Lugtenberg, B., and Kamilova, F. (2009). Plant-growth-promoting rhizobacteria. *Annual Review of Microbiology*, *63*, 541-556.
Meenakshi, J. V., Johnson, N. L., Manyong, V. M., De Groote, H., Javelosa, J., Yanggen, D. R., and Bouis, H. E. (2010). How cost-effective is biofortification in combating micronutrient malnutrition? An ex-ante assessment. *World Development*, *38*(1), 64-75.
Montagnac, J. A., Davis, C. R., and Tanumihardjo, S. A. (2009). Nutritional value of cassava for use as a staple food and recent advances for improvement. *Comprehensive Reviews in Food Science and Food Safety*, *8*(3), 181-194.
Mousavi, S. R., Galavi, M., and Rezaei, M. (2011). Zinc (Zn) importance for crop production - A review. *International Journal of Agronomy and Plant Production*, *2*(9), 374-378.
Panitnok, K., Rodpai, E., and Phongphanphanee, A. (2013). Foliar fertilizer treatment with zinc, sulphure, and magnesium improves quality of cassava. *International Journal of Agriculture and Biology*, *15*(1), 57-62.
Pérez-Montaño, F., Alías-Villegas, C., Bellogín, R. A., Del Cerro, P., Espuny, M. R., Jiménez-Guerrero, I. And Ollero, F. J. (2014). Plant growth promotion in cereal and leguminous agricultural important plants: From microorganism abilities to crop production. *Microbiological Research*, *169*(5-6), 325-336.
Saravanan, V. S., Subramoniam, S. R., and Raj, S. A. (2004). Assessing in vitro solubilization potential of different zinc solubilizing bacterial (ZSB) isolates. *Brazilian Journal of Microbiology*, *35*(1-2), 121-125.
Saravankumar, D., Lavanya, N., Sathiyamurthy, M., and Reetha, D. (2008). Plant growth promoting rhizobacteria (PGPR): Prospects and applications. *Journal of Agricultural and Biological Sciences*, *3*(6), 301-312.
Sashidhar, B., and Podile, A. R. (2010). Mineral phosphate solubilization by rhizosphere bacteria and scope for its application in agriculture. *Progress in Natural Science*, *20*(4), 587-597.

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Spatial Variability of Physical and Chemical Properties of Downstream Section of Chanchaga River, Minna Niger State Nigeria

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Abstract

Physico-chemical properties of downstream Chanchaga River Minna, Niger State was studied for period of four months twice each month (March-June 2017) with four different sampling stations. The river has a reservoir and is under the care of Niger State water board and serves as the most important River for Minna town water supply and a source of livelihood to Riverine communities. Results showed monthly variation of physico-chemical parameters. Means of monthly values of temperature ranges between 29.00-32.13°C, Dissolved oxygen (DO) and biological oxygen demand values ranges between 4.38±0.43 Mg/L -6.13±0.61 Mg/L and 2.19±0.25Mg/L - 3.13±0.51Mg/L respectively, phosphate and nitrate value ranges between 0.09±0.02Mg/L - 0.28±0.03 Mg/L and 3.40±1.03 Mg/L - 5.21±1.23 Mg/L while Potential Hydrogen ion concentration (pH) ranges between 7.36±0.08 -7.81±0.07 respectively. The physico – chemical parameters analyzed indicated that most of them fall within limit standard set by the Federal Ministry of Environment (FMENV, 2OOO). However, temperature mean value was slightly above recommended range of the of 25^0C and 32^0C for productive water the changes could be due to discharge of hot water from the water treatment plant from the water board directly to the river and increased nitrate was observed in May and June, potentially indicating agricultural runoff into the river. These findings highlight the importance of adequate monitoring of water quality is essential and regulation of anthropogenic activities in order to slow down the aging process of Chanchaga River for both water supply and ecological health.

Keywords: Physico-chemical properties, hydro environment, Downstream, Chanchaga, Anthropogenic activities.

INTRODUCTION

Among all resource water turns out to be the universal most treasured resource to living organisms and man. Water accounts for 70% of the weight of human body and several biological activities solely rely on it (FMENV, 2000). The changing aspect of hydro environment relies on the characteristics of water and the vital purpose of limnology is to clear a view of the underlying causes of the change (Kolo and Oladimeji, 2004). Also, this can be of vast importance in mapping out tactics for the administration for utilization of hydro environment and also be of immense value in drawing management plans for such water bodies when evaluating fluctuations which occurred as a result of the activities of man and nature over the years. Aquatic life is mainly precise by physico-chemical properties and their occurrence, these properties enabled living organism in the region to adjust in order to improve productivity and regulate its metabolism (Olele and Ekelemu, 2008). Edward and Ugwumba, (2010) stated that any changes in physico-chemical parameters may positively or negatively affect the primary productivity of water bodies in a number of ways such as their survival, growth rate, distribution, behavior and these may result in extinction of some species of organisms or its reproduction. Changes might have transpired over a period of time in downstream Chanchaga reservoir due to release of hot water and chemicals during water treatment. This activity may affect the physico-chemical parameters of the downstream Chanchaga reservoir, hence there is need to know the current status of the downstream reservoir.

MATERIALS AND METHODS

Description of the study area

Chanchaga River is located on Latitude 9˚ 31’60"N and Longitude 6˚ 34’60"E in Paikoro Local Government area in southwest zone of Minna but part of the river falls under Bosso Local Government area. The river is under the care of Niger State water board and serves as the most important River for Minna town water supply and a source of livelihood to Riverine communities.

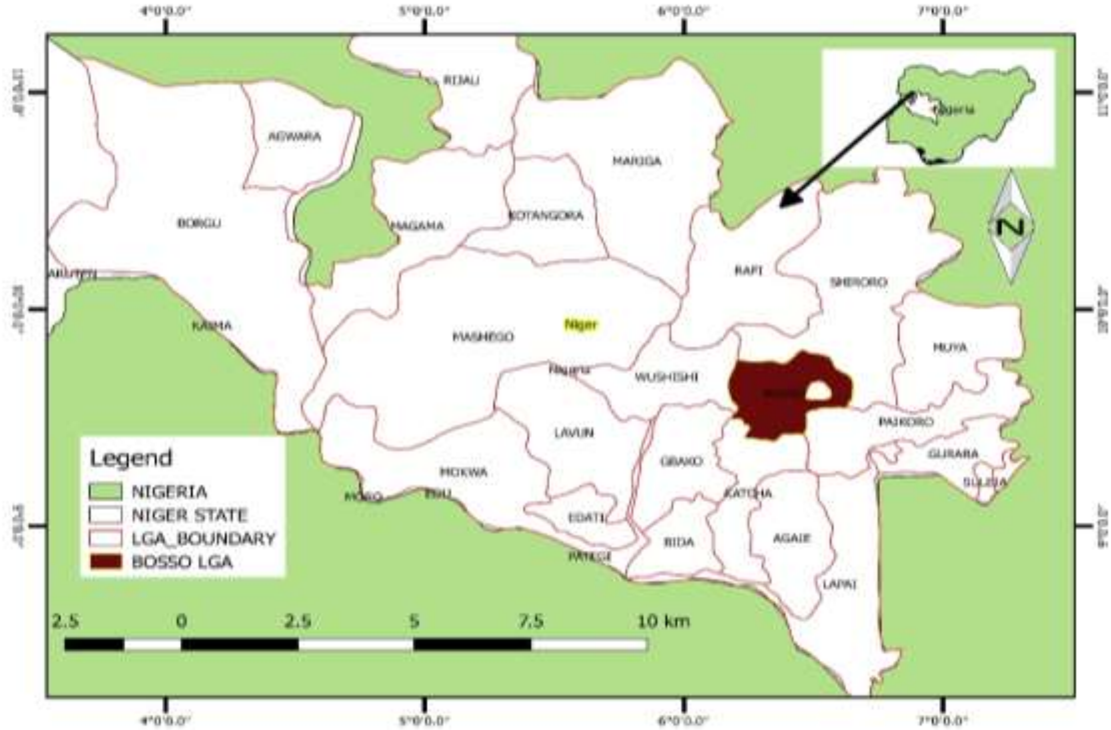

Figure: 1a Nigeria indicating Niger State

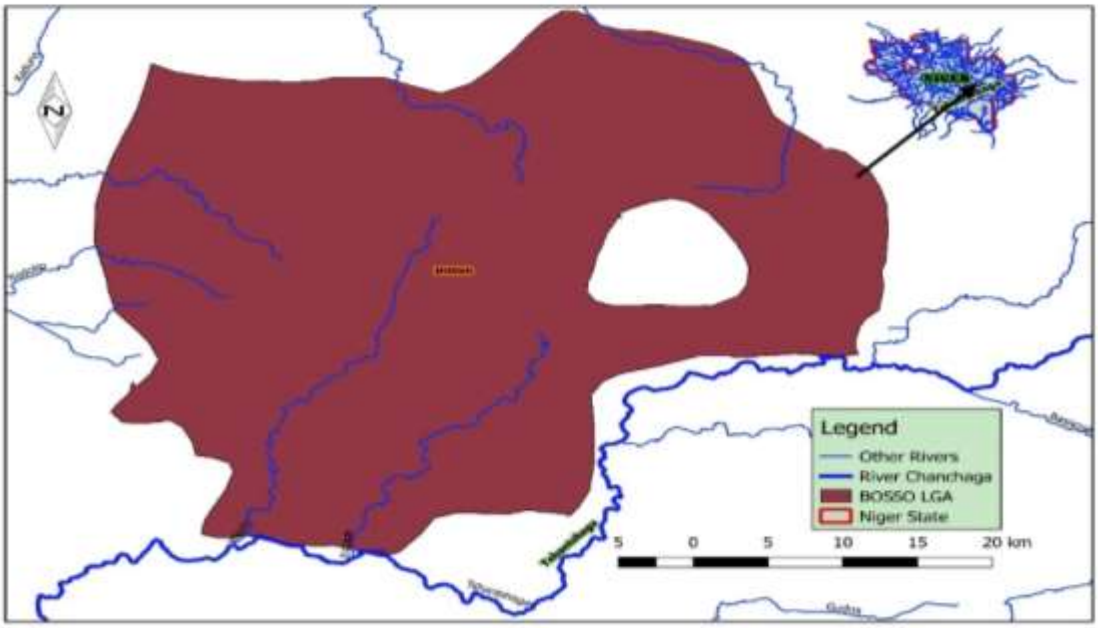

Figure 1b: The Study Area showing Rivers within and around.

Figure 1: The Study Area Showing Nigeria, Niger State and Bosso LGA

The study assessed the water quality of downstream Chanchaga river using various methods and materials ranging from DO bottle, GPS (GPSMAP 76 garmin product), thermometer (wet and dry mercury), pH meter, digital camera, plastic jar, Shapefile map and research data from various report. The data were obtained from two main sources which are primary data and secondary data. The study was carried for the period of four months twice in each month (March to June 2017) with four stations.

Physico-chemical parameters
Water temperature, Dissolved oxygen (DO) and biological oxygen demand (BOD) were taking in-situ. The pH was measured using a digital pH meter model, Phs -25 at room temperature in the laboratory, Nitrate and phosphate was calculated according to (APHA 2008).

Statistical analysis
Data collected were subjected to One-way ANOVA at $p<0.05$ to see the variations due to months and stations, Turkey was used as the mean separator.

RESULTS AND DISCUSSION
The significant differences and visible variation in physico-chemical parameters of water may be as a result of different ecological conditions. These variations may be due to temperature and rainfall (Ayoade *et al*., 2006). There was significant difference in the monthly variation ($p<0.05$). The river temperatures were higher in March (32.13^{o}C) and reduced gradually in June (29.00^{o}C). The lowest water temperature recorded in June coincided with the period of rain. The average mean value of temperature of downstream Chanchaga reservoir observed ranges from 29.00^{0}C to 32.13 ^{0}C. This is not within the recommended temperature range of 25^{0}C and 32^{0}C in line with the findings of Kolo and Tukura, (2007). It could probably be due to the onset of raining season. This agrees with

findings of Brown, (2003) that water temperature varies with seasons. High temperature values were recorded at all stations and these may be attributed to the shallowness of the sampling stations.

The range of DO record were 4.38Mg/L – 6.13Mg/L. The high values of DO obtain in June may be due to cool water, which agrees with APHA (1995) that cool water more DO than warm water. High DO value obtained at stations 4 could be due to water movement, human activities such as bathing, fetching of water and animal activities which lead to the agitation of water and subsequently increased the DO content in the water. Low DO at station 3 could be due to discharge of organic and inorganic waste into the water around the station. This agrees with the findings of Ojutiku and Kolo (2008), who reported that water with high organic or inorganic pollution may have very little oxygen in them.

High BOD value was recorded at stations 3 and station 2. This could be attributed presence of decay processes. The organic decay process might have used up the DO, thus resulting to lower DO content and higher BOD. The lower values recorded at station 1 and 4 could be due to little organic matter and low temperature process which subsequently leads to decrease in biodegradation of organic matter.

The pH range recoded in the study was 6.7-8.5 and the pH range obtained in this study was within the suitable level recommended for drinking water (WHO, 1996). This agree with the study of Kolo and Tukura (2007), reported that pH values between 6.5-8.5 have been associated with productive waters, there was no significant difference in the monthly and station variation ($p>0.05$) this agree with the study of Yakubu *et al.,* (2014) when they assessed the water quality parameters of Agaie/Lapai dam and reported a no significant difference in pH level.

The major sources of eutrophication in reservoirs are nitrate and phosphate level (Kolo *et al.,* 2010). There was a significant difference of nitrate and phosphate level in the river during the study period within the months. The increase in nitrate and phosphate level in the river may be due to human activities close to the bank of the river such as washing of fertilizer from the nearby farm, bathing, washing of cloths using detergent which tend to increase the phosphate level of the river. Mohammed and Saminu (2012) highlighted that in most water bodies' phosphate appears to be the ultimate limiting factor for biological productivity.

COCLUSION AND RECOMMENDATIONS

The differences observed between months and other variations in the physico chemical parameters of downstream Chanchaga reservoir could be attributed to the site/location of the river, discharge of hot water from the water treatment plants to the river, amount of precipitation obtained annually as well as the anthropogenic activities taking place around the river, Thus adequate monitoring of water quality is essential and regulation of anthropogenic activities in order to slow down the aging process of Chanchaga river for both water supply and ecological health.

REFERENCES

American Public Health Association (APHA) (1995): Standard Methods for the examination of water and waste-water, 14th edition AHWA-WPCP Washington DC

American Public Health Association (APHA 2008): *Standard methods for the examination of water and waste-waters, and potable water*, 22[th] edition AHWA-WPCP Washington DC.

Brown, A C (2003): *Watershed Protection Plan Development Guide Book*, Northeast Georgia Regional Development Centre.

Edward, J.B. and Ugwumba, A.A.A. (2010): *Physico-Chemical parameters and plankton Community of Egbe Reservoir, Ekiti State, Nigeria. Research Journal of Biological Sciences* 5(5):356-367.

Federal Ministry of Environment (FMENV) (2000): National Guidelines and Standards for Water Quality in Nigeria (First edition).

Kolo, R.J and Oladimeji, A.A (2004): *Water Quality and Some Nutrient Levels in Shiroro Lake, Niger State,* Nigeria. *Journal of Aquatic Sciences* 19(2):99-106.

Kolo, R.J and Tukura, M.D (2007): Aspects of limnlogical studies of tagwai dam, minna, Niger State Nigeria. *Journal of Aquatic Sciences* 22 (1): 59-64.

Kolo, R.J. Ojutiku, R.O and Musulmi, D.T (2010*):* Plankton Communities of Tagwai Dam Minna, Nigeria. Continental *Journal of Fisheries and Aquatic Science* 4: 1.

Mohammed, M. A. and Saminu M.Y. (2012): Water Quality and Phytoplankton of Salanta River Kano, Nigeria*. Journal of Biological Science and Bio Conservation*, (4):65-73.

Olele, N.F. and Ekelemu, J.K. (2008): Physicochemical and Phytoplankton Study of Onah Lake, Asaba, Nigeria*. African Journal of General Agriculture* 4(3).

WHO (World Health Organisation). (1996). *Guidelines for Drinking Water Quality* 2‖ Edition WHO. Geneva Switzerland. Vol. 1-3.

Yakubu, U.P., Oyero, J.O., Zakari, B.H. & Ibrahim, A, (2014): The Assessment of the Water Quality Parameters of Agaie/Lapai Dam in Niger State, Nigeria*. Global Journal of Biological Science and Biotechnology,* Volume.3 (2) 2014: 139-148.

Table 1: Monthly variation of Physico-chemical parameters of downstream section of Chanchaga Riverr

MONTH	DO(Mg/L)	BOD (Mg/L)	Temperature (ºC)	pH	Nitrate (Mg/L)	Phosphate (Mg/L)
March	4.79±0.34[a]	2.83±0.29[a]	32.13±0.40[a]	7.81±0.07[a]	3.40±1.03[a]	0.28±0.03[a]
April	4.38±0.43[a]	2.19±0.25[a]	32.00±0.38[a]	7.71±0.09[a]	4.33±0.98[a]	0.09±0.02[b]
May	4.63±0.46[a]	2.23±0.28[a]	31.88±0.40[a]	7.66±0.32[a]	5.17±1.03[a]	0.19±0.04[a]
June	6.13±0.61[b]	3.13±0.51[a]	29.00±0.33[b]	7.36±0.08[a]	5.21±1.23[a]	0.20±0.03[a]

Means on the same column having the same superscript are not significantly different from other means (p>0.05) while Mean on the same column with different superscript are significantly different (p<0.05).

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Sources of Microcredit and Factors Influencing the Adoption of Improved Agricultural Technologies among Cassava Farmers in Osun State, Nigeria

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Abstract

The study examines sources of microcredit and factors influencing the adoption of improved technology among cassava farmers in Osun State. This study broadly relies on primary data collected utilising questionnaires from three administrative zones in Osun state: Ife, Ilesa, and Iwo zone. Microcredit and non-microcredit users were analysed using descriptive statistics, the Tobit regression model, and a T-test analysis. Findings revealed that 48% had access to microcredit and 52% did not have access to microcredit. Out of 48% that have access to microcredit sources, 22% got it through cooperative societies, 25% got their own from farmers group and, 1% from religious group. Research further revealed that labour, quantity of fertilizer, and contact with extension workers significantly affect the utilization of enhanced technology by cassava farmers in Osun State. it is crucial to ensure that extension workers are well-trained, adequately resourced, and culturally sensitive and provide relevant and accurate information tailored to the farmers' specific needs and circumstances. It is also recommended that the formal microcredit sources should be made more easily accessible to farmers in the study area.
Keywords: Microcredit, Improved Technology, Adoption, Cassava Production, Osun State.

INTRODUCTION

Cassava (*Manihot* spp) is a vital food and cash crop in many tropical African countries, playing a significant role in their economies (Ogunleye, 2018). Nigeria stands as the world's top producer of cassava, with an output of approximately 59 million metric tonnes. However, the rate of cassava production in Nigeria has not kept up with the rapid population growth (Adeosun *et al*., 2023). Several factors, including limited access to credit, low adoption of technology, climate change, and inconsistent government policies, contribute to this low productivity (Oyekola *et al*., 2021). Microcredit refers to small loans and related services provided to smallholder farmers and poor non-farmers in rural areas. These services aim to enhance agricultural production and sustainability, improve the living standards of rural populations, and stimulate economic growth and development in rural sectors (Tijani, 2008). Despite the critical role of credit in the economy, numerous studies have highlighted that a lack of information about accessible credit sources is a major barrier for farmers seeking credit facilities (Mahmud, 2021; Bonnke *et al*., 2022). Adoption is the process of identifying the extent of use of a new technology in the long run when the farmer knows about the new technology and it benefits (Ali, 2016). Improved agricultural technologies are essential for enhancing agricultural productivity, reducing poverty, and ensuring food security in developing countries. However, the rate of adoption of these technologies remains low in many developing nations due to various influencing factors (Yokamo, 2020). Addressing these factors is crucial for improving the adoption rates of these technologies. Therefore, this study aims to profile the different sources of microcredit and investigate the factors that influence the adoption of improved agricultural technologies among cassava farmers in Osun State.

MATERIALS AND METHODS

Study Design

The study was conducted across the six administrative zones of Osun State, Nigeria, which include Ife, Ilesa, Iwo, Ede, Osogbo, and Ikirun zones. A multi-stage sampling method was employed to select the respondents. In the first stage, 50% of the administrative zones were randomly chosen, resulting in the selection of the Ife, Ilesa, and Iwo zones. In the second stage, one local government area (LGA) was randomly selected from each of these zones, leading to a total of three LGAs. In the third stage, a total of 10 communities were proportionally selected from the chosen LGAs. Finally, cassava farmers were stratified into two groups based on their access to microcredit, and 10 respondents were randomly selected from each community, resulting in a total of 100 respondents.

Data Collection

The study employed quantitative data collection techniques to gain a comprehensive understanding of the factors affecting the adoption of enhanced agricultural technologies among cassava farmers in Osun State. Data were gathered through structured questionnaires, which included inquiries about sources of microcredit and factors such as education, household size, years of farming experience, fertilizer usage, labour, extension services, and gender, all of which could impact the adoption of these improved technologies among cassava farmers in the area.

Analytical Tools

The data were analyzed using a Tobit regression model, an econometric approach where the dependent variable is censored in the original model. The Tobit model offers better performance compared to estimates from OLS regression. It explains the relationship between a non-negative dependent variable y and an independent variable or vector x. The primary reason for employing the Tobit model in any study is the necessity to censor both dependent and independent variables, which was applicable in this case. This model was used to identify the factors affecting cassava technology adoption among farmers. These factors include years of education, household size, years of cassava farming experience, labour usage, the quantity of fertilizer used, and the frequency of contact with extension services.

RESULTS AND DISCUSSION

Descriptive Statistics

The data presented in Table 1 reveals that 48% of the respondents have access to credit, while 52% do not have access to microcredit. Among those with access, 22% obtain credit through cooperative societies, 25% through farmers' groups, and only 1% through religious organizations. This suggests that informal sources are the primary means of accessing microcredit in the study area. Specifically, farmers' groups and cooperative societies were identified as the key sources of microcredit. These findings align with Akinola *et al*. (2023) and Ogunleye *et al*. (2024), who noted that farmers often belong to various cooperative societies to secure funding for their agricultural activities**.**

Table 1: Profile of the different sources of microcredit in the study area

Variable	Frequency	Percentage (%)
Access to credit		
Access	48	48.0
Non access	52	52.0
Sources of microcredit organization		
Cooperative society	22	22.0
Farmers group	25	25.0
Religious group	1	1.0

Econometric analysis

Table 2 presents the results of the Tobit regression model analysis, which examines the factors influencing the adoption of improved technology among cassava farmers in the study area. The factors considered include the level of education, years of experience, quantity of fertilizer, contact with extension workers, and the number of labourers employed.

The analysis reveals that the level of education has a positive but statistically insignificant effect on the adoption of improved technology. This suggests that as the level of education increases, there is a corresponding positive influence on the likelihood of adopting improved agricultural technologies, with educated farmers being more inclined to embrace such innovations compared to their less-educated counterparts. This finding aligns with the study by Oluoch-Kosura et al. (2004), which posits that educated individuals are more likely to access information and recognize the benefits of new technology earlier than those who are not educated. Household size, on the other hand, shows a negative relationship with the adoption of improved technology and is statistically insignificant. This indicates that as household size increases, the rate of technology adoption decreases. Household size impacts various factors, such as labour usage, with smaller households tending to rely more on improved technology to compensate for their limited labour force. This finding is consistent with Ali (2016). Years of farming experience also exhibit a negative but insignificant relationship with technology adoption. This may be attributed to the fact that farming experience is often correlated with the farmer's age; older farmers, who possess more experience, may be less inclined to adopt new technologies, preferring traditional methods. This observation is supported by Tsosho (2004). Labour shows a negative and significant effect on improved technologies, implying that an increase in labour availability causes a reduction in the adoption rate. As more labour is employed, farmers may become less motivated to invest in machinery that could simplify their tasks. The discovery aligns with the research conducted by Awotide and fellow researchers in 2014, which suggests that the adoption rate is impacted by the ease of access to hired workers.s. The study also finds that extension visits negatively impact technology adoption, contrary to expectations and the findings of Omonoma, Oni, and Uwagboe (2006), who reported a positive relationship between extension visits and technology adoption. This discrepancy could be due to either a poor relationship between extension agents and farmers or a misunderstanding on the part of the farmers regarding the role of extension agents. Lastly, the amount of fertilizer is positively and significantly affected by advancements in technology, indicating that an increase in fertilizer use leads to higher adoption rates.

Factors influencing the adoption of improved agricultural technologies

Socioeconomic factors	Coefficient.	Standard error	T- test	P-value
Level of education	0.00318	0.01087	0.29	0.770
Household size	-0.00556	0.00713	-0.78	0.438
Years of experience	-0.00042	0.00120	-0.35	0.728
Labour	-0.00097*	0.00030	-3.24	0.002
Extension visits	-0.10076*	0.03028	-3.33	0.001
Quantity of fertilizer	0.00051*	0.00014	3.71	0.000
-cons	0.44494	0.09215	4.83	0.000
/Sigma	0.13992	0.01044		

Note: *significant at 5%

CONCLUSION AND RECOMMENDATIONS

The study examines sources of microcredit and factors influencing the adoption of improved technology among cassava farmers in Osun State using quantitative data. Sources of microcredit in the study area include cooperative societies, farmers' groups, and religious groups. Factors influencing the adoption of improved agricultural technologies include labour, extension visits, and quantity of fertilizer. It is recommended that extension workers are well-trained, adequately resourced, and culturally sensitive and that they provide relevant and accurate information tailored to the farmers' specific needs and circumstances. It is also recommended that the formal microcredit sources should be made more easily accessible to the farmers in the study area.

REFERENCES

Adeosun, D. R., Adegbite, D. A., Sanusi, R. A., Ayansina, S. O., & Oke, F. O. (2023). Impact of credit use on profitability among cassava smallholder farmers in Southwest, Nigeria. *Agricultura Tropica et Subtropica*, *56*(1), 198-208.

Ali K. S. (2016) Factors influencing adoption of improved cassava varieties in increasing farm yield.

A case study of Magharibi district, Zanzibar, Tanzania 2016

Akinola, A., Kehinde, A.D., Tijani, A., Ayanwale, A., Adesiyan, F., Tanimonure, V., Ogunleye, A. and Ojo, T. (2023), “Impact of membership in agricultural cooperatives on yield of smallholder tomato farmers in Nigeria.”, *Environmental and Sustainability Indicators*, *20*, 100313.

Awotide B.A, Abdoulaye T, Alene A, Manyong V.M. (2014). Assessing the extent and determinants of adoption of improved cassava varieties in south-western Nigeria. *Journal of development and agricultural economics*, *6* (9), 376-385.

Bonnke, S., Nguezet, P. M., Biringanine, A., Jean-Jacques, M. S., Manyong, V., & Bamba, Z. (2022). Farmers’ credit access in the Democratic Republic of Congo: Empirical evidence from youth tomato farmers in Ruzizi plain in South Kivu. Cogent Economics & Finance, *10*(1), 2071386.

Mahmud H. U, P. (2021). Determinants of Level of Accessibility to Microfinance among Loan beneficiaries of some Commercial Crop Production Farmers in Niger state, Nigeria. *International Journal of Environment Agriculture and Biotechnology*, *6*(1), 216-223.

Ogunleye, A., Akinloye, M. O., Kehinde, A., Ajayi, O. M., & Wongnaa, C. A. (2024). Impacts of credit constraints on adoption of risk management strategies and income of maize farmers in Northern Nigeria. Agricultural Finance Review.

Oluoch-Kosura, W.A., Marenya, P.P. and Nzuma,M.J. (2004). “Soil Fertility Management in Maize-Based Production Systems in Kenya: Current Options and Future Strategies.” In Integrated Approaches to Higher Maize Productivity in the New Millennium: Proceedings of the Seventh Eastern and Southern Africa Regional Maize Conference. February –11, 2002, Nairobi, Kenya. Ed. Friesen, D.K. and Palmer,A. F. E. Nairobi: CIMMYT Maize Program and Kenya Agricultural Research Institute.350–355pp.

Omonona, B. T., Oni, O. A., Uwagboe, A. O. (2006). “Adoption of Improved Cassava Varieties and Its Welfare Impact on Rural Farming Households in Edo State, Nigeria” *Journal of Agricultural and Food Information, 7*(1): 39–55.

Oyekola, I. A., Oye, A. J., Samuel, F., Oyeyipo, E. J., Arisukwu, O. C., Iwelumor, O. S., & Rasak, B. (2021). Social, Economic and Ecological Factors Influencing Cassava Farming in Nigerian Rural Context. *International Journal of Social Sciences*, *10*(4), 295-303.

Tijani, I.A. (2008). Analysis of the Effect of Microcredit on Food Crops Production in Ogun State, Nigeria. Unpublished M. Agric. (Agricultural Economics) Dissertation, Department of Agricultural Economics & Farm Management, UNAAB, Nigeria.

Tsosho, B.A. (2004). Economics of tomato-based cropping systems under small-scale irrigation in Sokoto State, Nigeria. Unpublished MSc. Thesis. Department of Agricultural Economics and Farm Management, University of Ilorin, Nigeria. 30-31pp.

Yokamo, S. (2020). Adoption of improved agricultural technologies in developing countries: Literature review. *International Journal of Food Science and Agriculture*, *4*(2), 183-190.

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21-25 OCT. 2024
PROCEEDINGS

Influence of Organic Fertilizers Yield Components and Grain Yield of *Zea mays* L.

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Abstract

The study was conducted to evaluate the influence of different organic fertilizer sources and application rates on yield components and grain yield of hybrid maize. An experiment was conducted in a lowland field of Ogun state organic fertilizer plant at Eleweran, Abeokuta from November 2010 to March 2011. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replicates. Three distinct organic fertilizer sources were utilized: Gateway Fertilizer 1(GF1), Gateway Fertilizer 2 (GF2) and Sunshine Fertilizer (SF) applied at three different rates: 0, 10, and 20 tons per hectare (t/ha) using OBA SUPER 2 maize variety. Results showed that the three sources of fertilizer at different rates did not affect 50% tasseling, 50% silking and 50% flowering. Grain yield was higher significantly (p<0.05) with GF1 (3.90 t/ha) compared with GF2 (3.28 t/ha) and SF (3.15 t/ha). With GF2 and SF, application of 10 t/ha and 20 t/ha produced comparable yield (3.59 t/ha, 3.25 t/ha and 3.50 t/ha, 3.44 t/ha respectively) but were significantly (p<0.05) higher than the control (2.75 t/ha). But for GF1, the interaction of organic fertilizer sources x rates revealed that application 20 t/ha produced higher yield than 10 t/ha and control.

Keywords: Organic, Fertilizer Sources, Hybrid Maize, Grain Yield, Application Rates.

INTRODUCTION

Maize (Zea mays L.) is one of the essential cereals globally, that serves as food for human, animal feed, and raw materials various industries (Fayeun and Sesay, 2019; Adunola *et a*l., 2019). Its excessive yield ability and adaptableness to diverse agro-climatic conditions make it a crucial crop for meals safety and monetary development. However, attaining excessive yields sustainably is a large undertaking, particularly in the context of growing environmental concerns and the need for sustainable agricultural practices. Organic fertilizers, derived from plant or animal remains provide several benefits over synthetic fertilizers, including the development of soil structure, more suitable microbial activities, and the slowly supply of nutrient source (Shaji *et al*., 2021). Also, by way of advertising carbon sequestration in soils, natural fertilizers assist lessen the environmental pollutants and alleviate climate change (Verma *et al*., 2020). The necessity to protect natural resources, food security and minimize the environmental impact of farming is driving the advancement toward sustainable agricultural practices (Arulbalachandran *et al*., 2017). Although being extremely efficient in stimulating crop productivity, synthetic fertilizers are also commonly resulted in adverse environmental effect such as soil degradation, water contaminants and emission of gas from greenhouse. Organic fertilizers provide a workable opportunity, however their efficacy can range greatly depending on supply and application rate (Shaji *et al*., 2021). It is necessary to investigate not only how other natural soil fertilizers have an effect on maize yield components together with plant peak, ear period and kernel wide variety but also typical grain yield. This knowledge is necessary for developing optimized fertilizer management practices that enhance productivity and sustainability. Knowledge of the outputs from organic fertilizers and dose response through hybrid maize can assist farmers, agronomists in planning sustainable fertilization techniques (Gao *et a*l.2020). According to Soto-Gómez and Pérez-Rodríguez (2021), the specific effect of different natural fertilizer types, as well as their usefulness rate on yield components and grain yield in hybrid maize fields are little known. This examines pursuits to fill this gap by way of investigating how numerous natural fertilizers have an effect on hybrid maize production, providing insights that would improve sustainable maize farming practices. This research will contribute to the body of knowledge on natural farming practices, offering empirical data that may be used to promote sustainable agriculture. Additionally, the findings can tell policy-making, encouraging the adoption of organic fertilizers to enhance soil fitness and reduce environmental effects.

MATERIALS AND METHODS

Description of experimental site

Field experiment was established on lowland filed of Ogun State organic plant at Eleweran, Abeokuta (Latitude 3^{0}25'N and Longitude 7^{0}10'E).

Experimental treatment and design

The treatments consisted of three fertilizer sources: Gateway Fertilizer 1 (GF1), Gateway Fertilizer 2 (GF2) and Sunshine Fertilizer (SF) and three rates (0, 10 and 20 t ha^{1}). The experiment was arranged in randomized complete block design with four replicates. GF1 was the mixture of cow dung, cassava peel and OBD+ (Osho Bio-Degrader), GF2 consisted of poultry waste, cow dung and wood ash while Sunshine Fertilizer was poultry manure. The size of the plot (gross) was 5 m by 5 m (20 m^2), while the net plot was 3 m by 2 m (6 m^2). A total of 36 plots were used with a path of 1 m separated adjacent replication and each plot was separated by 0.5 m. pre-planting soil physic-chemical properties were determined as prescribed by Mehlich, (1984). The land was cleared manually, plots were marked out and ridges were made. Organic fertilizers were added and mixed in the soil two weeks before sowing. Seeds were sowed on November 16th, 2010 (two weeks after incorporating organic fertilizers) at a depth of 5 cm with a spacing of 75 cm by 50 cm with two seeds per hole and later thinned to one plant per stand. Weeds were controlled manually with the use of hoe. Harvesting was carried out manually when the grains have reached physiological maturity, indicated by dry and brown colour of the husks covering the ears of maize.

Sampling and data collection

Days to 50 % tasseling, 50 % silking and 50 % flowering were determined when 50 % of the plant in each plot tasseled, silked and flowered respectively (Abasi and Atilade, 2005). Yield components (1000 grain weight, cob weight, cob girth, cob length, cob per plant, grain per row, weight of stover, shelling percentage, harvest index and yield of grains) were determined at harvest maturity according to Shrestha, (2015). Average means of data collected were subjected to Analysis of variance using 12th Edition of Genstat Statistical Package with the treatment structure that consisted fertilizer sources and rates. Significant means were separated using Duncan's Multiple Range Test (DMRT) at probability level of 5% Toungos and Yahya, 2018).

RESULTS AND DISCUSSION

The experimental site consisted of 75.2 % sand, 6 % clay and 18.8 % silt with soil pH of 6.6. Total nitrogen was moderate (1.2g kg^{-1}), available phosphorus was 5.64 ppm, exchangeable potassium was 0. 96 cmol kg^{1}, 5.43 cmol kg^{-1} of calcium, 1.49 cmol kg^{-1} of sodium. Organic matter was 9.3 g kg^{-1} with 99.53 % base saturation (Table 1). The nitrogen, phosphorus and potassium present in the organic fertilizers were 5 g kg^{-1}, 0.02 % and 2.0 % for gateway fertilizer 1, 6 g kg^{-1}, 1.0 % and 3.0 % for gateway fertilizer 2, 3.5 g kg^{-1}, 1.0 % and 1.2 % for sunshine fertilizer respectively (Table 2).

Nitrogen (N), Phosphorus (P), Potassium (K)

Application of organic fertilizer sources at different rates were not significantly ($p<0.05$) affect 50 % silking, 50 % tasseling and 50 % flowering (Table 3) which is an indication that the other factors such as temperature, photoperiod, rate of rate of growth and moisture were responsible for development of maize rather than fertilizer as reported by Shehu *et al*., (2018) and Shrestha *et al.,* (2018).

Cob girth and row per plant were significantly ($p<0.05$) increased when 10 t/ha and 20 t/ha were applied compared with when 0 t/ha was applied while application of 10 t/ha significantly ($p<0.05$) increased cob length, harvest index, stover weight and shelling percentage (Table 4) which supports the report by Jjagwe *et al*., (2020). Most of the yield components were not significantly ($p<0.05$) affected by sources of fertilizer which could be due to low-medium nutrient status of the soil as reported by Federal Fertilizer Department, (2002) that one of the most important pre-requisite for formulating fertilizer for a given crop in a given area is the nutrient level of the soil (Table 4). Yield was higher significantly ($p<0.05$) where GF1 (3.90 t/ha) was applied than with GF2 (3.28 t/ha) and SF (3. 15 t/ha). However, application of 20 t/ha and 10 t/ha were significantly ($p<0.05$) higher (3.63 t/ha and 3.96 t/ha respectively) than control (Table 4) which suggests that the sources and rates of the organic fertilizer applied affected the maize grain yield and this could be attributed to appropriate supply of nutrients as supported by Jjagwe *et al.,* (2020) that organic fertilizers could perform better when the essential macronutrients are supplied appropriately by the fertilizers.

Interaction of organic fertilizer sources x rates was significant ($p<0.05$) on yield where application of 20 t/ha with GF1 was higher significantly ($p<0.05$) (4.93 t/ha) compare with 10 t/ha and control. On the other hand, both GF1 and GF2 gave yield that was comparable and higher than the control (0 t/ha) (Table 5) which indicates that organic fertilizer are require in large quantity to supply nutrient required by plant (Timsina, 2018). Of all the three sources of organic fertilizer used, GF1 produced higher yield when compared with GF2 and SF though the analysis of the fertilizers indicated that GF1 had less N, P and K percentage than GF2. However, this could be as a result of immobilization of nutrients (Islam *et al*., 2020) or factors beyond the scope of this study.

CONCLUSION AND RECOMMENDATIONS

It can be concluded from this study that GF1 produced grain yield higher than GF2 and SF. Also 10 t/ha and 20 t/ha showed increased in some yield components and yield compared with control (0 t/ha) which is an indication that application of organic fertilizer is necessary for better performance of maize. However, when the inherent nitrogen status of the soil is 1.2g kg^{-1} (medium) as revealed by soil analysis in this study (Table

1), application of GF2 and SF above 10 t/ha will not be economical as 10 t/ha and 20 t/ha were not significantly different. But for GF1, interaction of organic fertilizer sources x rates revealed that application of 20 t/ha increased yield significantly above 10 t/ha and the control**.**

REFERENCES

Abasi, S. A. A., and Atilade, S. A. (2005). Sowing-Date Studies on Maize (*Zea Mays* L.) Under Rainforest Conditions: Effects of Sowing Date on the Vegetative and Flowering Stages. *Ife Journal of Agriculture*, *21*(1), 209-215.

Adunola, P. M., Akinyele, B. O., Odiyi, A. C., Fayeun, L. S. and Akinwale, M. G. (2019). Introgression of Opaque-2 Gene into the Genetic Background of Popcorn Using Marker Assisted Selection. *International Research Journal of Biotechnology* 5(1):10-18.

Arulbalachandran, D., Mullainathan, L. and Latha, S. (2017). Food Security and Sustainable Agriculture. In: Dhanarajan, A. (eds) Sustainable Agriculture towards Food Security. *Springer, Singapore*. https://doi.org/10.1007/978-981-10-6647-4_1

Fayeun, L. and Sesay, S. (2019). Evaluation of Drought Tolerant Top Cross and Three-Way Cross Maize Hybrids for Grain Yield and Related Traits in Three Agro-Ecological Zones of Southwest Nigeria. *Notulae Scientia Biologicae 11*(3):414-421.

Gao, C., El-Sawah, A. M., Ali, D. F. I., Hamoud, Y. A., Shaghaleh, H. and Sheteiwy, M. S. (2020). The ntegration of bio and organic fertilizers improve plant growth, grain yield, quality, and metabolism of hybrid maize (*Zea mays* L.). *Agronomy, 10*(3), 319. https://doi.org/10.3390/agronomy10030319

Islam, S. ul, Nisar, S., Kmail, A. and Umar, A. (2020). A review on immobilization techniques for fertilizer. *International Journal of Chemical and Biochemical Sciences*, *18*(1), 14-25. https://www.academia.edu/download/76936188/10-IJCBS-18-14-10.pdf

Jjagwe, J., Chelimo, K., Karungi, J., Komakech, A. J. and Lederer, J. (2020). Comparative performance of organic fertilizers in maize (*Zea mays* L.) growth, yield, and economic results. *Agronomy, 10*(1), 69. https://doi.org/10.3390/agronomy10010069

Kandil, E. E., Abdelsalam, N. R., Mansour, M. A. and Siddiqui, M. H. (2020). Potentials of organic manure and potassium forms on maize (*Zea mays* L.) growth and production. Scientific Reports **10**, 8752 (2020). https://doi.org/10.1038/s41598-020-65749-9

Mehlich, A. (1984). "Mehlich 3 soil test extractant: A modification of Mehlich 2 extractant." *Communications in Soil Science and Plant Analysis, 15*(12), 1409-1416.

Pahalvi, H. N., Rafiya, L., Rashid, S., Nisar, B. and Kamili, A. N. (2021). Chemical Fertilizers and Their Impact on Soil Health. In: Dar, G.H., Bhat, R.A., Mehmood, M.A., Hakeem, K.R. (eds) Microbiota and Biofertilizers, Vol 2. *Springer, Cham*. https://doi.org/10.1007/978-3-030-61010-4_1

Shaji, H., Chandran, V. and Mathew, L. (2021). Organic fertilizers as a route to controlled release of nutrients. In Agriculture pp. 231-245. *Elsevier*. https://doi.org/10.1016/B978-0-12-819555-0.00013-3

Shehu, B. M., Merckx, R., Jibrin, J. M., Kamara, A. Y. and Rurinda, J. (2018). Quantifying variability in maize yield response to nutrient applications in the northern Nigerian Savanna. *Agronomy, 8*(2), 18. https://doi.org/10.3390/agronomy8020018

Shrestha, J. (2015). *Growth and productivity of winter maize (Zea mays L.) under different levels of nitrogen and plant population*. Universal-Publishers.

Shrestha, J., Yadav, D. N. and Sharma, J. P. (2018). Effects of nitrogen and plant density on maize (Zea mays L.) phenology and grain yield. *Current Agriculture Research Journal, 6*(2), 25-38. https://doi.org/10.12944/CARJ.6.2.06

Soto-Gómez, D., and Pérez-Rodríguez, P. (2021). Sustainable agriculture through perennial grains: Wheat, rice, maize, and other species. A review. *Agriculture, Ecosystems & Environment, 319*, 107747. https://doi.org/10.1016/j.agee.2021.107747

Timsina, J. (2018). Can organic sources of nutrients increase crop yields to meet global food demand? *Agronomy, 8*(10), 214. https://doi.org/10.3390/agronomy8100214

Toungos, M., and Yahya, R. (2018). Performance of Sweet Pepper (Capsicum annuum L.) under Five Levels of Nitrogen Fertilizer in Zaria, Kaduna State, Nigeria. *Asian Journal of Advances in Agricultural Research*, *5*(4), 1-7.

Verma, B. C., Pramanik, P. and Bhaduri, D. (2020). Organic Fertilizers for Sustainable Soil and Environmental Management. In: Meena, R. (eds) Nutrient Dynamics for Sustainable Crop Production. *Springer, Singapore*.

Table1: The physico-chemical properties of the experimental site

Parameters	Composition
Sand	75.20%
Clay	6%
Silt	18.80%
Total Nitrogen	1.2g kg^{-1}
Organic carbon	9.3g kg^{-1}
Available phosphorus	5.64ppm
Exchangeable potassium	0.96cmol kg^{-1}
Calcium	5.43 cmol kg^{-1}
Sodium	1.49 cmol kg^{-1}
Base saturation	99.53%
pH	6.6

Source: IITA, 2011

Table 2: Composition of organic fertilizers used for the experiment

Fertilizer	N (g/ kg)	P (%)	K (%)
Gateway fertilizer 1	5	0.02	2.0
Gateway fertilizer 2	6	1.0	3.0
Sunshine fertilizer	3.5	1.0	1.2

Table 3: Influence of organic fertilizer sources and rates on maize development.

Treatment	50% Tasseling (days)	50% Silking (days)	50% Flowing (days)
Sources			
GF1	54.25	60.08	58.75
GF2	54.59	61.25	59.92
SF	54.42	60.67	58.83
SED+_	0.57	0.65	0.57
Rates			
0	54.25	61	59.00
10	54.08	60	58.92
20	54.92	61	59.58
SED+_	0.57	0.65	0.57
F x R	Ns	Ns	Ns

Eleweran, 2011

Table 4: Influence of organic fertilizer sources and rates on yield components and grain yield of hybrid maize

Treatment	1000GW (g)	CW(kg)	CG(cm)	CL(cm)	C/P	G/R	HI%	R/C	SW(kg)	Shelling%	Y(tha^{-1})
Sources											
GF1	235.50	1.12	13.09	14.59	10.33	29.67	37.40	13.00	1.05	74.80	3.80^{a}
GF2	232.30	1.08	12.86	13.88	10.25	27.75	35.00	12.97	0.83	62.20	3.28^{b}
SF	236.80	0.99	12.83	15.07	9.83	26.33	35.10	12.92	0.83	63.70	3.15^{b}
SED±	12.65	0.10	0.38	0.74	0.61	2.25	3.12	0.34	0.07	7.28	0.21
Rates											
0	236.80	1.08	12.23^{b}	13.63^{b}	9.75	29.00	33.40	12.22^{b}	0.65^{b}	62.10^{b}	2.75^{b}
10	240.90	0.96	13.23^{a}	15.42^{a}	10.17	27.75	39.00	13.25^{a}	1.33^{a}	79.50^{a}	3.63^{a}
20	226.90	1.14	13.23^{a}	14.49^{ab}	10.50	27.00	35.20	13.42a	1.03^{a}	65.10^{ab}	3.96^{a}
SED±	21.90	0.10	0.38	0.74	0.61	2.25	3.12	0.34	0.07	7.28	0.21
FxR	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	0.77

Mean value of figures with the same superscript in a column are not significantly different ($p<0.05\%$). Gateway fertilizer 1GF!), Gateway fertilizer 2 (GF2), Sunshine fertilizer (SF), Cob weight (CW), Cob girth (CG), Cob length (CL), Cob per plot (C/P), Grain per row (G/R), Harvest index (HI), Row per Cob (R/C), Stover weight (SW), Grain Yield (Y).

Table 5: Interaction between organic fertilizer sources and rates on grain yield of hybrid maize

Rates	Sources		
	GF1	**GF2**	**SF**
0 ($t\ ha^{-1}$)	2.75^{c}	2.75^{b}	2.75b
10 ($t\ ha^{-1}$)	4.02^{b}	3.59^{a}	3.25^{a}
20 ($t\ ha^{-1}$)	4.93^{a}	3.50^{a}	3.44^{a}
SED	0.21	0.21	0.37

Mean value of figures with the same superscript in a column are not significantly different ($p<0.05\%$).

Effect of Date of Planting on Taro (*Colocasia esculenta* (L.) Schott) Flowering and Tuber Yield in Umudike Southeastern Nigeria

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Abstract
Taro Leaf Blight (TLB) disease is devastating and debilitating disease of field Taro. To determine the time for crossing block establishment in the rain-fed agriculture is imperative. Hence, a trial was conducted in Umudike Southeastern Nigeria to determine the Effect of Date of Planting on Taro (Colocasia Esculenta) Flowering and Tuber Yield with ***objectives:*** *to determine the time for Taro crossing blocks establishment, to generate botanical seeds, to select high flowering, corm+cormels yielding cultivars as parents for future breeding plan and to select cultivars resistant to TLB. Two sets of crossing blocks were established in first week of April and first week of July 2023. Corm sett size of 100 to 150g of the 16 cultivars of Taro were laid down in plot size of 20m^2 and spaced 100cm within plants and 100cm between ridges. To avoid erratic flowering, gibberellic acid (GA$_3$) prepared at 500ppm was applied at 3-leaf stage. Crosses were made. Data were on: number of plants flowered, number of fruit-heads, number of seeds, weight of corm+cormels and response of cultivars to TLB. Data were analyzed with ANOVA. Results indicated that TLB was prevalent in April which led to no flower and seed production while in July, reduction in rainfall distribution resulted to low bulking of the Taro tubers. The cultivar SM126/29 gave the highest number of fruit-heads in April and flowered in July but failed to produce botanical seeds. Cultivars with mean weight of corms +cormels higher than the general mean were selected as parents for future crossing block.*

Keywords: Taro, Hybridization block, crosses, Time of planting and Parents

INTRODUCTION

Taro (*Colocasia esculenta*) and Tannia (*Xanthosoma saggittifolium*) mainly found in West Africa and popularly called cocoyam are important members of the *Araceae* family. However, Taro has been on the high pedestal for feeding over 800 million people in over 90 countries across the globe (FAOSTAT, 2022). The physiological and agronomical variability that has been observed in Taro revealed interesting traits that can be exploited in breeding programmes. The Taro landraces have been recognized as a special germplasm base with distinctive organoleptic and adaptability traits that can increase the income of farmers through their value-added products. The objectives of Taro improvement programme as recognized by Godden (1999) differ according to location, end-use of the corm and cormels, and the available resources. However, the common goal for each programme is high yield, yield stability, high nutritional quality and resistance to abiotic and biotic stresses. Parental selection for hybridization is necessary to develop heterosis for yield, early maturity and other good agronomic characteristics. Due to the distinctive qualities and adaptation to local soil and climatic conditions, local Taro varieties are often used as parents as reported by Ivancic (2003). Landraces are cultivated in many states of the country and this present a wide diversity of morphological, phenological and agronomical traits that can be exploited in breeding programmes. Several morphological and agronomical characters present polymorphism among them, Jackson and Pelomo (1980) observed that growth habit and vigour, flesh colour and organoleptic quality are related traits. According to Onyeka et al. (2011) TLB has been a devastating field disease of Taro. However, crosses have to be made between landraces to produce F_1 hybrids which would be compared with commercial landraces in open field cultivation in term of yield, vigour, pests and diseases reactions. Morphological and molecular distances between the parents will have to be used to predict the progenies performances (Laurie and Niederwieser, 2004). In order to develop new varieties and increase the genetic base of Taro, crossing block had to be established and hybridization has to take place for the generation of botanical seeds. Therefore, the objectives of this trial were: to determine the time for Taro crossing blocks establishment for botanical seed generation, to generate botanical seeds for the development of new Taro progenies, to select high flowering and corm+cormels yielding cultivars as parents for future breeding plan and to select cultivars resistant to major biotic stresses of Taro.

MATERIALS AND METHODS

Two sets of crossing blocks were established in June 26th 2023 at the Western experimental field of National Root Crops Research Institute, Umudike on sandy loam soil of Field H5. The first crossing block of the Taro (*Colocasia Species*) was established in the first week of April and the Second crossing block was established precisely first week of July 2023. The land area for the experiment was slashed, ploughed and ridged. The field was then demarcated into plots and Blocks. In the first crossing block, ten (11) exotic lines and five (5) landraces of Taro varieties totaled 16 cultivars were established in 16 plots. Each plot contained 20 plants stand per plot. Each plot measured 20m2 (4 x5m ^{2}) and replicated three times. The first trial was established in the first week of April, 2023, while in the second crossing block was established in first week of July 2023. Each corm sett weight for each cultivar was 100 to 150g. The corm sett was planted 100cm within plants on the crest of the ridge and 100cm between ridges. To overcome the problem of erratic flowering, freshly prepared gibberellic acid (GA_3) was applied to the plants at the 3-leaf stage at the rate of 500ppm per plant of Taro. Flowering and production of fruit-heads commenced two and half months after induction with gibberellic acid and continued until the Taro plants started to senescence. Bi parental crossing in Inter-varietal crosses were made in the controlled crosses carried out. (Control crosses between landraces and exotic lines, and within exotic lines). Data were collected as follows: number of plants that flowered, number of fruit-heads (berries) per cultivar and total number of seeds collected per cultivar. Also collected were: weight of corm+cormels per cultivar and response of the cultivars to major biotics stresses of Taro. Data collected were statistically analyzed using ANOVA and means were separated using Standard Error of difference mean.

RESULTS AND DISCUSSION

Number of plants that flowered and Seed production in April field establishment

The result of the: Number of Taro plants that flowered, Total number of fruit heads, Total number of seeds, produced by the Taro plants established in the crossing block in the months of April and July 2023 are presented in Table 1. The result indicated the mean total number of Taro plant that flowered in the month of April 2023 was 115 which was equivalent to 82% of the mean number of Taro plants established in the crossing block. The mean total number of fruit-heads harvested was 201 with mean of 12.6 per plant. Mean total fruit heads ranged from one (NCe/005 (Ukpong)) to 20 (SM126/29) with mean of 12.6 per Taro plant. However, these number of fruit heads produced no fruit-heads (berry) and no seeds were collected. This was as result of the attack of Taro leaf blight that attacked the fruit-heads, the peduncles and the Taro leaves. This led to the death of the fruit-heads which resulted into no seed production. This was observed from the disease score rating in the plots established in April. The disease score rating ranged from 3.2 (moderate) for SM138/32 to as high as 4.4 (very severe) for Ede-Ofe –Green NCe/002 with mean of 3.9 severity score. This severity rating affected the Taro plants established in April severely. Hollaway et al (2007) reported that Taro Leaf Blight Caused *by Phytophthora colocasiae* is favoured by very wet conditions which facilitates entry of the fungi into the plant. The disease tends to occur when plant biomass is high and leaf microclimates are humid. The spores are airborne and germinate during periods of leaf wetness or high humidity. Rain splash is generally required to release and spread the spores formed during the initial infection and humid conditions or leaf wetness are required for their germination. Also, that increased CO_2 levels are expected to increase canopy growth and density, which will increase canopy humidity and length of leaf wetness. The cultivar that gave the highest number of fruit-heads (21) was SM126/29 in April and flowered in July (4 mean of flowers) but failed to produce botanical seeds.

Number of plants that flowered and Seed production in July field establishment
There were mean total of 13 Taro plants that produced flowers after hormonal induction in the crossing block established in July with mean of 0.8 per plant. This very low average indicated that many Taro plants did not produce any flower. However, the flowers did not develop into fruit heads and seeds were not collected (nil). This resulted into total nil for number of fruit heads, which showed that there was no flower production by all the parents in the hybridization block. However, the TLB disease severity score indicated that TLB disease severity in July planting ranged from 1.1 (no disease present) for most of the cultivars to severity score of 3.3 for some cultivars (Table 1). This observation concurs with Challinory *et al* (2006) findings that hotter, drier conditions are likely to reduce the impact of TLB disease

Weight of Corms+cormels
The result of the weight of Corms+cormels of the Taro plants established in April and July 2023 are presented in Table 2. The yield of the cultivars established early in April differed significantly ($p<0.01$) and ranged from **7.7 (**SM132//25) to as high as 14.5t/ha (Ukpong NCe/005) with mean of 10.3t/ha per plant. Cultivars that yielded more than the grand mean could be selected as good candidate for further evaluation. The July cultivar evaluation also differed significantly ($p<0.01$) and ranged from 0.4 t/ha for SM138/28 to 7.2t/ha for Cocoindia NCe/001 with mean of 6.7t/ha per plant however, the yield of April (73%) was higher than the yield of Taro in July (27%) by 46%. According to Onwueme and Sinha (1999), tuber bulking in Taro takes place three months after planting and invariably which coincide with the time of flower production and high moisture requirement. If hybridization block for Taro was established at the time when moisture content of the soil is low/reducing, it will drastically affect the yield of corm+cormel and flowering may not be effective no matter whether the clones were inducted or not except if complemented with irrigation.

CONCLUSION AND RECOMMENDATIONS

High humidity adversely affected flower production during period of high field humidity in April, when the Taro Leaf Blight disease is prevalent, it destroyed the flowers, fruit-heads and berries leading to no botanical (true) seed production. This affected breeding plans and objectives. The cultivar that gave the highest number of fruit-heads (21) was SM126/29 in April and flowered in July (4 mean of flowers) but failed to produce botanical seeds. Cultivars with mean number of corms +cormels higher than the general mean could be selected as parents for the crossing block. Again, establishment of hybridization block at the period leading to sharp and sudden reduction in rainfall distribution led to low bulking rate of the Taro tubers. Planting for flower induction and seed set during drier periods of the year could be supplemented with controlled irrigation as the crop requires high soil moisture for flowering and seed set plus corm+cormel bulking for high tuber yield.

REFERENCES

Challinor, T.R. Wheeter, P.Q. Crauford, C.A.T. Ferro, and D.B. Stephenson (2006). Adaptation of crops to climate change through genotypic responses to mean and extreme temperatures. *Agricultural Ecosystem Environment*, 119, 190–204

FAOSTAT. (2022, November 24). Production of commodity in selected country, production share by region and production of top 10 producers. FAO.

Godden D (1999). Economic rationale for cooperation in germplasm conservation. Paper presented at ACIAR/NARI Workshop on Regional Co-operation in Conservation and Management of Plant Genetic Resources in the Pacific. Lae. 1999

Ivancic A, (2003). Development of visual tools for selecting qualitative corm characteristics of taro (*Colocasia esculenta* (L.) Schott). *Australian Journal of Agricultural Research*, 2003; 54:581-587.

Jackson GVH and Pelomo PM (1980). Breeding for resistance to diseases of taro, *Colocasia esculenta*, in Solomon Islands. In: International Symposium on Taro and Cocoyam, Visayas State College of Agriculture, Baybay, Leyte. Provisional Report. 1980; 5:287-298.

Onyeka T. J. (2011) Understanding Taro Leaf Blight: A new challenge to cocoyam (*Colocasia esculenta*) production in Nigeria. In: Amadi, C. O., Ekwe, K. C., Chukwu, G. O., Olojede, A. O. and Egesi, C. N. edited Root and Tuber Crops Research for Food Security and Empowerment. National Root Crops Research Institute Umudike. Pp 301-312

Laurie, S.M. and Niederwieser, J.G. (2004). The sweet potato plants. In: Guide to sweet potato production in South Africa. J. G. Niederwieser (ed.). Agricultural Research Council, South Africa, Pretoria. 1: 7-14.

Onwueme, I. C. and Sinha, T.O. (1999), “Field crop production in Tropical Africa, principles and practice". CTA (Technical Centre for Agriculture and Rural Cooperation), Ede. The Netherlands. pp. 267-275.

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Challenges of Rural Road Transportation among Rural Farmers in Irepodun/Ifelodun Local Government Area, Ekiti State, Nigeria

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Abstract

Rural road transportation problems had served as a major problem to agricultural value chain within Irepodun/Ifelodun L.G.A Area in Ekiti State. This poses threat to sustainable food security and agricultural development. This study examined the challenges of rural road transportation among rural farmers in Irepodun/ Ifelodun Local Government Area-Ekiti, Ekiti State, Nigeria. Structured and self-administered questionnaires were purposively and randomly administered to one hundred and sixty (160) farmers in the study area. The purposive sampling is to ensure that only farmers who are member of each of the villages selected were sampled. The random technique is to ensure that individual farmer has equal rights to be sampled for the purpose of the study. Data collected were analyzed using descriptive statistics in the form of frequency and percentages. The results indicate poor state of road transportation system in the area hindering agricultural production. The study recommended construction of access roads in the rural areas to reduce poverty level of the rural dwellers.

Keywords: road transportation, food, rural farmers, challenges

INTRODUCTION

Rural road transportation problems had served as a major problem to the production of food due to the rise in cost of transportation in rural areas. Rural areas in Africa are made up of people who are poor and characterized by a low educational standard. These Africa rural areas are capable of offering the highest opportunity capable of transforming the continent through adequate agricultural production reinforced by reliable and adequate transportation (Olorunfemi & Adenigbo, 2017). There is no escape route from transport even in the most remote and least developed of inhabited regions (Afolabi *et al*., 2016). This means that no individual can do without transportation for his/her survival. The development of a country and the local economy is enriching by adequate, reliable and efficient transportation system (Olamigoke & Emmanuel, 2013).To facilitate the development of agriculture, there must be efficiency in the road mode of transport system and this will also boost socio-economic status of the people dwelling in the rural areas. This is because the road is the major means of moving produce to various consumers (Orakwue *et al*., 2015), who make payment for their consumption. Olorunfemi, S.O. (2018). observed that the farmers engaged in both cash and arable crops farming and the roads in the rural areas of the local government is characterized by poor road condition which led to high cost of transportation in moving farm produce in the area to the market which lead to inadequate supply and high cost of food is as a result of inefficient transportation and distribution of farm produce. Olorunfemi and Adenigbo (2017) demonstrated that impact of lack of basic infrastructural facilities most especially how the neglect of transport sector has resulted in poor quality of life with its attendant implication on food insecurity as a result of poor agricultural output. It is against this background that the paper seeks to look at challenges of rural road transportation in Irepodun /Ifelodun Local Government Area, Ekiti State, Nigeria. The objectives are to identify the types of agricultural produce and means of transportation in the study area; identify the major transportation challenges facing farmers in the study area.

METHODOLOGY

The study was conducted in Irepodun/Ifelodun LGA of Ekiti comprises of 12 towns. The study made use of survey approach to collect data for the achievement of its objectives. Major data for the study were sourced using primary techniques of data collection involving questionnaire administration. In the course of this research, one hundred and sixty (160) questionnaires were purposively and randomly administered to the farmers in the selected villages in the study area. The purposive sampling is to ensure that only farmers who are member of each of the villages selected were surveyed. The random technique is to ensure that individual farmer has equal rights to be sampled for the purpose of the study. The survey was conducted to spread across 16 different farm settlements within the study area. The reason for selecting these 16 farm settlements villages in the study area is because there are the major farm settlements that have received government attention overtime. The data collected for the study were analyzed using simple descriptive statistics in form of frequency counts.

RESULTS AND DISCUSSION

Socio-Economic Characteristics

The findings in Table 1 shows the socioeconomic characteristics of farmers who were sampled for the study. The variables examined include respondents' gender, age, educational status, years of experience and income. The gender of the farmers in the study revealed that majority (66.9%) shows that male has the highest percentage of farmers while female has 33.1% in the study area. This may be to the fact that males are more energetic than females and being the head of the family, has to provide for the family while females support in their own little ways. The educational status of the farmers revealed that majority (45%) possessed primary school education while 12.5% possessed post- secondary education. This implies that they did not receive enough education to enable them to engage in modern agricultural production. The age of the farmers shows that majority (40%) fall within the ages of 46-60 year and 12.5% fall with the age of 18-30. This is in line with the findings of Alfred (2018), who pointed out that large percentage of farmers in the country fall within the age bracket of 45 years and above, which implies that before the end of the 21st century, a greater percentage of these farmers may be no more. A look at the number of years of farmers experience as presented in Table 1 shows that majority of the farmers' surveyed accounting for over 60.6% had spent more than 15 years and 6.3% had spent below 5 years in farming system in the study area. It is to be noted from Table 1 that majority (36.3%) of the farmers surveyed for the study had annual income above N500, 000 and 7.5% had annual income of N100, 500 -N200, 000.

Table 1: Socio-Economic Characteristics of the Farmers

Variables	Frequency	Percentage
Sex		
Male	107	66.9
Female	53	33.1
Age (years)		
18-30	20	12.5
31-45	32	20
46-60	64	40
Above 60	44	27.5
Educational qualification		
No formal education	43	26.9
Primary education	72	45
Secondary education	25	15.6
Post- secondary education	20	12.5
Years of experience (years)		
Below 5	10	6.3
5-10	23	14.4
11-15	30	18.8
Above 15	97	60.6
Annual income status(N)		
100,500- 200,000	12	7.5
200,500- 300,000	27	16.9
300,500- 400,000	46	28.8
400,500-500,00	17	10.6
Above 500,000	58	36.3

Types of Agricultural Produce in the Study Area

Types of agricultural produce discovered in the study area include cash crops such as palm-oil, citrus trees, cocoa, and kola-nut, banana, plantain, avocado pea among others. The arable crops in the area include yam, maize, cassava, coco-yam, vegetable, pepper, tomatoes, garden eggs etc. It was revealed in the area that majority (60%) of the farmers engaged in both cash and arable crops farming while 40% engaged in arable crop only (Table 2). It was discovered during study survey that the majority of those that engaged in both cash and arable crops farming are indigene of Irepodun/Ifelodun local government while majority of those that engaged in arable crops are non-indigene (ebira, igede, etc) of the area.

Table 2: Types of Crops Grown in the Study Area

Crops	Frequency	Percentage
Arable and cash	96	60
Arable only	64	40
Total	**160**	**100**

Means of transportation to the Market Centers in The Study Area

Means of transporting farm produce to the market shows in the table 3 that majority (60%) of the farmers transport their farm produce to market with the use of motorcycles while 5% transport their farm produce to the market with the use of bicycle. This is evident as a result of the flexibility nature of motorcycle services occasioned by ease of manipulation on narrow and bad roads (Olorunfemi, 2018). Motorcycles have a highly limited capacity to carry farm produce that can substantially contribute to sustainable food security in the study area. Due to this, a huge volume of agricultural products wasted away in the farm.

Table 3: Means of Transportation

Means of transportation	Frequency	Percentage
Vehicle (car and truck)	40	25
Motorcycle	96	60
Bicycle	8	5
Foot	16	10
Total	**160**	**100**

Road Transportation Challenges in the study Area

Result from table 4 showed that 10% of the farmers claimed poor road network, 20% claimed high cost of transport, 10% indicate inadequate road transport service, 5% responded to be wastage of farm produce on station and transit, 5% noted it to be overloading and 50% of the farmers indicated that all the identified variables are problems hindering movement of agricultural produce in the area. Perhaps, this could be one of the major reasons for cost of food items in the area.

Table 4: Road Transportation Challenges in Rural Areas of Irepodun/Ifelodun LGA

Challenges	Frequency	Percentage
High cost of transportation	32	20
Poor road network	16	10
Insufficient transport service	16	10
Wastage	8	5
Overloading	8	5
All	80	50
Total	**160**	**100**

CONCLUSION AND RECOMMENDATIONS

The study examined the challenges of rural road transportation among farmers in Irepodun /Ifelodun Local Government Area, Ekiti State, Nigeria. Findings revealed that the farmers in the study area engaged in both cash and arable crops farming and the roads in the rural areas of the local government is characterized by poor road condition which led to high cost of transportation in moving farm produce in the area to the market. This result in wastage of agricultural products in most cases because majority of the farmers relied on motorcycle for transporting their farm produce and that has a limit to what it can carry. To amend these problems, the Local Government should make provision of good roads and other social amenities in the rural areas in the area to boost the agricultural production in the Local Government area. This will also motivate the youth to stay and involve in farming activities and also discourage rural-urban migration. For effective operation of the Local Government Council in the country, most especially in the area of rural development, the Federal Government should approve the total autonomy of Local government in the country. This will allow them to be focused to the rural development in their areas without depending on federal government allocation to fund developmental projects within their area.

REFERENCES

Afolabi, O.J., Ademiluyi, I.A. and Oyetubo, A.O. (2016). Analysis of Rural Transportation of Agricultural Produce in Ijebu North Local Government Area of Ogun State Nigeria. *International Journal of Economics and Management Sciences 6*(1): 1-6

Alfred, S.D. (2018). Attitudinal and Behavioural Change Nexus in Agricultural Extension Communication. 97th Inaugural Lecture of the Federal University of Technology, Akure, Nigeria. Geography, University of Bergen.

Olorunfemi, S.O and Adenigbo, J.O (2017). Road Transportation Challenges to Food Security in Ikere Ekiti Local Government Area of Ekiti State, Nigeria. *Paper Presented at Quantitative Methods for Integrated Food and Nutrition Security Measurements*-Lessons to be learned Conference organized by European Commission and International Food Policy Research Institute held at Thon Hotel Brussels, Belgium.

Gbadamosi, K.T. and Olorunfemi, S.O. (2016). Rural Road Infrastructural Challenges: An Impediment to Health Care Service Delivery in Kabba-Bunu Local Government Area of Kogi State, Nigeria. *Academic Journal of Interdisciplinary Studies, 5*(2):34-43.

Olorunfemi, S.O. (2018). Rural Road Transportation Challenges and Food Security. *Ethiopian Journal of Environmental Studies and Management 11*(5): 553 – 564

Orakwue, C.O., Umeghalu, I.C.E. and Ngini, J.O. (2015). Effects of Road Transport on Agricultural Productivity: A Case Study of Ayamelum Local Government Area of Anambra State, Nigeria. *International Journal of Applied Science and Engineering., 3*(1): 1-4.

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Effects of Banditry on Farming Activities of Rural Women in Niger State, Nigeria

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Abstract

The study examines the effects of banditry on farming activities of rural women in Niger State, Nigeria. Three stage sampling technique was employed to select 202 rural women, Primary data were elicited from the respondent with the aid of a structured questionnaire complemented with interview schedule. Data collected were analyzed using descriptive statistics (such as mean, frequency distribution count and percentages) and inferential statistics (such as poison regression). The study revealed that In the pre-planting phase, the study revealed that only 45.5% of women participated in land clearing, while only 10.0% participated in ridging, Regarding planting phase of crop farming, the study revealed high participation rates among rural women: 86.6% participated in weeding, 80.7% in planting and 72.8% in fertilizer application. The study also revealed that drying (82.7%), winnowing (81.2%), bagging (81.2%), harvesting (79.2%) and marketing (74.3%) were the major post-planting operation participated by rural women. Furthermore, the study revealed that hoe (89.6%), cutlass (83.7%), fertilizer (77.7%), land (68.3%), and winnowing tray (61.4%) were the major production inputs assessed by rural women. In addition, weak governance (95.0%), corruption (85.1%), economic inequalities (83.2%) and unemployment (69.3%) were the perceived causes of banditry in study area. Lastly, loss of crops due to banditry (p<0.05), loss of asset due to banditry (p<0.01), frequency of attack (p<0.01) and death of farming household due to banditry (p<0.01) had inverse relation with the farming activities of rural women. The study recommended that the federal government should provide tailored support to enhance the productivity and profitability of maize, rice, and soybean cultivation. This could involve introducing high-yielding, drought-resistant varieties, and offering training on improved farming practices for these crops.

Keywords: banditry, women, farming, Nigeria

INTRODUCTION

Banditry entails the activities of individuals or groups of people who engage in a wide range of criminal activities, which includes but not limited to kidnapping, murder, robbery, rape, and cattle-rustling (Isah *et al.*, 2022). Bandits usually operate in areas with weak governance structures and are known for terrorizing rural communities, attacking villages, and causing loss of lives and properties. These activities often lead to a breakdown of law and order and creating an atmosphere of fear and insecurity in the affected areas. In recent times, banditry has become a major security challenge in several regions of the world, In Europe, bandits operate mainly in mountainous regions of countries such as Italy, Spain, Greece, and Turkey, where they would rob travelers and attack villages (Ako, 2019). In Asia, banditry has also been prevalent in countries like Iran, the Philippines, and India, where armed groups engage in kidnapping, extortion, and other criminal activities. In Africa, particularly in Nigeria, banditry pose a significant security challenge particularly in the northern region of the country, where criminal gangs engage in violent activities such as kidnapping, robbery, rape, and cattle rustling (Epron, 2019). These criminal activities mostly occur in isolated areas such as villages, community market squares, and places of worship, making it challenging for the government to tackle the issue. Banditry has a long history in Nigeria and continues to persist despite government efforts to curb its prevalence. The prevalence of banditry in these communities is particularly worrisome, given that the livelihoods of many rural dwellers, particularly women crop farmers, are heavily dependent on agriculture. Banditry in Nigeria has significantly impacted the country's agricultural sector, leading to the destruction of farmland, crops, and infrastructure, as well as the displacement of rural communities. The effects of banditry on the rural economy and food security of Nigeria remain largely understudied. Although the government has made efforts to combat banditry, including deploying military forces to affected areas, the problem persists, and its impact on farming activities of rural women is not well evaluated. The effects of banditry on farming activities and the livelihoods of those who depend on agriculture for their income, including rural women, have been documented in various reports and studies (Isa *et al.,* 2022). However, there is a need for further research to understand the specific ways in which banditry affects the welfare status of rural women in Niger State. This research problem presents an opportunity to explore the effects of banditry on the farming activities and welfare status in Nigeria, with a particular focus on women crop farmers. By examining the issue in greater detail, policymakers and other stakeholders can develop more effective strategies to combat banditry and mitigate its impact on rural communities. It is against this backdrop that this research was conceived to assess the effects of banditry on farming activities.

METHODOLOGY

The study was carried out in Niger State which is located between Latitudes 8^{o}22'N and 11^{o}30'N and Longitudes 3^{o}30'E and 7^{o}20'E. Currently, the State covers an estimated total land area of 74.244sq.km, which is about 9.3% of Nigeria's total land area. The population of the State is 3,950,249, comprising 2,082,725 males and 1,867,524 females. The projected population of the State as at 2021 was 5,644,139 at 3.2% population growth (National Bureau of Statistic (NBS), (2022). Three stage sampling technique was employed to select 202 rural women. The data collected were analysed using descriptive statistics (such as mean, frequency distribution count and percentages) and inferential statistics (such as poisson regression)

RESULT AND DISCUSSION

Crop farming activities engaged by rural women

Table 1 presents the results of rural women's participation in various stages of crop farming activities. In the pre-planting phase, the study revealed that only 45.5% of women participated in land clearing, while only 10.0% participated in ridging. This suggests low participation by rural women in pre-planting activities, this may be due to traditional gender roles and cultural norms that may limit rural women's participation in physically demanding tasks such as land clearing and nursery bed preparation, which are often considered as men's responsibilities. Regarding Planting phase of crop farming, the study revealed high participation rates among rural women: 86.6% participated in weeding, 80.7% in planting and 72.8% in fertilizer application. These findings suggest that weeding, planting, and fertilizer application are the primary planting activities undertaken by rural women. This is because weeding, planting and fertilizer application typically occur during specific windows within the growing season. Table 1 also revealed that drying (82.7%), winnowing (81.2%), bagging (81.2%), harvesting (79.2%) and marketing (74.3%) were the major post-planting operation participated by rural women. This implies that rural women participated more in this phase of crop farming processing as compared to others, this is because post-harvest activities such as drying, winnowing, bagging and sorting typically require less physical effort compared to tasks like land preparation or transplanting. This may make them more manageable for women, especially those with childcare responsibilities or limited mobility. Also, many post-harvest operations can be performed close to home or within the household compound. This allows women to participate in these tasks while attending to other household duties. Women may possess traditional knowledge and skills passed down through generations related to specific post-harvest activities like winnowing and drying.

Table 1: Stages of crop farming activities participated by rural women

Variable	Frequency*	Percentage
Pre-planting		
land clearing	92	45.5
nursery bed preparation	18	8.9
Seed treatment	20	9.9
Ridging	22	10.9
Planting Operation		
Transplanting	32	15.8
Planting	163	80.7
fertilizer application	147	72.8
water management	13	6.4
weed control	175	86.6
pest and disease control	33	16.3
Spraying of herbicides	52	25.7
Carrying out scarecrow	37	18.3
Post Planting Operation		
Harvesting	160	79.2
Drying	167	82.7
Winnowing	164	81.2
Bagging	164	81.2
Storage	34	16.8
Marketing	150	74.3

Source: Field survey, 2024. *Multiple responses were recorded

Level of rural women's participation in crop farming activities

Table 2 presents the results of the level of rural women's participation in crop farming activities. It reveals that more than half (55.9%) had a low level of participation in crop farming activities, while the remaining (44.1%) had moderate and high levels of participation. This implies that, on average, rural women had a low level of participation in crop farming in the study area. This is because the majority of rural women participated less in the pre-planting and planting operations phases of crop farming, which are critical phases of crop farming, as presented in Table 1.

Table 2: Distribution of the respondents based on their Level of participation

Class	Level of participation	Frequency	Percentages
(1 - 8)	Low	113	55.9
(9 – 10)	Moderate	59	29.2
(11 – 18)	High	30	14.9
Total		202	100.0

Source: field survey, 2024

Perceived causes of banditry

The result in Table 3 present the perceived causes of banditry in the study area. It revealed that weak governance (95.0%), corruption (85.1%), economic inequalities (83.2%) and unemployment (69.3%) were the perceived causes of banditry in Niger State, Nigeria. Weak governance, perceived by 95.0% of respondents as a major cause of banditry in the study area. Weak governance refers to the inability of governmental institutions to effectively deliver public services, enforce laws and maintain order. Corruption, perceived by 85.1% of respondents as a cause of banditry, exacerbates the problem by undermining the integrity and effectiveness of both governance and law enforcement. When public officials, including police officers, are involved in corrupt practices, it erodes public trust and diminishes the capacity of institutions to function properly. Corruption can manifest in various ways, such as bribery, embezzlement, and favoritism, which divert resources away from essential services and hinder economic development. In the context of banditry, corruption can lead to the misallocation of funds meant for security and community development, making it easier for bandits to operate. Economic inequalities, identified by 83.2% of respondents, play a significant role in the prevalence of banditry. In regions where there is a stark disparity between the rich and the poor, social tensions and grievances can build up. Individuals who are marginalized and lack access to economic opportunities may turn to criminal activities out of desperation or as a means of protecting their conditions. Banditry can become an attractive option for those who feel excluded from the benefits of economic growth and development.

Table 3: Perceived causes of banditry

Causes	Frequency	Percentage
Weak governance	192	95.0
Corruption	172	85.1
economic inequalities	168	83.2
Unemployment	140	69.3
political instability	130	64.4
political marginalization	126	62.4
Poverty	125	61.9
lack of educational opportunities	122	60.4
arms proliferation	114	56.4
lack of social amenities	113	55.9
ethnic and religious conflicts	84	41.6
religious extremism	72	35.6
Climate change	67	33.2
Hardship in the country	194	96.0
Drug abuse	95	47.0

Source: Field survey, 2024

Effects of banditry on the farming activities of rural women

The results of the Poisson regression analysis on the effects of banditry on the farming activities of rural women are presented in Table 4. The coefficient for loss of crops due to banditry (.0094), loss of asset due to banditry (4.35e-06), frequency of attack (.0264) and death of farming household due to banditry (.0377) were negative and statistically significant at different levels of probability.

Table 4: Effects of banditry on the farming activities of rural women

Variable	Coefficient	Standard error	z-value
Loss of farm land	-.0063	.0040	-1.59
Loss of crops	-.0094	.0042	-2.20**
Loss of farm animals	-.0078	.0072	-1.09
Loss of asset	-4.35e-06	1.13e-06	-3.86***
Relocation	-.0001	0.0001	-1.40
Frequency of attack	-.0264	.0053	-4.95***
Death of farming household	-.0377	.0054	- 6.95***
Number of training received	.0274	.0038	7.20***
Farming experience	-.0001	.0004	-0.33
Constant	1.0016	.1399	7.16***
Pseudo R2	0.3101		
LR chi2(10)	460.53		
Log likelihood	-512.40224		
Prob > chi2	0.0000		

Source: Field survey, 2024

The negative coefficient for loss of crops due to banditry indicates that as crop losses increase, the farming activities of rural women are adversely affected. This is significant because the destruction of crops directly affects the availability of food and income for farming households. Banditry disrupts agricultural productivity by causing direct damage to crops, leading to reduced harvests and financial losses. This makes it harder for women farmers to sustain their farming operations and maintain their livelihoods. The negative coefficient for loss of assets due to banditry suggests that the loss of farming assets such as tools, livestock and farm house due to banditry has a detrimental effect on the ability of rural women to engage in farming activities. Assets are crucial for efficient farming operations, and their loss means that women farmers have to spend additional resources and time to replace them or adjust their farming practices, often leading to reduced productivity. The negative coefficient for the frequency of attacks signifies that increased frequency of bandit attacks severely hampers the farming activities of rural women. Frequent attacks create a climate of fear and insecurity, disrupting the regular farming schedule and discouraging women from tending to their fields. This constant threat also leads to psychological stress and reduces the overall efficiency and output of farming activities. The negative coefficient for the death of farming household members due to banditry is particularly impactful. The death of household members has a profound effect on the remaining family members, both emotionally and practically. It reduces the available labor force, which is critical for maintaining farming activities, and increases the burden on surviving family members who must cope with the loss while continuing to farm.

REFERENCES

Ako, A. I., Ifejika, I. M., & Onah, E. C. (2019). Gender and climate change challenges in rural Nigeria: Exploring women farmers' vulnerability and adaptation strategies.

Environmental Development, 31, 108-116. https://link.springer.com/10.1007/978-3-030-45106-6_182

Isah, H. L., Salihu, L. M., & Abubakar, I. B. (2022). The role of savings groups in enhancing the economic resilience of rural women to climate change in North-Eastern Nigeria. *International Journal of Disaster Risk Reduction*, 100, 103723.

National Bureau of Statistics. (2022). Nigeria Living Standards Measurement Study - Household Panel Survey (Wave 5). NBS. https://www.nigerianstat.gov.ng/

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21-25 OCT. 2024
PROCEEDINGS

Virus Types and Distribution in Cowpea Seeds in Selected Markets of Katsina State, Sudano-Sahelian Savannah of Nigeria

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Abstract
Field surveys were conducted during the 2024 wet season to identify and determine the distribution of cowpea viruses in Katsina State, Nigeria. Three locations were visited during the surveys. Seed samples were collected from various markets from the three locations. The antigen coated plate - enzyme linked immunosorbent assay (ACP–ELISA) method was employed for virus detection in the collected samples. Results showed that Blackeye cowpea mosaic virus (BICMV), Cowpea mild mottle virus (CPMMV) Cucumber mosaic virus (CMV) and Cowpea mottle virus (CPMoV) were the viruses detected. Thus, BICM and CMV were more prevalent in all cowpea varieties. The detection of these viruses in seeds of cowpea in the surveyed areas indicates their importance in the ecology, survival and the significant role they play in the epiphytology of the various virus diseases. The occurrence of BICMV, CPMoV and CPMMV in few cowpea varieties is believed to be the first report in the study area
Keywords: ACP-ELISA, Cowpea, Occurrence, Susceptible, Virus.

INTRODUCTION

Cowpea (*Vigna unguiculata* L*. Walp.*) is an important grain legume, a major staple food crop for household nutrition in sub-Saharan Africa, especially in the dry savanna regions of Nigeria. It plays an important role in human nutrition, food security, and income generation for both farmers and food vendors in the region. The grain is rich in protein (25%), carbohydrates, vitamins, and minerals and complements the mainly cereal diet in countries that grow cowpea as a major food crop (Singh *et al*., 1995). In Nigeria, farmers who cut and store fodder for sale at the peak of the dry season have been found to increase their annual income by 25% (Dugje *et al.* 2009). Cowpea also plays an important role in providing soil nitrogen to cereal when grown in rotation, especially in areas where poor soil fertility is a problem. Cowpeas are susceptible to a wide range of insect pests and pathogens which can cause damage at all stages of growth (Aliyu *et al*., 2012). Smallholders and medium scale farmers are faced with two factors that constitute the major constraints to the cropping of cowpea i.e abiotic and the biotic (Dugjie *et al.*2010). Diseases of cowpea which constitute biotic constraints are usually induced by fungi, bacteria, nematodes, viruses (Alegbejo, 2015) and the parasitic flowering plants such as *Striga gesnerioides* and *Alectra vogelii* (Dugjie *et al.*2010). Virus diseases are considered to be a major limiting factor for the production and productivity of legumes in the tropical and sub-tropical countries (Bashir *et al*., 2008). Virus, an economic important disease agent in cowpea seeds causes serious problems such as reduction in yield and germination, changes in shape and colour of seeds (Mandhare and Gawade, 2010). Seed-borne viruses are important for source of diseases at the beginning of production even at low rates of seed transmission (Alabi *et al*., 2010). In addition, seed-borne viruses can aggravate other transmission methods and cause disease to spread rapidly. Seed-borne and seed transmitted viruses are also damaging to cowpea productivity owing to inherent primary inoculum and potential for their widespread. Also, information on the possibility of seed transmission in virus infected cowpeas will be valuable to numerous cowpea farmers. The study therefore was to determine virus types and distribution in cowpea seeds in some selected markets in Katsina State, Sudano-Sahelian Savannah of Nigeria

MATERIALS AND METHOD

Description of study area

The study was conducted in 2024 wet seasons at five major grain markets in Katsina (12°26'N and 07°29'E, 212 m above sea level), Nigeria. The average annual rainfall is about 700 mm. The pattern of rainfall in the area is highly variable. The vegetation of the area is the Sudan Savanna type which combines the characteristics and species of both the Guinea and Sahel Savanna (Abaje *et al*., 2014).

Sample collection

A multi-stage sampling procedure was employed to select five major grain markets in Katsina, these includes Ajiwa, Funtua and Dutsin-Ma respectively. From each market, 20g of cowpea seed samples was collected irrespective of the variety, preserved in air-tight vial tubes and transferred to the laboratory at the Department of Crop Protection, Faculty of Agriculture, Federal University Dutsin-Ma for serological test.

Serological detection of legume viruses in cowpea seed samples

The sampled seeds were subjected to Antigen – Coated PlateEnzyme-Linked Immunosorbent Assay (ACP - ELISA) as described by Kumar (2009). Samples were ground in coating buffer at a rate of 100 mg/mL (1:10 w/v). Wells of microtitre plates were coated with 100 µL of each sample. Plates were incubated at 37 ^{o}C for 1 hour, washed thrice at three minutes intervals with Phosphate Buffered Saline-Tween (PBS-T) and tap-dried. One g of healthy cowpea leaf was ground with 20 mL of conjugate buffer. The crude extract was filtered and rabbit antibody for various legume viruses was added at 1:10,000. One hundred µL of this was loaded into each well. The plate was incubated at 37 ^{o}C for 1 hour, washed thrice with PBS-T and tap-dried. This was followed by addition of 100 µL of anti-rabbit, goat anti-mouse diluted with conjugate buffer at the rate of 1:15,000 dilutions. Also, another round of incubation at 37 ^{o}C for 1 hour was performed and plates tap-dried after washing with PBS-T. Substrate was prepared using *p*-nitrophenyl phosphate and diluted in substrate buffer at the rate of 1 mg/ml and 100 µLof the substrate solution was added to each well. The plate was then incubated in the dark at room temperature of 37 ^{o}C. Absorbance values were quantified at 405 nm using a microplate reader (MRX, Dynex Technologies, Inc., USA) after overnight. Values were accepted to be positive when the optical density reading was at least twice that of the mean for the negative controls.

RESULT AND DISCUSSION

Identification of Legume Viruses

Results obtained from the identification of the viruses infecting cowpea seeds in Katsina State, Sudano-sahelian Savanna of Nigeria using ACP - ELISA are shown in Table 1. The results showed the presence of viruses in locations studied. *Blackeye cowpea mosaic virus* (BlCMV), *Cowpea mild mottle virus* (CPMMV), *Cucumber mosaic virus* (CMV) and *Cowpea mottle virus* (CPMoV) were the only viruses detected in the seed samples tested. These viruses occurred in single and mixtures of two or more on at the different markets surveyed. Specifically, BICMV was detected in Kwankwasiya, Mai Fitila and Kanaando varieties in higher concentrations in samples obtained at Ajiwa. Also, CMV was detected in Dan Arba'in and Dan Sayi varieties at Ajiwa, although not as high as BICMV. Same trend was observed with samples collected from the other location with BICMV and CMV as dominant viruses infecting same cowpea varieties with higher concentrations. CPMMV was detected in few samples at Ajiwa and Dutsin-Ma although in a milder/very low concentration while CPMoV was detected in Dan Arba'in and Kananado varieties at Ajiwa, Kwankwasiya had higher concentration of CPMoV at Funtua while at Dutsin-Ma, Mai Fitila and and Kwankwasiya were the major viruses recorded with high concentration.

Table 1: Reaction of cowpea seed samples from selected markets in Katsina State, Nigeria during the 2024 wet season in Enzyme-Linked Immunosorbent Assay (ELISA)

	Polyclonal antibody						
Location & Variety	BICMV	CABMV	CMV	CPMMV	CPMoV	CYMV	SBMV
AJIWA							
Dan Arba'in	0.273	0.132	0.942*	0.314	0.554*	0.269	0.149
Dan Sanyi	0.192	0.119	0.812*	0.21	0.132	0.201	0.231
Kwankwasiya	0.991*	0.173	0.238	0.235	0.157	0.217	0.217
Mai Fitila	0.854*	0.129	0.184	0.359*	0.149	0.142	0.146
Kananado	0.882*	0.171	0.825*	0.176	0.473*	0.187	0.199
FUNTUA							
Dan Arba'in	0.231	0.11	0.502*	0.21	0.11	0.241	0.301
Dan Sanyi	0.421*	0.09	0.411*	0.214	0.211	0.219	0.21
Kwankwasiya	0.426*	0.137	0.536*	0.134	0.788*	0.162	0.146
Mai Fitila	0.208	0.119	0.203	0.201	0.196	0.114	0.106
Kananado	0.132	0.201	0.312	0.119	0.21	0.201	0.201
DUTSIN-MA							
Dan Arba'in	0.093	0.11	0.208	0.239	0.19	0.116	0.119
Dan Sanyi	0.491*	0.217	0.039	0.219	0.22	0.191	0.201
Kwankwasiya	0.835*	0.137	0.544*	0.523*	0.323*	0.169	0.151
Mai Fitila	0.671*	0.167	0.597*	0.276	0.543*	0.186	0.211
Kananado	0.133	0.156	0.201	0.2	0.172	0.11	0.192
Diseased control	2.562	2.138	2.915	2.424	2.876	2.454	2.899
Healthy control	**0.294**	**0.138**	**0.245**	**0.161**	**0.141**	**0.242**	**0.246**
Buffer	0.186	0.128	0.175	0.128	0.178	0.182	0.205

BICMV: *Blackeye cowpea mosaic mosaic virus*; CABMV: *Cowpea-aphid borne mosaic virus;* CMV: *Cucumber mosaic virus*: CPMMV: *Cowpea mild mottle virus*; CPMoV: *Cowpea mottle virus*; CYMV: *Cowpea yellow mosaic virus;* SBMV: *Southern bean mosaic virus*.

The detection of BICMV, CMV, CPMMV and CPMoV at all surveyed markets within the state collaborate the findings of Aliyu *et al.* (2012) who discovered two different types of viruses from the same genus co-existing in the nearby field in Kwara State, Nigeria. However, the implication of this is that subsequent mutation and replication of the viruses could simply result in several serotypes with varying degree of pathogenicity on the one hand and multiple infections of legume crops on the other hand. The occurrence of CPMoV and CPMMV in naturally infected cowpea is believed to be the first report from Katsina State. BICMV was detected at Ajiwa, Futua and Dutsin-Ma in mixture with CMV. Multiple virus infection in field-grown plants modifies symptoms and essentially precludes field diagnosis (Alegbejo, 2015). Shoyinka *et al*. (1997) earlier reported CPMoV and CPMMV in Samaru, Kaduna State which is a neighboring State to Katsina State. In addition, the seed borne nature of CPMoV (Alabi *et al*., 2010), and recent detections suggest that the virus could be spreading through seeds to other parts of the Agro-ecological zone of Nigeria. Odedara (2011) reported CPMoV as seed-borne virus that is considered as major constraint to yield in legume fields, because emerging plants are quickly exposed to viral inocula producing greater damage at early stages of crop plant development and this shows how important the virus could be in the ecological zone.

CONCLUSION AND RECOMMENDATIONS

The survey results provided baseline information on the occurrence and distribution of cowpea viruses in Katsina State. Virus diagnosis showed that four important legume viruses (BICMV, CMV, CPMoV and CPMMV) were prevalent in some specific locations surveyed. There is the need, therefore, for constant monitoring of legume fields through regular disease surveys to identify new and emerging viruses because these facts present a good starting point for legume virus diseases diagnosis in the study area. The ultimate goal of this information has the possibility of designing sustainable management strategies for legume viral diseases. This could be of agricultural importance for food security.

REFERENCES

Abaje, I. B., Sawa, B. A. and Ati, O. F. (2014). Climate Variability and Change, Impacts and Adaptation Strategies in Dutsin-Ma Local Government Area of Katsina State, Nigeria. *Journal of Geography and Geology*. *6*, (2) 103-112.

Alabi, O. J., Kumar, P. L., Mgechi-Ezeti, J. U., Naidu, R. A., 2010. Two new legume viruses (Genus *Begomovirus*) naturally infecting soybean in Nigeria. *Archeology and Virology 155*(5), 643-656.

Alegbejo, M. D., 2015. *Virus and virus-like diseases of crops in Nigeria. Zaria, Nigeria. Ahmadu Bello University Press*. 273p.

Aliyu, T. H., Balogun, O. S., Kumar, L., 2012. Survey of the symptoms and viruses associated with cowpea (*Vigna unguiculata* (L.)) in the Agroecological zones of Kwara State, Nigeria. *Ethiopian Journal of Environment Study Management 5*(4), 613-619.

Bashir, M., Ahamad, Z., Ghafoor, A., 2008. Cowpea aphid-borne mosaic potyvirus: A review. *International Journal of. Pest Management 48*, 155-168.

Dugje, I.Y., L.O. Omoigui, F Ekeleme, A.Y. Kamara and H. Ajeigbe (2009). *Farmers' Guide to Cowpea Production in West Africa*. IITA, Ibadan, Nigeria, 5-12

Kumar, L., 2009. Methods for the diagnosis of Plant Virus diseases. Laboratory Manual, Ibadan IITA. 94p.

Odedara, O. O, Hughes, J., Odebode, A. C., Tarawali, S. A., 2011. Survey of viruses infecting herbaceous forage legumes in Nigeria. *Academy Journal Plant Science 4*(3), 69-76.

Shoyinka, S. A., Thottappilly, G., Adebayo, G. G., Anno-Nyako, F. O., 1997. Survey on cowpea virus incidence and distribution in Nigeria. *International Journal of Pest Management 43*(2), 127-132.

Singh, B. B. Terao, T. T, and S. K. Asante (1995) Highlights of IITA's cowpea research relevant to Northern Nigeria. Paper presented at IAR/ABU campus (Zaria).

Climate-Smart Pest Management in Nigerian Agroecosystems: A Holistic Approach to Mitigating Insect Pest Outbreaks and Safeguarding Food Security through Interdisciplinary One Health Strategies

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Abstract
Climate-smart pest management (CSPM) is a transformative approach designed to enhance food security in Nigerian agroecosystems. This study investigates the efficacy of CSPM strategies in mitigating insect pest outbreaks through the lens of interdisciplinary One Health strategies. Conducted in Abeokuta, Southwest Nigeria, over two years (2021 and 2022), the study used a randomized complete block design (RCBD) with four treatments: climate-adapted pest-resistant crop varieties, biological control agents, integrated pest management (IPM) practices, and a control group with no intervention. Each treatment was replicated across 20 plots (5 x 5 m each) per cropping season. Empirical results reveal a significant reduction in pest incidence by 45% ($p < 0.05$) in IPM-treated plots and a 30% increase in crop yield. Furthermore, climate-adapted varieties exhibited a 55% reduction in pest damage compared to control plots. These findings underscore the effectiveness of CSPM strategies in promoting sustainable agricultural practices and safeguarding food security. The data suggest that employing CSPM, underpinned by One Health principles, provides a holistic framework for managing insect pests in a changing climate. Adopting these practices is critical for enhancing resilience against pest outbreaks, securing livelihoods, and ensuring environmental sustainability.
Keywords: climate-smart pest management, Nigerian agroecosystems, One Health strategies, insect pest outbreaks, food security, integrated pest management, sustainable agriculture

INTRODUCTION
Agricultural productivity in Nigeria is significantly threatened by the increasing prevalence of insect pest outbreaks, exacerbated by climate change. As one of the most diverse agroecological zones in Africa, Nigeria's farming systems are vulnerable to pests such as *Helicoverpa armigera*, *Spodoptera frugiperda*, and *Bemisia tabaci*, which threaten food security by reducing crop yields (FAO, 2022). In response, the aim of Climate-Smart Pest Management (CSPM) has emerged as a multidimensional strategy safeguarding agricultural production through sustainable pest control measures. CSPM integrates climate adaptation, mitigation, and resilience-building strategies to manage pest populations while minimizing adverse environmental impacts (Pretty *et al*., 2018). This approach is grounded in the principles of One Health, which recognizes the

interconnectedness of human, animal, and environmental health (WHO, 2020). CSPM encompasses pest-resistant crop varieties, biopesticides, and ecological pest management practices that enhance biodiversity, promote ecosystem services, and reduce reliance on synthetic pesticides (Schroth *et al*., 2015). The relevance of CSPM in Nigerian agroecosystems cannot be overstated. With over 70% of Nigeria's population engaged in agriculture, pest outbreaks severely undermine livelihoods and food security (Nwankwo *et al*., 2021). Climate change has further complicated pest dynamics, leading to altered pest distribution, increased pest incidence, and the emergence of new pests (IPCC, 2019). Thus, there is an urgent need to develop adaptive pest management strategies that are robust, sustainable, and inclusive. Research has demonstrated the potential of CSPM to reduce pest populations and enhance crop productivity under changing climatic conditions (Jactel *et al*., 2019). However, there is a shortage of empirical data applying these strategies in the Nigerian context. This study addresses this gap by evaluating the effectiveness of CSPM practices in mitigating pest outbreaks in Nigerian agroecosystems. Specifically, the integration of pest-resistant varieties, biological control agents, and integrated pest management (IPM) within a holistic One Health framework were explored. By doing so, we aim to provide evidence-based recommendations for policymakers, researchers, and farmers to adopt climate-resilient pest management practices.

Objectives:
This study aims to:
(i) Assess the effectiveness of climate-adapted pest-resistant crop varieties in reducing insect pest incidence.
(ii) Evaluate the role of biological control agents in managing insect pests.
(iii) Determine the effect of integrated pest management (IPM) practices on crop yield and pest population dynamics.
(iv) Examine the broader implications of CSPM on environmental sustainability and food security.

MATERIALS AND METHODS

Study Area

The study was conducted over two years (2021-2022) in Abeokuta, Southwest Nigeria, characterized by a tropical climate with distinct wet and dry seasons. The average annual rainfall is 1,200 mm, and temperatures range from 22°C to 33°C. The soil type is predominantly sandy loam, suitable for diverse agricultural practices (Olaniyi *et al*., 2020).

Experimental Design

A Randomized Complete Block Design (RCBD) was employed, with four treatments: (1) climate-adapted pest-resistant crop varieties, (2) application of biological control agents (e.g., parasitoids, predators), (3) integrated pest management (IPM) practices combining cultural, mechanical, and chemical methods, and (4) a control group with no intervention. Each treatment was replicated across 20 plots (5 x 5 m) per cropping season, totaling 80 plots per season.

Sample Collection and Data Analysis

Pest incidence data were collected weekly using visual counts and light traps. Yield data were obtained at harvest by measuring crop biomass and grain weight per plot. Soil samples were analyzed for organic matter, pH, and nutrient content to determine the impact of treatments on soil health. The data were analyzed using ANOVA, and significant means were separated using Turkey's HSD test at $p < 0.05$. Standard Error of the Mean (SEM) values were attached to all figures, and mean separations were indicated with alphabetical superscripts.

Climate-Adaptive Pest Management Strategies

Climate-adapted pest-resistant crop varieties were selected based on their documented resilience to specific pest species and adaptability to local climatic conditions (Anderson *et al*., 2021). Biological control agents, such as *Trichogramma spp.*, were released at predetermined intervals to manage pest populations. IPM practices, including crop rotation, intercropping, and using neem-based biopesticides, were implemented to enhance pest suppression.

Data Presentation

Data were presented in tables showing the two years of data collection. Each table displayed the average pest incidence, crop yield, and associated SEM, with comparisons between the years to highlight trends and treatment effects. All statistical analyses were conducted using SPSS (Version 27).

RESULTS AND DISCUSSION

The results of this study indicate a significant reduction in pest incidence across all CSPM treatments compared to the control (Table 1). Applying IPM practices resulted in a 45% reduction in pest incidence ($p < 0.05$) and a 30% increase in crop yield relative to the control group. Using climate-adapted pest-resistant varieties demonstrated a 55% reduction in pest damage, significantly outperforming the control plots.

Table 1: Pest Incidence and Crop Yield Under Different CSPM Strategies (2021-2022)

Treatment	2021 Pest Incidence (%)	2022 Pest Incidence (%)	2021 Crop Yield (kg/ha)	2022 Crop Yield (kg/ha)
IPM	10.5^{a}	8.2^{b}	$3{,}200^{a}$	$3{,}450^{b}$
Biological Control Agents	12.0^{a}	10.0^{b}	$2{,}950^{a}$	$3{,}100^{b}$
Pest-Resistant Varieties	9.8^{a}	7.5^{b}	$3{,}500^{a}$	$3{,}600^{b}$
Control	18.5^{c}	20.0^{d}	$2{,}500^{c}$	$2{,}400^{d}$
SEM	0.05	0.06	0.07	0.08

Different superscript letters within the columns indicate significant differences ($p < 0.05$) according to Turkey's HSD test.

This research shows strong evidence that a Climate Smart Pest Management (CSPM) approach may successfully decrease insect infestations in Nigerian agroecosystems. Statistics demonstrate that IPM systems incorporating cultural, mechanical, and controlled chemical treatments drastically reduced insect populations and boosted crop output. These results are consistent with past studies that underlined the benefits of IPM in pest control in diverse agroecological zones (Gurr *et al*., 2016). The efficacy of climate-adapted pest-resistant cultivars in reducing insect damage by 55% highlights their potential as a vital component of CSPM initiatives. This is comparable to the findings of Anderson *et al*. (2021), who obtained identical outcomes in other tropical locations. Furthermore, the observed decrease in pest abundance produced by biological control agents stresses the significance of using natural enemies to keep pest populations below economic threshold level (Jactel *et al*., 2019). The differences in performance between the two years of treatment suggest that climatic variations may affect the effectiveness of these strategies. This highlights the need for adaptive management approaches that reflect local climatic conditions and pest dynamics. The findings' broader implications propose that a CSPM strategy based on One Health principles offers a sustainable pathway to strengthening agricultural resilience in Nigeria.

CONCLUSION AND RECOMMENDATIONS

This study demonstrates the potential of Climate-Smart Pest Management (CSPM) strategies to mitigate insect pest outbreaks and safeguard food security in Nigerian agroecosystems. The findings show that integrated pest management practices, climate-adapted pest-resistant varieties, and biological control agents significantly reduce pest incidence and increase crop yield. Implementing Climate-Smart Pest Management (CSPM) approaches in Nigerian agroecosystems may effectively translate to food security and reduction of insect pest outbreaks. The strategies include integrated pest management systems, pest-resistant cultivars tailored for climatic circumstances, and biological control agents. They complement sustainable agriculture and One Health aims and offer a comprehensive strategy to control insect populations in the face of climate change. Further research is needed to understand the long-term effects of CSPM techniques on biodiversity, soil health, and ecosystem services.

REFERENCES

Anderson, P., Jactel, H., Gurr, G. M., Verheggen, F., Duyck, P. F., Watts, N., & Heong, K. L. (2021). Climate-esilient pest management strategies in tropical agroecosystems. *Journal of Pest Science, 94*(3), 321-334.

FAO. (2022). The State of Food Security and Nutrition in the World 2022. Rome: Food and Agriculture Organization.

Gurr, G. M., Wratten, S. D., & Luna, J. M. (2016). Multi-function agricultural biodiversity. *Agricultural Systems*, *123*, 1-8.

IPCC. (2019). Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems. Geneva: Intergovernmental Panel on Climate Change.

Jactel, H., Nicoll, B. C., Branco, M., et al. (2019). The influence of forest management practices on pest and disease dynamics in oak forests. *Forest Ecology and Management*, *418*, 25-34.

Nwankwo, C., Okoye, C., & Afolabi, O. (2021). Pest management in Nigeria's agricultural landscape: Challenges and opportunities. *African Journal of Agricultural Research*, 16(8), 1094-1103.

Olaniyi, J. O., Kolawole, A. O., & Adewale, B. O. (2020). Soil characterization and its effect on crop production in Southwest Nigeria. *Soil Science Society of Nigeria Journal*, 30(1), 71-80.

Pretty, J., Benton, T. G., Bharucha, Z. P., et al. (2018). Global assessment of agricultural system redesign for sustainable intensification. *Nature Sustainability*, *1*(8), 441-446.

Schroth, G., Laderach, P., Dempewolf, J., et al. (2015). Climate change and agricultural pests. *Environmental Research Letters*, *10*(8), 085012.

WHO (2020). One Health: Joint Plan of Action for Global Health Security. Geneva: World Health Organization.

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Effects of Shea Butter Processing on Livelihood Status of Rural Women in Niger State, Nigeria

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Abstract
This study was conducted to assess effects of Shea Butter Processing on Livelihood Status of Rural Women in Niger State, Nigeria. Three-stage sampling procedure was used to select 212 respondents for the study; Data were collected from primary source using semi-structured questionnaire complemented with interview schedule. Data collected were analyzed using both descriptive statistics (such as means, percentages and frequency distribution) and inferential statistics (such as Simpson livelihood index and ordered logit regression). The result of the findings indicated that considerable proportion (69.8%) had a moderate level of shea butter processing, 28.3% had a low processing level, and only 3.8% had a high level of processing. Also, 69.3% of women shea butter processors had moderate livelihood status while 25.0% had low livelihood status with only few (5.7%) who had high livelihood status. The findings also revealed that quantity of shea butter processed ($p < 0.01$), processing experience ($p < 0.01$) and years spend in school ($p < 0.05$) were the factors influencing livelihood status of women shea processors. The study recommended that women should be supported with credit facilities like their male counterparts in order to improve their livelihood

Keywords; shea, butter, livelihood, rural and women

INTRODUCTION

Shea nut tree is indigenous to Sub-Saharan Africa and belongs to the family *Sapotaceae*. Based on distribution, two species of the plant have been identified *Vitellaria paradoxa* and *Vitellaria nilotica. Vitellaria paradoxa* is commonly known as the African shea tree or shea butter tree (Aidoo *et al.*, 2017). It is predominantly found in the West African sub-region, covering countries such as Ghana, Nigeria, Burkina Faso, Mali, and Cote d'Ivoire, while *Vitellaria nilotica* often referred to as the East African Shea tree, mainly grown in Northern Uganda and Southern Sudan (Okullo, 2020). It is a dicotyledonous woody plant that grows typically in the savannah and naturally stretches over Africa in the Northern hemisphere from Southeastern Senegal to Ethiopia and Uganda (Aidoo *et al.*, 2017). The plant thrives naturally in the dry savannah belt of West Africa from Senegal in the west to Sudan in the East, and onto the foothills of the Ethiopian highlands. It occurs in 19 countries across the African continent, namely Benin, Ghana, Chad, Burkina Faso, Cameroon, Central African Republic, Ethiopia, Guinea Bissau, Cote D'Ivoire, Mali, Niger, Nigeria, Senegal, Sierra Leone, Sudan, Togo, Uganda, Zaire and Guinea (Tano-Debrah *et al.,* 2019). Thus, covers a swath of the continent, that is 5,000km long and 400 – 750km wide (Zan *et al.,* 2020).

Nigeria is abundantly blessed with Shea trees (*vitellaria paradoxa*) which could be harnessed for the industrial development of the country. Currently, Shea trees grow in the wild across many states in Nigeria, including Niger Nasarawa, Kebbi, Kwara, Kogi, Adamawa, Benue, Edo, Katsina, Plateau, Sokoto, Zamfara, Taraba, Borno, and Oyo (Diop *et al.,* 2020). Nigeria has the largest Shea trees in the world and accounted for over 50 percent of the shea butter production in West Africa with a total trade value of $400,000 (Food and Agriculture Organization (FAO), 2018; Diop *et al.,* 2020). The Shea tree plays a vital role in maintaining biodiversity in the regions where it grows, providing habitat and sustenance to various wildlife and plant species. Additionally, the tree's deep root system helps prevent soil erosion and contributes to soil fertility, making it an essential component of sustainable land management in the Nigeria (Okullo, 2020). The white ivory colour fat extracted from the nut is called Shea butter which has many uses as edible oil, chocolate and beverage as well as pharmaceutical and cosmetic industries (Diop *et al.,* 2020).

Shea butter processing in Niger State holds significant importance as it serves as a key driver of socio-economic development in the producing areas of the State. The production encompasses various stages (picking of shea nut - marketing). Each stage contributes to the production of the valuable commodity (shea butter) with diverse applications in industries such as cosmetics, pharmaceuticals and food. The shea butter processing in Nigeria which is primarily driven by the efforts of rural women, is confronted with several challenges that influence both the quality of the end product and the socio-economic status of these women. The inefficient traditional processing methods, characterized by manual labour and rudimentary equipment may contribute to suboptimal yield and quality of the shea butter produced. Moreover, the lack of access to modern processing technologies and training limits the value addition potential of shea butter, affecting the income and livelihood status of the women involved.

The existing studies conducted by Ololade and Ibrahim (2014) in Kwara State, Nigeria and Abdullahi (2020) in the Northern Region of Ghana have provided insights into the contributions of shea butter processing to poverty reduction and income generation among rural women. These studies shed light on the significance of shea butter-related activities in enhancing the economic well-being of women. Additionally, Tanzile *et al*. (2021) conducted same studies in the North-Western region of Ghana on effects shea butter processing on livelihood status of rural women. However, despite the wealth of knowledge generated from these studies, there remains a dearth of empirical evidence in the literature pertaining to the effects of shea butter processing on the livelihoods of rural women in the Nigeria. The identified knowledge gap in literature necessitates the conduct of this research which is to assess the effects of shea butter processing on the livelihood status of rural women in Niger State, Nigeria.

METHODOLOGY

The study was conducted in Niger State. Niger State is located between Latitudes 8°22'N and 11°30'N and Longitudes 3°30'E and 7°20'E. The State covers an estimated total land area of 74.244sq.km, which is about 9.3% of Nigeria's total land area (Kolapo and Adeyera, 2021). The population of the State is 3,950,249, comprising 2,082,725 males and 1,867,524 females (National Population Commission (NPC), 2006). The projected population of the State as at 2021 was 5,644,139 at 3.2% population growth (National Bureau of Statistics (NBS), (2022). The average annual rainfall in the State is 1,219 mm. Three-stage sampling procedure was 212 employed to select Shea butter processors in the study area. Data collected were analyzed using both descriptive statistics (such as means, percentages and frequency distribution) and inferential statistics (such as Simpson livelihood index and ordered logit regression).

RESULTS AND DISCUSSION

Level of shea butter processing

Table 1 reveals the level of shea butter processing among rural women, showing that a considerable proportion (69.8%) had a moderate level of shea butter processing, 28.3% had a low processing level, and only 3.8% had a high level of processing. This suggest that most of women shea butter processors operate at a moderate processing level, indicating that they possess a decent understanding for producing shea butter. They likely use a combination of traditional and semi-improved techniques, resulting in reasonably good quality and quantity of shea butter. However, being at a moderate level means there is substantial room for improvement in terms of efficiency, product quality and scalability. Enhancing their skills through training and providing access to better equipment and technologies could elevate their processing capabilities to a higher level, thereby increasing their productivity and livelihood status. This is in tandem with the study of kosa and Ujah (2016) in Northern Nigeria who reported that 80% of rural women engaged in shea butter processing operated at a moderate level, reflecting their ability to produce shea butter using traditional methods and tools.

Table 1: Level of shea butter (n=212)

Output (kg)	Variables	Frequency	Percentage
100 – 400	Low	60	28.3
500 – 900	Moderate	144	67.9
>900	High	8	3.8

Sources: Field survey, 2024

Livelihood status

Table 2 present the result of livelihood status of women shea butter processors in the study area. It showed that 69.3% of women shea butter processors had moderate livelihood status while 25.0% had low livelihood status with only few (5.7%) who had high livelihood status. This implies that most of shea butter processors had moderate livelihood status which could be attributed to their involvement in shea butter processing. Many women in the study area have acquired essential skills in shea butter processing, allowing them to produce and market their products effectively. Thus, this activity provides a steady source of income, enabling women to meet their basic needs and support their households. This steady income helps improve their overall financial stability and contributes to a moderate livelihood status. This is corroborate the study of Akosa and Ujah (2018) who found that most rural women engaged in shea butter processing in Kwara State had moderate livelihoods status, indicating a level of economic security and stability.

Table 2: Distribution of rural women shea butter processors according to livelihood status (n=212)

Livelihood status	Livelihood class	Frequency	Percentage
High	$\geq$67	12	5.7
Medium	0.34-0.66	147	69.3
Low	$\leq$ 0.33	53	25.0

Sources: Field survey, (2024)

Effect of shea butter processing on livelihood status of rural women

Table 4.8 present the results of ordered logit regression on effects of shea butter processing on livelihood status of rural women. The pseudo R-squared value was 0.7314 which indicates that the independent variables in the model explained approximately 73% of the variation in the dependent variable (livelihood status). The log-likelihood was -49.75164 indicating that the model is a good fit for the data, as it represents the maximum value of the likelihood function. The Chi square 79.10 p-value of 0.0000 for the likelihood ratio test (which is typically the F-test of overall significance) indicates that the regression model as a whole is statistically significant. This means that at least one of the independent variables in the model is significantly related to the dependent variable. Therefore, the model is a good fit for the data and provides a meaningful explanation of the relationship between the independent variables and the dependent variable.

Table 4.8: Effects of shea butter processing on livelihood status of rural women (n=212)

Variable	Coefficient	Standard error	Z-value
Quality processed	0.2346	0.0569	4.12***
Processing experience	0.0237	0.0086	2.76***
Distance to market	-0.0017	0.0081	-0.21
Access to credit	22.27	1245.	0.02
Years spent of school	0.0241	0.0110	2.19**
Income	2.24E-06	2.11E-06	1.07
Household expenditure	-0.1248	0.0671	-1.86*
Distance to sources of water	-0.1913	0.0846	-2.26**
Pseudo R^2	0.7314		
Prob > chi2	0.0000		
Log likelihood	-49.751648		

Sources: Field survey, 2024, Note: *** = significant at 1%, **= significant at 5%

The coefficient quantity of shea butter processed (0.2346; $p < 0.01$), processing experience (0.0237; $p < 0.01$) and years spend in school (0.0241; $p < 0.05$) were positive and statistically, implying that a unit increase in those variables will increase the likelihood of improving the livelihood status of women shea processors. Darkwa *et al*. (2015) reported that women who produced higher quantities of shea butter, had more experience in processing, and had higher levels of education were more likely to have higher incomes and better livelihoods. The coefficient for quantity of shea butter processed is (0.2346), indicating that higher production levels are associated with better livelihood status. Increased production allows women processors to generate higher incomes from their sales. This increase in income can improve their ability to meet household needs, invest in better processing equipment and expand their operations. Additionally, higher production volumes can enable women to access larger markets and negotiate better prices, further enhancing their financial stability.

The coefficient for processing experience is (0.0237), highlighting the importance of experience in improving livelihood status. Experienced women processors are likely to have skills, leading to higher quality and more efficient production. This expertise can result in better products that fetch higher prices in the market, contributing to improved income and economic stability. The coefficient for years spent in school is (0.0241), highlights the role of education in enhancing livelihood status. Education equips women with critical thinking skills, literacy and numeracy, which are essential for effective business management. Educated women are better able to adopt new technologies, understand market dynamics, and manage their finances. They are also more likely to access and utilize information from various sources, including extension services and digital platforms. More so, the coefficients for household expenditure (0.1248; $p< 0.10$) and distance to sources of water for processing (0.1913; $p < 0.05$) were negative and statistically significant implying that increase in any of these variables is associated with a decrease in livelihood status of women shea butter processors. The negative coefficient for household expenditure (0.1248) suggests that higher household expenses are associated with a decrease in livelihood status. This could be because increased household expenditure reduces the disposable income available for reinvestment in shea butter processing. High household expenses may include costs related to food, healthcare, education and other essential needs, which can drain financial resources that could otherwise be used to improve processing efficiency, purchase better equipment, or expand production. Asem (2020) found that rural households that spent more on non-essential items, such as alcohol and tobacco, were less likely to have high livelihoods status, as this decreased their savings and reduced their ability to invest in income-generating activities.

The negative coefficient for distance to sources of water for processing (0.1913) indicates that longer distances to water sources are associated with a decrease in livelihood status. Water is a critical resource in shea butter processing, and having to travel long distances to access water can significantly reduce productivity. The time and effort spent on fetching water could otherwise be used for processing activities, leading to lower production volumes and reduced income. Furthermore, transporting water over long distances can increase the cost and physical strain on the processors. This is similar to the study of Akulaku *et al.* (2018) who reported that the distance to water sources was a significant factor affecting the livelihoods of rural women in Northern Nigeria. Women who had to travel long distances to fetch water for processing and other household needs had less time for productive activities, reducing their income and overall livelihood status.

REFERENCES

Abdullahi, A. (2020). The impact of shea butter processing on poverty reduction and income generation among rural women in Northern Ghana. *Journal of Agricultural Economics and Development*, *12*(4), 112-123.

Aidoo, R., Osei-Asare, Y., & Osei-Asare, A. (2017). Shea butter production and its contribution to rural livelihoods in Northern Ghana. *International Journal of Agricultural Policy and Research*, *5*(3), 120-130.

Akosa, P., & Ujah, F. (2018). The socio-economic contributions of shea butter processing to rural women's livelihood in Kwara State, Nigeria. *Journal of Rural Development and Agriculture*, *14*(2), 55-67.

Akulaku, D., & Awoyemi, A. O. (2018). Challenges in shea butter processing: A case study of women in Northern Nigeria. *International Journal of Agricultural Extension and Rural Development Studies*, *6*(2), 37-49.

Asem, A. (2020). The relationship between household expenditure and livelihood status among rural households in Sub-Saharan Africa. *African Journal of Development Studies, 5*(2), 44-60.

Darkwa, B., Gbogbo, F., & Danquah, L. O. (2015). Experience, education, and income effects on women’s livelihood in rural shea butter processing. *Journal of Development Economics*, *17*(1), 99-115.

Diop, D., Zongo, N., & Traore, F. (2020). Shea butter industry and its role in socio-economic development in West Africa: Nigeria's potential. *African Journal of Agricultural Research*, *15*(9), 1234-1242.

Food and Agriculture Organization (FAO). (2018). Shea nut and butter production in West Africa. Retrieved from http://www.fao.org/shea-butter-production-2018

Kolapo, A. & Adeyera, A. (2021). Environmental factors influencing agricultural production in Niger State, Nigeria. *Journal of Sustainable Agriculture and Environmental Management*, *9*(1), 47-59.

Kosa, K., & Ujah, S. (2016). Shea butter production: The role of rural women in Northern Nigeria. *Journal of Rural Sociology*, *18*(1), 12-21.

National Bureau of Statistics (NBS). (2022). Niger State population estimates. Abuja, Nigeria.

National Population Commission (NPC). (2006). *Nigerian population census report*. Abuja, Nigeria.

Okullo, J. B. L. (2020). The East African shea tree: Vitellaria nilotica and its role in rural livelihoods. *Journal of Sustainable Forestry*, *39*(5), 421-432.

Ololade, R. A., & Ibrahim, A. (2014). Shea butter processing as a means of livelihood for rural women in Kwara State, Nigeria. *International Journal of Agriculture and Food Sciences*, *6*(2), 56-61.

Tano-Debrah, K., Kwakye, K., & Osei-Yeboah, S. (2019). Shea butter: A natural resource for development in Sub-Saharan Africa. *Sustainability in Agriculture and Food*, *3*(2), 223-232.

Tanzile, F., Osei, B., & Nyarko, K. (2021). Shea butter production and livelihood enhancement: Evidence from North-Western Ghana. *Journal of Economic Development in Africa*, *25*(4), 188-205.

Zan, M. W., Khan, R. S., & Osman, F. A. (2020). The economic potential of shea butter in the global market. *Global Business and Economic Review*, *22*(7), 96-105.

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Pretreatment of Lignocellulose Biomass for Biofuel Production

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Abstract

Lignocellulosic biomass (LCB) such as crop residues, debarking wastes, forest residues or forage grasses are the most attractive renewable bioenergy sources and are abundantly found in waste. Biofuels produced from lignocellulose biomasses have the potential to be a valuable substitute for fossil fuels. The goal of pretreatment is to make the cellulose accessible to hydrolysis for conversion to fuels. Various pretreatment methods such as physical and chemical methods change the physical and chemical structures of lignocellulosic biomass and improve the hydrolysis rates. This paper provides an overview and brief discussion on various pretreatment methods. The success in biofuel production strongly depends on the pretreatment method used. Overall, pretreatment is the major step in the successful production of biofuel from lignocellulosic biomass.

Keywords: Biofuel; hydrolysis; Lignocellulosic biomass; Pretreatment, Biofuel.

INTRODUCTION

Lignocellulos's biomass (LCB) is an organic residue which consists of mainly cellulose, lignin and hemicelluloses, whose basic units are sugars that can be fermented into ethanol or other chemicals (Miller, 1999). These structural materials are produced by plants to form the cell walls of leaves, stems, stalks, and woody portions of the plant. The carbohydrate polymers (cellulose and hemicelluloses) are tightly bound to the lignin. Up to 80% of the lignocelluloses are polysaccharide (Kaparaju *et al.,* 2009). Lignocelluloses plant structures also contain a variety of plant-specific chemicals in the matrix, called extractives (resins, phenolics, and other chemicals), and minerals (calcium, magnesium, potassium, and others). Examples of LCB include: straw, sugar beet pulp, alfalfa, corn stover, crop residues, debarking waste, forage grasses, forest residues, municipal solid waste, paper mill residue, pomace, scraps and spoilage (fruit and vegetable processing), sawdust, spent grains, spent hops, switch grass, waste wood chips, wood chips among others. The content of the cellulose, hemicelluloses and lignin varies according to different types of biomasses (Kaparaju *et al.,* 2009).

MATERIALS AND METHODS

Pretreatment

Pretreatment is the process through which the cellulose component is exposed to and made more susceptible to enzymatic hydrolysis. The pretreatment techniques involve a synergism between the heat action, the medium pH and the time of exposure under process conditions. This results in a decrease in cellulose crystallinity, and consequently, making it more susceptible to the action of cellulases (Lynd *et al.,* 2002).

Because of the difference of the structure and composition of the lignocellulosic matter in different sources, the choice of one pretreatment method as the best is rather illogical and not possible. The choice of pre-treatment method used depends a lot on the source of the matter, its composition, the subsequent method of hydrolysis the pretreated matter will be subjected to, and several other factors and parameters (Anindita and Ashwani, 2013).

Mechanical Pretreatment Methods
All lignocelluloses feedstock needs some basic mechanical breaking down or tearing up before further action can be taken. The mechanical methods mainly involve commination and extrusion. Comminuting of the material through fragmentation, chipping, milling or grinding is an essential step in most pretreatment methodologies. During extrusion, the feedstock is exposed to heating, mixing and shearing leading to physical and chemical changes (Karunanithy, 2008). The objective of these procedures is to reduce the particle size and crystallinity of lignocellulose in order to increase the surface area and reduce the degree of polymerization. However, the high energy requirement of these processes makes it uneconomically feasible on a large scale especially as a sole pretreatment method (Karunanithy, 2008).

Steam Explosion pretreatment Method
This is reported to be an efficient pretreatment technique that is carried out by compression with steam followed by explosive decompression. In this method, the lignocellulosic material is placed under high pressure steam of 7-50 atm at a temperature of 160-190^{o}C, followed by a sudden decrease of the pressure resulting in a violent explosion causing the structural matrix of the lignocellulosic material to rupture (Sun and Cheng 2002; Negro *et al.,* 2003). This results in a wet solid material with a disorganized lignocellulosic complex (cellulignin) and a liquid phase which can be extracted by explosion. The resultant matter is basically composed of: xylose, xylo-oligosaccharides and uronic and acetic acids. During the process, there is partial hydrolysis of hemicellulose, especially of highly acetylated xylanase. Thus, the process is also called “autohydrolysis” (Negro *et al.,* 2003).

Catalyzed Steam-Explosion
This involves the use of chemical agents in steam explosion technology to increase its process efficiency. The main reagents used are sulfuric acid with concentration varying between 0.1 and 5% v/v and sulfurous anhydride. The material is either soaked in the sulfuric acid before the steam explosion process or exposed to a mixture of steam and sulfurous anhydride. The temperature range and the exposition time are similar to the simple steam-explosion (Lynd 1996; Ogier *et al.,* 1999; Hamedinck *et al.,* 2005). Other chemical substances such as the carbonic gas (Hohlberg *et al.,* 1989), and ammonium or ammonia fiber Explosion (AFEX) are also used (Teymouri *et al.,* 2005). AFEX process treats the biomass in liquid ammonia for 15 mins at 50^{o}C, and later subjected to high pressure for different periods of time (Holtzapple *et al.,* 1991). The pressure is then rapidly released resulting in a sudden gaseous expansion that causes swelling and physical disruption of fibers and partial decrystallization of cellulose. However, the process becomes burdensome for raw materials with high lignin content (Wyman *et al.,* 2005). Glasser *et al.,* 1998 reported that the steam-explosion method enhanced the recovery of pentoses in the liquid stream from 45 to 65%, in the simple steam explosion technology to 80-90%.

Liquid Hot Water (LHW) Pretreatment
This method utilizes pressurized hot water at a pressure of less than 5 Mpa and temperature range of 170–230ºC for several minutes followed by decompression down to atmospheric pressure (Bobleter *et al.,* 1979). The solubilized hemicelluloses and lignin are present in low concentrations, while the water and energy demand are high. According to some authors this technology which is also called thermohydrolysis, involves the washing of the material with pre-heated water under high pressure and temperature of about 220ºC for 2 minutes. However, in addition the efficiencies of this process are low, when compared with the steam-explosion or with the acid prehydrolysis (Mosier *et al.,* 2005).

Thermo-chemical processes
These generally involve the use of extremely high temperatures and pressures. For example, in gasification, where the biomass is transformed into synthetic gas or "syngas" (a mixture of hydrogen and carbon monoxide) and pyrolysis, which involves the heating of organic material in the absence of oxygen. These methods also produce a wider variety of fuels than biochemical conversion processes (Larson, 2008).

Alkaline Pretreatment
This is frequently used to increase the digestibility of lignocellulosic materials. The process was originally developed in the paper and pulp industry in the pulping processes to attain paper with long fiber because of their lignin content. The normal conditions used in this pretreatment procedure are concentration of NaOH constituting 8-12% of the dry biomass to be treated, time of treatment which is between 30-60 minutes and a temperature range of 80-120ºC (Mosier *et al.,* 2005). The major disadvantages of this procedure are the prohibitive price of caustic soda and its difficult retrieval.

Alkaline Peroxide pretreatment
An alternative to the alkaline pretreatment is the simultaneous use of hydrogen peroxide (H_2O_2). The delignification with hydrogen peroxide depends strongly on the pH the feedstock is subjected to, the dissociation occurring at a pH around 11.5. The dissociation results in the creation of extremely reactive radicals, which solubilize the lignin and oxidizes it. This process is also operated, at times, in two phases- the first part makes use of caustic soda and the second soda and peroxide. The oxidative delignification with peroxide occurs at low temperatures from 25 to 40ºC. The generated residues have a low concentration of pollutants. Another highly oxidizing agent which selectively breaks the lignin structure is the peracetic acid. It opens up the aromatic rings of the lignin, forming dicarboxylic acids and their lactones (Teixeira *et al.,* 2000). This process also can be operated in two phases, like in peroxide, to minimize the costs with peracetic acid, since its price is high (Sun and Cheng 2002; Ogier *et al.,* 1999; Hamedinck *et al.,* 2005).

Organo-solvent pre-treatment
This involves the use of diluted alkalis with solvents such as ethanol, acetone, methanol, ethylene glycol tetrahydrofurfuryl alcohol, etc. This method achieves considerably high removal of lignin with minimal loss of cellulose and relatively pure lignin recovery (Zheng *et al.,* 2009). The chief advantage of the alkaline or the alkaline-oxidative pre-treatment is the low energy consumption although the process present some potential disadvantages. Strong alkaline environments can convert the hemicelluloses into saccharinic acids, which cannot be fermented, and oxidize the lignin forming phenolic monomers and oligomers, which inhibit the subsequent biotransformation steps (Zheng

et al., 2009). The organosolv process is considered a promising alternative for the delignification process. However, the process is not economic and research on this area is still going on. Other problems are the hurdle of inhibitors which presently is not fully resolved.

Acidic pretreatment methods

The acidity of the medium is one of the basic aspects for creating an efficient pretreatment method. Thus, the acid pretreatment processes, especially the ones which utilize diluted sulfuric acid, are more and more preferred in pretreatment method. The fast reaction rates and the low consumption of acid combined with its low cost, when compared with alkalis, comprise added advantages of these processes. Again, the disadvantages are the corrositivity and depending on the imposed conditions of operation, and the formation of inhibitors. The acid concentration for this method is between 0.1 - 5% at temperatures of 110 - 220ºC, and an exposition time of 10-180 minutes. Various research reports have indicated that the multi-stage pretreatment achieves higher efficiency and reduces the consumption of cellulases during the enzymatic hydrolysis phase (Mosier *et al.,* 2005).

Enzymatic pretreatment

The enzymatic pretreatment, aims at the hydrolysis of the hemicelluloses and the delignification. There are two major types of lignolytic enzymes widely used. These are the phenol oxidase (laccase) and peroxidases (lignin peroxidase (LiP) and manganese peroxidase (MnP) (Krause *et al.,* 2003). Other enzymes also used, but whose mode of action are not clearly known are glyoxal oxidase, glucose oxidase, oxidoreductase and methanol oxidase. In the case of the hydrolysis of the hemicelluloses, in spite of the specificity of xylanases, where the action is carried out through the synergy of the β-xylosidase, endo 1,4-β-xylanases, α-glucuronidase and L-arabinofuranosidase enzymes, hurdles exist in the form of high cost of enzyme and adequate scale up to industrial level. The main area of application is the paper and pulp industry, where such enzymes are used to convert to chlorine and chorine derivative substances. This creates another problem due to the irreversible tendency of total chlorine free bleaching (TCF systems) and elemental chlorine free (ECF systems) (Viikari *et al.,* 1994).

Irradiation

The use of irradiation with micro-waves has been a target of some researches (Saritha *et al.,* 2012). Commonly used conditions are irradiation at 240 W per 10 minutes. However, contrary to all described pretreatment technologies, irradiation is still studied on bench scale, and remains uncertain about its application on an industrial scale, in view of the inherent energy demand for the process (Saritha *et al.,* 2012).

CONCLUSION AND RECOMMENDATIONS

Pretreatment technologies for lignocellolosic biomass alter various feedstock characteristics at various levels. Because of the difference in the structure and composition of the lignocellulosic matter in different sources, the choice of one pretreatment method as the best is rather illogical and not possible. The choice of pre-treatment method used depends a lot on the source of the matter, its composition, the subsequent method of hydrolysis the pretreated matter will be subjected to, and several other factors and parameters.

REFERENCES

Bobleter, O. and Cocin, R. (1979). Degradation of poplar lignin by hydrothermal treatment. *Cellular Chemistry and Technology, 13:*583–593.

Glasser, W.G. and Wright, R.S. (1998). Steam-assisted Biomass Fractionation. II. Fractionation behavior of various Biomass Resources, *Biomass and Bioenergy,* **14**:219 – 235.

Hamelinck, C. N., Van Hooijdonk, G. and Faaij, A. P.C. (2005). Ethanol from Lignocellulosic Biomass: Techno-economic performance in short-, Middle- and Long-term, *Biomass and Bioenergy,* **28**:384 – 410.

Hohlberg, A. I., Aguilera, J.M., Agosín E. and San Martín R. (1989). Catalyzed Flash Pretreatments improve Saccharification of Pine (*Pinus radiata*) sawdust. *Biomass,* **18**: 81 – 93.

Holtzapple, M.T., Jun, J.H., Ashok, G., Patibandla, S.L. and Dale, B.E. (1991). The ammonia freeze explosion Process: practical lignocelluloses pretreatment. *Applied Biochemistry and Biotechnology, **28–29***:59–74.

Kaparaju, P., Serrano, M., Thansen, A.B., Kongian, P. and I Angelidai, I. (2009). Bioethanol, biohydrogen and biogas production from wheat straw in a bio – refinery concept. *Bio resource Technology,*
100: 2562 – 2568.

Karunanithy, C., Muthukumarappan, K. and Julson, J.L. (2008). Influence of high shear bioreactor parameters on carbohydrate release from different biomasses, *American Society of Agricultural and Biological Engineers Annual International Meeting*.

Kitchaia, P., Intanakul, P. and Krairiksh, M. (2003). Enhancement of enzymatic hydrolysis of lignocellulosic wastes by microwave pretreatment under atmospheric – pressure, *Journal of Wood Chemistry and Technology,* **23**:217 – 225.

Krause, D.O., Denman, S.E. and Mackie, R.I. (2003). Opportunities to improve fibre degradation in the rumen: microbiology, ecology, and genomics. *FEMS Microbiology Review, 797*:1–31.

Larson, E.D. (2008). Biofuel production technologies: status, prospects and implications for trade and development. Paper presented at the United Nations conference on trade and development (UNCTAD).

Lynd, L.R., Weimer, P.J., Van Zyl, W.H. and Pretorius, I.S. (2002). Microbial cellulose utilization: fundamentals and biotechnology. *Microbiology and Molecular Biology Review* 66: 506 – 577.

Miller, R.B. (1999). Structure of wood. In*: Wood handbook: Wood as an engineering material.* Madison, WI: USDA Forest Service, Forest Products Laboratory. General Technical Report, FPL. GTR, 113: 2.1-2.4.

Mosier, N., Wyman, C., Dale, B., Elander, R., Lee, Y.Y., Holtzapple, M. and Ladisch, M. (2005). Features of promising technologies for pretreatment of lignocellulosic biomass. *Bioresource Technology, 96*: 673 – 686.

Negro, M. J., Manzanares, P., Oliva, J. M. and Ballesteros, I. and Ballesteros, M. (2003): Hydrothermal pretreatment conditions to enhance ethanol production from popular biomass, *Applied Biochemistry and Biotechnology, 105*:87 – 100.

Teixeira, L.C., Lden, J.C. and Schroeder, H. A. (2000). Simultaneous saccharification and cofermentation of peracetic acid-pretreated biomass. *Applied Biochemistry and Biotechnology, 84-86:*111 – 127.

Teymouri, F., Laureano-Perez, L., Alizadeh, H. and Dale B. E. (2005). Optimization of the ammonia fiber explosion (AFEX) treatment parameters for enzymatic hydrolysis of corn stover. *Bioresource Technology, 96*: 2014 – 2018.

Viikari, L., Kantelinen, A., Sundquist, J.M. and Linko, M. (1994). Xylanases in bleaching: from an idea to the industry, *FEMS Microbiology Reviews. 13:* 335 – 350.

Wyman, C. E., Dale, B.E., Elander, R. T., Holtzapple, M., Ladisch, M.R. and Lee, Y.Y. (2005). Comparative sugar recovery data from laboratory scale application of leading pretreatment technologies to corn stover. *Bioresource Technology,* 96: 2026 – 2032.

Zheng, Y., Pan, Z., Zhang, R., and Wang, D. (2009). Enzymatic saccharification of dilute acid pretreated saline crops for fermentable sugar production; *Applied Energy* 86: 2459 – 2465.

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Grain Yield, Nitrogen Use Efficiency and Grain Proximate Composition of Pearl Millet as Affected by Applied Nitrogen Levels

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Abstract
Field experiments were conducted during 2022 and 2023 rainy seasons to assess the effect of Nitrogen (N) levels and variety on grain yield, nitrogen use efficiency (NUE) and grain proximate compositions of pearl millet. The treatments consisted of five levels of Nitrogen (0, 30, 60, 90 and 120 kgN/ha). Two pearl millet varieties were used: Super Sosat and Zango, with 30kg each of P2O5 and K2O to balance crop nutrient requirements. The experiments were laid out in a Randomized Complete Block Design (RCBD) with three replications. The highest grain yields (2332.08 kg/ha and 2004.52 kg/ha in 2022 and 2023 respectively) were recorded from Super Sosat supplied with 90kg N/ha, while Zango variety from the control plot (0kg N/ha) recorded lower grain yields (208.23 and 152.70 kg/ha). Application of 90kg N/ha on Super Sosat also showed the highest NUE of 23.52 and 20.14 kg grains/kgN. The highest mean crude protein percentages (11.92% and 11.81%) were recorded from 120kgN/ha treated Super Sosat. It is concluded that grain yield, CP content, and NUE in pearl millet increase with elevated levels of Nitrogen. However, N application above 90kg/ha retards NUE and yield of pearl millet. For high grain yield and CP in pearl millet, as well as efficient N utilization and reduced N losses, Super Sosat variety should be cultivated and supplied with 90kg N/ha, 30kg P2O5/ha, and 30kg K2O/ha.

Keywords: Nitrogen Use Efficiency, grain yield, proximate composition, N-fertilizer

INTRODUCTION

Pearl millet (*Pennisetum glaucum* (L.) R. Br.) accounts for 95% of global millet production and is vital for food security in semi-arid and arid regions of South Asia, Africa, and Latin America (Ati and Ikpe, 2020; Habteslase *et al*., 2021). In Nigeria, it is a staple cereal for over 40 million subsistence farmers (Abubakar *et al*., 2019). Millet grains are nutritionally rich and have health benefits including reducing risks of anemia, diabetes, and cancer (Shweta, 2015). Fertilizers are essential to balance nutrient gaps in soils, but excessive nitrogen (N) application can lead to environmental degradation. Nitrogen Use Efficiency (NUE) measures the effectiveness of N conversion into grain yield (Johnston and Poulton, 2009). Efficient N application is crucial to enhancing millet production, especially in regions like Damaturu where soil fertility is low.

MATERIALS AND METHODS

Field experiments were conducted at the Research and Training Farm, Federal Polytechnic Damaturu during the

2022 and 2023 rainy seasons. The soil is loam with pH 6.51, total nitrogen 0.146 gkg^{-1}, available phosphorus 3.73 $mgkg^{-1}$, and organic matter 1.44%. Treatments included four N fertilizer rates (30, 60, 90, and 120 kg N ha^{-1}) and a control, combined with two pearl millet varieties: Super Sosat and Zango. The RCBD design had three replications. Urea (46% N) was the nitrogen source, with 30kg each of P2O5 and K2O to balance crop nutrient requirements. Seeds were sown by dibbling at 75cm × 25cm spacing. Data on 1000-grain weight, grain yield per hectare, NUE, and grain proximate composition were collected. NUE was calculated as grain yield advantage divided by N application rate (Djaman *et al*., 2018). Grain proximate composition was determined using standard procedures (Shahin *et al*., 2018). Data were analyzed using ANOVA and means were separated using Duncan Multiple Range Test (DMRT) at 5% probability level.

RESULTS AND DISCUSSION

Grain Yield: Nitrogen application rates significantly affected grain yield ($P<0.05$). The highest yields (2332.08 kg/ha and 2004.52 kg/ha) were recorded from Super Sosat receiving 90kg N/ha, while the lowest yields (208.23 kg/ha and 152.70 kg/ha) were from Zango with no N application (Table 1). Grain yield increased with N levels up to 90kg N/ha, beyond which no significant yield increase was observed, indicating 90kg N/ha as optimal. This aligns with findings by Djaman *et al*. (2018). Nitrogen Use Efficiency: NUE values ranged from 23.52 to 17.31 kg/kgN in 2022 and 20.14 to 15.26 kg/kgN in 2023 (Table 1). Super Sosat at 90kg N/ha had the highest NUE, while the lowest NUE was at 120 kgN/ha, suggesting optimal N utilization at 90kg N/ha. Similar results were reported by Haque and Haque (2016).

Table 1: Grain yield components and NUE of pearl millet as influenced by N rates

Treatments Varieties	Yield (kg/ha) N Rates (kg/ha)	1000 Grain Weight (g) year 1	NUE (kg/ha) year 2
Super Sosat	120	2301.30a	2004.52a
Zango	120	2294.37a	1983.88a
Super Sosat	90	2332.08a	1951.55a
Zango	90	2218.24a	1943.83a
Super Sosat	60	1494.70b	1256.91b
Zango	60	1208.82b	1175.89c
Super Sosat	30	892.96c	720.06d
Zango	30	860.24c	664.60d
Super Sosat	0	215.16e	138.25e
Zango	0	208.23e	152.70e
SEM	52.98	31.60	0.63
Significance	*	*	ns

*Means followed by the same letter are not significantly different at 5% level using DMRT, ns= not significant, *= significant at 5% level*

Grain Proximate Composition: Nitrogen rates significantly affected crude protein (CP) content ($p<0.05$) but had no significant influence on carbohydrate, fat, fiber, ash, and moisture content (Table 2). The highest CP contents (11.92% and 11.81%) were recorded from Super Sosat at 120kg/ha N, while the lowest CP (9.19% and 9.61%) was observed at 0kg/ha N. CP content increased with N levels, similar to findings by Parihar (2009), Jadhav (2011), and Bhanu *et al*. (2016).

Table 2: Proximate composition of 2 pearl millet varieties as influenced by NPK rates in year 1

Treatments	Varieties	NPK (kg/ha)	CHO (%)	CP (%)	Fat (%)	Fiber (%)	Ash (%)	MC (%)
Sosat-C88	120	66.70	11.92a	5.57	2.51	2.27	11.02	11.02
Zango	120	67.51	11.58ab	5.46	2.52	2.24	11.44	11.44
Sosat-C88	90	67.20	10.72abc	5.63	2.57	2.23	11.64	11.64
Zango	90	67.39	11.00abc	5.67	2.54	2.19	11.20	11.20
Sosat-C88	60	68.47	10.13abc	5.36	2.51	2.31	11.22	11.22
Zango	60	67.42	10.02abc	5.46	2.57	2.37	12.17	12.17
Sosat-C88	30	68.38	9.19c	5.51	2.53	2.40	11.99	11.99
Zango	30	68.69	9.66bc	5.52	2.56	2.41	11.16	11.16
Sosat	0	66.78	8.13e	5.56	2.55	2.38	11.46	11.46
Zango	0	67.54	7.98e	5.44	2.52	2.32	11.67	11.67
SE±		1.35	0.99	0.37	0.17	0.33	1.46	1.46
Sig.		ns	*	ns	ns	ns	ns	ns

Means in a column followed by same letter(s) are not significantly different at 5% level of significance using Duncan's Multi ple Range Test (DMRT), ns = not significant, * = significant at 5% level, Yr1= 2022 season. CHO: Carbohydrate; CP: Crude Protein; Fat: Fat Content; Fiber: Fiber Content; Ash: Ash Content; MC: Moisture Content; SE±: Standard Error; Sig.: Significance; ns: not significant; *: significant at 5% level

In Table 2, carbohydrate (CHO) content ranged from 66.70% to 68.69%, with the highest in the Zango variety at 30 kg/ha NPK and the lowest in Sosat-C88 at 120 kg/ha NPK. Crude protein (CP) content varied significantly, highest in Sosat-C88 at 120 kg/ha NPK (11.92%) and lowest in the Sosat variety at 0 kg/ha NPK (8.13%). Fat content was consistent, ranging from 5.36% to 5.67%. Fiber content varied slightly, between 2.51% and 2.57%. Ash content ranged from 2.19% to 2.41%. Moisture content (MC) varied from 11.02% to 12.17%, with the highest in the Zango variety at 60 kg/ha NPK.

Table 3: Proximate composition of 2 pearl millet varieties as influenced by NPK rates in year 2

Treatments	Varietes	NPK (kg/ha)	CHO (%)	CP (%)	Fat (%)	Fiber (%)	Ash (%)	MC
Sosat-C88	120	66.98	11.81a	5.44	2.46	2.27	11.03	11.03
Zango	120	67.01	11.62a	5.29	2.49	2.18	11.41	11.41
Sosat-C88	90	67.18	11.13ab	5.51	2.47	2.20	11.50	11.50
Zango	90	67.39	11.04ab	5.57	2.51	2.33	11.17	11.17
Sosat-C88	60	68.27	10.29bc	5.43	2.44	2.28	11.28	11.28
Zango	60	67.86	10.06bc	5.53	2.52	2.35	11.76	11.76
Sosat-C88	30	67.94	9.65c	5.48	2.52	2.37	12.02	12.02
Zango	30	66.89	9.61c	5.57	2.66	2.35	11.92	11.92
Sosat	0	66.95	8.45e	5.34	2.50	2.29	11.69	11.69
Zango	0	68.01	8.58e	5.39	2.48	2.32	11.82	11.82
SE±		1.39	0.25	0.31	0.22	0.21	1.23	1.23
Sig.		ns	*	ns	ns	ns	ns	ns

Means in a column followed by same letter(s) are not significantly different at 5% level of significance using Duncan 's Multiple Range Test (DMRT), ns = not significant, * = significant at 5% level, Yr2= 2023 season. CHO: Carbohydrate; CP: Crude Protein; Fat: Fat Content; Fiber: Fiber Content; Ash: Ash Content; MC: Moisture Content; SE±: Standard Error; Sig.: Significance; ns: not significant; *: significant at 5% level

In Table 3, the carbohydrate content ranged from 66.89% to 68.27%. Sosat-C88 at 60 kg/ha NPK had the highest CHO content, while Zango at 30 kg/ha NPK had the lowest. Crude protein content was highest in Sosat-C88 with 120 kg/ha NPK (11.81%) and lowest in Sosat with 0 kg/ha NPK (8.45%). Fat content was consistent, with minor fluctuations between 5.29% and 5.57%. Fiber content varied slightly, ranging from 2.46% to 2.66%. Ash content was stable across treatments, between 2.18% and 2.37%. Moisture content ranged from 11.03% to 12.02%, with Sosat-C88 at 30 kg/ha NPK showing the highest value. However, both years displayed minor fluctuations in carbohydrate, fat, fiber, and ash contents across different treatments and varieties. Crude protein content showed more significant variations, particularly in the Sosat-C88 variety with higher NPK levels. Moisture content varied slightly between treatments and years, with the highest values observed in the Zango variety at lower NPK levels. The significance levels indicated some statistically significant differences in crude protein content but not in other parameters.

CONCLUSION AND RECOMMENDATIONS

The study concludes that nitrogen levels significantly impact grain yield, nitrogen use efficiency (NUE), and crude protein content in pearl millet. Among the treatments tested, the Super Sosat variety combined with 90 kg N/ha emerged as the most effective. This combination not only produced the highest grain yield but also demonstrated superior nitrogen use efficiency, indicating that the plants utilized the available nitrogen more effectively for growth and development. The increased crude protein content in this treatment suggests that nitrogen application enhances the nutritional quality of the millet, making it more valuable for both human consumption and animal feed. This finding is particularly important for farmers in the region, as it provides a clear recommendation for achieving optimal production outcomes. By choosing the Super Sosat variety with 90 kg N/ha, farmers can maximize their yield and improve the protein content of their crops, potentially leading to better economic returns and enhanced food security. This conclusion underscores the importance of appropriate nitrogen management in millet cultivation and offers practical guidance for farmers seeking to improve their agricultural practices.

REFERENCES

Abubakar A, Falusi OA, Adebola MO, Olayemi IK and Daudu OAY. (2019). Genetic diversity studies for morphological traits in pearl millet (*Pennisetum glaucum* L.) landraces of Northern Nigeria. *GSC Biological and Pharmaceutical Sciences*, 7(2), 60-70.

Ati, M. H. and Ikpe, J. G. (2020). Germplasm evaluation of pearl millet [*Pennisetum glaucum* (L.) R. Br.] For downy mildew infection, agronomic traits and yield. *FUDMA Journal of Sciences (FJS)*, 4(1): 697 –705.

Bhanu Prasad Reddy S., Naga Madhuri K.V., Keerthi Venkaiah and Prathima T. (2016). Effect of Nitrogen and Potassium on Yield and Quality of Pearl Millet (*Pennisetum glaucum* L.). *International Journal of Agriculture Innovations and Research. Vol. 4, Issue 4, ISSN (Online) 2319-1473*

Djaman K, Mel VC, Ametonou FY, El-Namaky R, Diallo MD and Koudahe (2018): Effect of Nitrogen Fertilizer Dose and Application Timing on Yield and Nitrogen Use Efficiency of Irrigated Hybrid Rice under Semi-Arid Conditions. *Journal of Agricultural Science and Food Research* 9: 223

Habteslase T.T., Woldeamlak A. and Angiras N.N. (2021). Evaluation of Germplasm of Pearl Millet (*Penissetum glaucum* L.) for Agronomic, Physiological and Biochemical

Traits under Semi-arid Conditions of Hamelmalo. *Journal of Botanical Research,* 3: 19 – 31

Haque, M.A. and Haque, M.M. (2016) Growth, Yield and Nitrogen Use Efficiency of New Rice Variety under Variable Nitrogen Rates. *American Journal of Plant Sciences*, 7, 612-622. Available online at http://dx.doi.org/10.4236/ajps.2016.73054 Retrieved on 28th march, 2017

Jadhav R. P., Khafi H. R. and Raj A. D. (2011). Effect of Nitrogen and Vermicompost on Protein Content and Nutrient Uptake in Pearl Millet. *Agricultural Science Digest*. 31(4). pp. 319-321.

Johnston, A.E. and P.R. Poulton (2009), "Nitrogen in Agriculture: An Overview and Definitions of Nitrogen Use Efficiency", *Proceedings International Fertilizer Society* 651, York, UK.

Parihar, C.M. (2009). Effect of Nitrogen Levels on Yield and Quality of Pearl Millet (*Pennisetum glaucum*). *Indian Journal of Agricultural Research*, 43(2), 123-126.

Shahin, M.G., Al-Oud, S.A. and Ahmed, F.A. (2018). Proximate Composition of Selected Pearl Millet Varieties As Affected by Nitrogen Fertilization. *Journal of Food Science and Technology*, 55(5), 1792-1799. Shweta, K. (2015). Nutritional and Health Benefits of Pearl Millet. Journal of Food and Nutrition Sciences, 3(4), 84-89.

Impact of Goat Production on Household Food Security and Living Standards in Nasarawa State, Nigeria

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Abstract

This study investigates the relationship between goat production and the household food security and living standards of farmers in Nasarawa State, Nigeria. Utilizing a descriptive survey research design, the study sampled 165 goat farmers from the Western Zone of Nasarawa State. Data were collected using a structured questionnaire and interview schedule, employing snowball sampling to identify respondents. The research questions were addressed using descriptive statistics, including frequency, percentage, and mean, while the Pearson Product Moment Correlation was applied to test the null hypotheses at a 0.05 significance level. The findings reveal that goat production significantly enhances household food security and improves the living standards of the farmers. However, the study identified several constraints, including feed scarcity, inadequate animal healthcare services, and difficulties in acquiring loans. The study concludes that enhancing goat production can substantially improve both food security and living standards for farmers. It recommends government interventions to ensure the availability of feed, provision of comprehensive veterinary services, and the promotion of cooperative societies to support farmers.

INTRODUCTION

Food security encompasses the consistent access to sufficient food necessary for leading a healthy life. According to the World Bank (2020), sustainable food security is achieved when there is physical and economic access to food not only for the present but also for future needs. In Nigeria, agricultural productivity stands as a critical factor in addressing food insecurity and elevating low living standards. Among various agricultural practices, goat rearing, particularly in rain-fed regions, holds significant promise. This practice is highly valued among the rural poor due to its economic and managerial advantages (Yakubu and Chapu, 2020). Despite its potential, goat rearing has not received the attention it deserves in Nasarawa State. Abdullahi (2017) highlights that this agricultural practice can play a vital role in enhancing household food security and improving living standards. This study aims to fill the gap by exploring the relationship between goat rearing and household food security and living standards in Nasarawa State. The research is guided by the following questions: 1.What are the socio-economic characteristics of goat farmers in Nasarawa State, Nigeria? 2. What is the relationship between goat production and farmers' food security in Nasarawa State, Nigeria? 3. What is the relationship between goat production and farmers' living standards in Nasarawa State, Nigeria? And 4. What are the constraints to goat production in Nasarawa State, Nigeria? Through this investigation, the study seeks to provide a comprehensive understanding of the role of goat rearing in addressing food security and improving the livelihoods of rural farmers in Nasarawa State.

METHODOLOGY

This study adopted a descriptive survey design to investigate the target population, consisting of 165 goat farmers. The snowball sampling technique was employed to select participants. This non-probability sampling method was chosen because it allows for the identification and recruitment of participants through referrals from initial subjects, which is particularly useful in reaching hard-to-access populations such as goat farmers. Data collection was carried out using a semi-structured questionnaire known as the Rural Goat Production Farmers' Survey on Livestock Sustainability (RGPFSLS). The questionnaire was designed to capture a wide range of information relevant to the study's objectives, including demographic details, farming practices, and challenges faced by the farmers. In addition to the questionnaire, on-the-spot interviews were conducted to gather more in-depth and nuanced data, ensuring a comprehensive understanding of the respondents' perspectives. The collected data were analyzed using descriptive statistical methods. Frequencies, percentages, and means were calculated to address the research questions and provide a clear summary of the findings. These descriptive statistics enabled the researchers to present the data in a manner that is easily interpretable and highlights key trends and patterns within the population. To test the null hypotheses, the Pearson Product-Moment Correlation Coefficient was employed. This statistical method was chosen to examine the relationships between the variables of interest. The hypotheses were tested at a significance level of 0.05, ensuring that the results are statistically robust and reliable. This comprehensive methodology, encompassing both quantitative and qualitative data collection techniques, along with rigorous statistical analysis, ensures the validity and reliability of the study's findings.
Results and Discussion

Table 1: Socioeconomic characteristics of respondents

Variables	Frequency	Percentage (%)
Sex		
Male	61	37
Female	104	63
Age		
21-30	26	13.9
31-40	43	26.1
41-50	79	47.9
Above 50	17	10.3
Years of Experience in Goat		
Farming	12	7.27
1-5		
6-10	38	23.03
11-15	71	43.03
Above 15	44	26.67
Household Size		
1-5	17	10.3
6-10	63	38.2
11-15	61	36.9
Above 15	24	14.5
Herd Size		
1-10	35	21.21

Variables	**Frequency**	**Percentage (%)**
11-20	67	40.62
21-30	36	21.83
Above 30	27	16.36
Income (₦ per annum)		
<50,000	21	12.73
50,000 – 100,000	87	52.73
>100,000	56	33.94
Educational Qualification		
Non-formal education	61	36.97
Primary education	50	30.30
Secondary education	43	26.06
Tertiary education	11	6.67
Goat Production System Operated	59	35.76
Free range		
Semi-intensive	74	44.85
Intensive	32	19.39
Total	165	100

Table 1 presents the socio-economic characteristics of the respondents, including sex, age, household size, annual income, years of experience in goat farming, and educational qualifications. It also covers goat production characteristics such as herd size and the production system operated by the respondents. The table indicates that 63% of the respondents are female, highlighting the significant involvement of women in goat farming. The majority (69.7%) of respondents have over 10 years of experience in goat farming. In terms of herd size, 40.62% own between 11-20 goats, while 16.36% have more than 30 goats. The mean household size is 10, and the average annual income from goat farming is ₦78,000. Regarding educational qualifications, 63.03% have at least a primary school education, enabling them to read and write. Additionally, 44.85% operate a semi-intensive production system, while 35.76% use a free-range system.

Table 2: Relationship between goat production and farmers' food security

Variable	**N**	**Mean**	**Std Dev.**	**R**	**Sig.**
Goat Rearing	165	3.57	0.857	0.296	0.000
Food Security	165	3.61	0.650		

Table 2 shows the relationship between goat production and farmers' food security in Nasarawa State, Nigeria. The correlation coefficient (r) is 0.296, and the p-value is 0.000, indicating a significant positive relationship between goat rearing and food security ($p < 0.05$). This suggests that goat farming contributes significantly to meeting the food needs of farming families. This finding aligns with Adeleye and Bako (2016), who reported that goat rearing positively affects women's living standards by increasing their savings, income, household food security, and assets. Rearing goats enhances the use of natural resources, improves the utilization of crop residues, and increases the integration of livestock with crop production systems, thus improving the standard of living for smallholder farmers.

Table 3: Relationship between goat rearing and farmers' living standard

Variable	N	Mean	Std Dev.	R	Sig.
Goat Rearing	165	2.79	1.204	-0.197	0.011
Standard of Living	165	2.82	1.144		

Table 3 depicts the relationship between goat rearing and farmers' living standards in Nasarawa State. The correlation coefficient (r) is -0.197, and the p-value is 0.011, indicating a significant negative relationship between goat rearing and living standards ($p < 0.05$). This suggests that while goat farming is crucial for the economic stability of farming households, it may not significantly improve their living standards. Abdullahi (2017) noted that goat farming serves as a primary cash reserve for many rural households, reducing risk and adding stability. Moreover, goat farming can contribute to socio-economic change by improving income, especially in areas lacking banking facilities, by providing a means to save cash for future needs.

Table 4: Constraints to goat rearing

S/N	Items	SA	A	UD	D	SD	Mean
1	Difficulty in obtaining loans for goat production	66	61	4	22	12	3.11
2	Scarcity of information on new production techniques	45	91	-	24	7	3.08
3	Inadequate animal health care services	87	66	-	9	3	3.44
4	High mortality rate due to lack of health care	22	18	2	34	89	1.84
5	Disease outbreaks	54	63	-	31	17	2.93
6	High cost of feeds	22	18	2	34	89	1.84
7	Scarcity of feeds	105	38	1	17	4	3.49
8	Insecurity	37	43	-	58	27	2.55
	Grand Mean						**2.92**

Table 4 highlights the constraints to goat rearing identified by the respondents. Six out of the eight items indicate significant challenges, including difficulty obtaining loans, scarcity of information on new techniques, inadequate animal health care services, disease outbreaks, high cost of feeds, and feed scarcity. The grand mean score is 2.92, which is above the benchmark agreement level, suggesting that these constraints significantly hinder goat farming in Nasarawa State. This concurs with Yasin *et al*. (2013), who emphasized the role of literacy in managing production constraints. Education enhances farmers' ability to read, understand, and implement sophisticated information, thus improving their capacity to manage constraints. Increased farming experience, as noted by Namwata *et al*. (2012), also positively impacts the adoption of improved agricultural technologies, potentially reducing the number of constraints faced by farmers.

CONCLUSION AND RECOMMENDATIONS

This study has demonstrated that enhancing the socio-economic characteristics of goat farmers is intrinsically linked to increased goat production. The findings indicate that goat rearing significantly contributes to food security and elevates the standard of living for farmers in Nasarawa State. The integration of goat farming into agricultural practices provides a reliable source of nutrition and income, thereby fostering economic stability and resilience among rural households. However, the study also identifies several constraints that impede the optimal productivity and sustainability of goat farming in the region. These challenges include the lack of access to financial resources, such as loans, which limits farmers' ability to invest in and expand their operations. Additionally, there is a notable deficiency in extension services and information dissemination, which hampers the adoption of best practices and innovative techniques in goat rearing. The availability and quality of animal health care services are also critical concerns, as they directly impact the management of disease outbreaks and overall animal mortality rates. Furthermore, issues related to theft and weak security measures exacerbate the vulnerabilities faced by goat farmers. To address these challenges, it is imperative that both governmental and non-governmental entities take proactive measures. The provision of accessible financial instruments, coupled with robust extension services, would empower farmers to enhance their productivity. Strengthening animal health care infrastructure and implementing effective disease control programs are essential to reducing mortality rates and ensuring the health and well-being of the goat population. Additionally, improving security measures to protect livestock from theft would contribute to the stability and growth of goat farming operations. In conclusion, the potential for goat farming to significantly improve the socio-economic conditions of farmers in Nasarawa State is substantial. By systematically addressing the identified constraints, there is a promising opportunity to uplift the livelihoods of farmers, enhance food availability, and promote sustainable agricultural development in the region. It is crucial for stakeholders, including the government, private sector, and development organizations, to collaborate and implement strategic interventions that support and sustain the growth of the goat farming industry.

REFERENCES

Abdullahi, A. (2017). Agriculture for sustainable economic diversification and growth. A paper presented at the National Agricultural Show and World Food Day, which began in Keffi Nasarawa state, on Monday 16 to Thursday 20,2017World Food Day retrieved from https://www.sciencedirect.com/science/article/abs/pii/0921448895006304

Adeleye, O. and Bako S. (2016). The effect of goat production on the livelihood of women in Igabi, Chikun and Kajuru Local Government Area of Kaduna State. *Science Journal of Tropical Agriculture, Food Environment and Extension*, 7, 7 – 11.

Namwata, B.M.L., Lwelamira, J. and Mzirai, O.B. (2012). Adoption of improved agricultural technologies for Irish potatoes (*Solanum tuberosum*) among farmers in Mbeya Rural district, Tanzania: A case of Ilungu ward. *Journal of Animal & Plant Sciences,* 8(1): 927- 935.

World Bank, (2020). Can small farmers protect themselves against bad weather? From evidence to policy, Note 71392, Washington D. C.

Yakubu, A. and Chapu, H. (2020). Assessment of production objective and breeding practices of rural goariceepers and implications for a breeding programmed in north central Nigeria 58 programmed. Animal Genetic Resources Information, 53: 69-78.

Yasin, G., Aslam, M., Parvez, I. and Naz, S. (2013). Socio-economic correlates of pesticide usage: The case of citrus farmers. *Journal of Research (Science)*, Bahauddin Zakariya University, Multan, Pakistan, 14(1), June, pp. 43-48.

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Proficient Computer Competency Requirements among Agricultural Extension Workers in Niger State, Nigeria

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Abstract
This study examines the proficient computer competency requirements of agricultural extension workers in Niger State. Multi-stage sampling was used, with 300 respondents randomly selected and interviewed using a well-structured questionnaire. Data were analyzed using descriptive statistics including mean weighted discrepancy score (MWDS). Results showed that "Able to use Microsoft Office Word" is the most important skill (M=4.49), followed by "Able to use Microsoft Office Excel" (M=4.34) and "Able to use Microsoft Office PowerPoint" (M=4.33). The highest mean proficiency score was in "Able to use Microsoft Office Excel" (M=3.73), followed by "Able to use the internet system to transfer technology" (M=3.65). The findings indicate the need for focused competency development in these areas.
Keywords: agriculture, extension workers, competency, proficiency, requirements

INTRODUCTION
Food demand is rising globally. By 2050, the world population will increase by 2 billion, reaching 9.7 billion (Tripathi et al., 2019). To meet future food demand, agricultural and food output must increase by 60% (Hemathilake and Gunathilake, 2022). Agricultural extension programs are crucial for human resource development (Safuri *et al*., 2022) and play significant roles in agricultural development (Olayemi et al., 2021). Extension workers, as key professionals, must be competent in specific skills to improve productivity and ensure the success of extension services (Amanah *et al*., 2021). Competent extension workers are essential for reducing rural poverty and enhancing the effectiveness of extension programs (Silva, 2020). This study aims to determine the computer competency requirements of AEWs to meet the evolving demands of farmers.

METHODOLOGY
The study population included agricultural extension workers from three agricultural zones in Niger State. Multi-stage sampling was used, selecting three local governments randomly from 25 as clusters. A list of 1,820 extension workers was compiled, and Raosoft Sample Size Calculator determined a sample size of 325. Data were collected via a well-structured questionnaire and analyzed using descriptive statistics and a modified Borich Need Assessment Model (B-NAM). Competency items were rated on a five-point Likert scale for perceived importance and proficiency, with scores categorized as high (3.67-5.0), medium (2.34-3.66), and low (1-2.33).

RESULTS AND DISCUSSION

Table 1 shows the perceived importance of core competencies among AEWs. The most important skill is "Able to use Microsoft Office Word" (M=4.49), followed by "Able to use Microsoft Office Excel" (M=4.34) and "Able to use Microsoft Office PowerPoint" (M=4.33). High importance is also attached to communication skills and data management. Effective communication skills are vital for interacting with farmers and conveying innovations (Vignare, 2013).

Table 1: Perceived importance of core competencies among AEWs

Competencies	Mean
Able to use the internet system to transfer technology	4.29
Able to use Microsoft Office Word	4.49
Able to use Microsoft Office PowerPoint	4.33
Able to communicate well with farmers using a projector	4.32
Able to use Microsoft Office Excel	4.34
Able to record information, data, and reports	4.31

Table 2 highlights the proficiency levels in core competencies among respondents. The highest proficiency score is in "Able to use Microsoft Office Excel" (M=3.73), followed by "Able to use the internet system to transfer technology" (M=3.65). The findings align with Walangadi *et al*. (2021), indicating that competencies in these areas are essential for effective extension service delivery.

Table 2: Proficiency of AEWs in core competencies

Competencies	Mean
Able to record information, data, and reports	3.49
Able to use Microsoft Office Excel	3.73
Able to use Microsoft Office PowerPoint	3.50
Able to communicate well with farmers using a projector	3.47
Able to use Microsoft Office Word	3.48
Able to use the internet system to transfer technology	3.65

Table 3 presents the MWDS scores of core competencies. "Able to use the internet system to transfer technology" ranks highest (MWDS=3.75), indicating a significant competency gap. Other notable gaps are in providing marketing information and guiding farmers in financial calculations.

Table 3: MWDS scores of core competencies. "Able to use the internet system to transfer

Statement	Mean	MWDS
Importance	Proficiency	
Able to use the internet system to transfer technology	4.29	3.49
Able to use Microsoft Office Word	4.49	3.73
Able to use Microsoft Office PowerPoint	4.33	3.50
Able to communicate well with farmers using a projector	4.32	3.49
Able to use Microsoft Office Excel	4.34	3.48
Able to record information, data, and reports	4.31	3.65

CONCLUSION AND RECOMMENDATIONS

The study identified crucial computer competencies for AEWs, emphasizing the need for training in Microsoft Office applications and internet use for technology transfer. These skills are vital for effective extension service delivery and should be prioritized in capacity-building programs. Continued professional development in these areas will enhance the overall effectiveness of agricultural extension services.

REFERENCES

Amanah, S., Suprehatin, S., Iskandar, E., Eugenia, L., and Chaidirsyah, M. R. (2021). Investing in farmers through public–private–producer partnerships: Rural Empowerment and Agricultural Development Scaling-up Initiative in Indonesia (Vol. 7). Food and Agriculture Org.

Hemathilake, D. M. K. S., and Gunathilake, D. M. C. C. (2022). Agricultural productivity and food supply to meet increased demands. In Future foods (pp. 539-553). Academic Press.

Olagunju, O., Hassan, S., Abd SAMAD, M. Y., and Kasin, R. (2021). Enhancing work performance of extension agents among cocoa farmers in Malaysia: The influence of human resource development skills. *Walailak Journal of Science and Technology* (WJST), 18(5), 8985-15.

Olayemi, S. S., Alo Adeola Ope-Oluwa, A. A. O. O., and Angba, C. W. (2021). Evolution of agricultural extension models in Sub-Saharan Africa: A critical review. *International Journal of Agricultural Extension and Rural Development Studies*, 8(1), 29-51.

Olorunfemi, T. O. (2019). Competency of extension agents on climate smart agricultural initiatives in South Western Nigeria (Doctoral dissertation, North-West University (South Africa).

Safuri, M., Muhyiddin, Y., and Nurhayati, S. (2022). Agriculturally based Equivalent Education: Insights on Nonformal Education Human Resources and Program Quality. *Journal of Human, Earth, and Future*, 3(4), 441-451.

Saleh, J. M., and Man, N. B. (2017). Training requirements of agricultural extension officers using Borich needs assessment model. *Journal of Agricultural and Food Information*, 18(2), 110-122.

Shah, J. A., Asmuni, A., and Ismail, A. (2013). Roles of extension agents towards agricultural practice in Malaysia. *International Journal on Advanced Science, Engineering and Information Technology*, 3(1), 59-63.

Silva, K. N. N. (2020). The roles of absorptive capacity, technology adoption, and extension services in a local agricultural innovation system in Sri Lanka.

Tripathi, A. D., Mishra, R., Maurya, K. K., Singh, R. B., and Wilson, D. W. (2019). Estimates for world population and global food availability for global health. *In The role of functional food security in global health* (pp. 3-24). Academic Press.

Vignare, K. (2013). Options and strategies for information and communication technologies within agricultural extension and advisory services. Michigan State University, East Lansing.

Walangadi, Y. T., Bahua, M. I., Arham, M. A., and Jamil, M. H. (2021, March). The influencing factors on the performance of agricultural extension agents in corn farming (a study conducted in Gorontalo province). *In IOP Conference Series: Earth and Environmental Science* (Vol. 681, No. 1, p. 012001). IOP Publishing.

Climate Change Impact and Social Adaptation: Evidence from Smallholder Rice Farmers in North-Central Nigeria

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Abstract
This study analysed the impact of climate change and social adaptation among smallholder rice farmers in North-Central Nigeria, targeting Kebbi, Niger, and Benue States. Using a multistage sampling technique, 500 farmers were surveyed with structured questionnaires. Descriptive statistics revealed mean scores of 3.532 for climate change impact on rice production, 3.167 for socio-economic impacts, and 2.781 for environmental impacts. The Social Adaptation Index (SAI) showed a 71.2% index value, indicating moderate adaptive capacity. The study suggests that the developed index could serve as a tool for monitoring and improving local adaptive capacities.
Keywords: climate change, social adaptation, index, rice farmer, smallholder

INTRODUCTION

Climate change poses significant risks to agriculture-dependent communities, particularly in North-Central Nigeria where farming is primarily subsistence and rain-fed (Nguyen *et al*., 2023). This region faces challenges such as changes in soil moisture, crop resilience, and increasing extreme weather events, which affect agricultural productivity and socio-economic stability (Bedeke, 2023). The study aims to fill the research gap on social adaptation to climate change impacts among smallholder rice farmers.

METHODOLOGY

A multistage sampling procedure was used to select 500 rice farmers from Kebbi, Niger, and Benue States. The sampling included selecting 9 major rice-producing LGAs and 16 villages. Data were collected using structured interviews and analysed with descriptive statistics. A five-point Likert scale was used to develop the Social Adaptation Index (SAI) based on 16 indicators from IUCN (Marshall, 2009).

RESULTS AND DISCUSSION

The study revealed that climate change significantly impacts rice production activities, with an overall mean score of 3.532 indicating a moderate level of impact.

Table 1: Climate Impact on Rice Production Activities

Statements	Mean	SD
My rice farm is less productive as a result of climate impact.	3.865	1.4807
My farm had been infected by diseases as a result of climate impact.	3.466	1.6144
My rice farm was severely damaged due to climate impact.	3.906	1.5118
Farm facilities e.g., irrigation facilities were destroyed	2.949	1.5922
My rice production activities were disrupted.	3.472	1.5338
Overall Mean	**3.532**	**1.5466**

The socioeconomic impact of climate change was moderate, with an overall mean score of 3.167

Table 2: Climate impact on socio-ecnomic factors

Statements	Mean	S.D.
Agricultural employment opportunities for locals were badly affected.	3.474	1.5143
Many residents cannot have stable income from farming due to the impacts.	3.558	1.4973
There is a shortage of labor as a result of climate impact.	2.464	1.5633
Some farmers in my area failed to continue with rice production.	3.051	1.6374
The price of rice, fertilizer, or input in my area was rising.	3.286	1.6122
Overall Mean	3.167	1.5649

The environmental impact of climate change on rice farming activities was moderate, with an overall mean score of 2.781.

Table 3: Climate impact on the environment

Statements	Mean	S.D.
My agricultural environment was severely damaged.	3.318	1.6245
No more beautiful scenery in the environment of my farm.	3.143	1.5968
Transportation access to my farm is destroyed.	2.828	1.6015
Topography of my farming area is no longer suitable for rice production.	2.380	1.5382
Structure and texture of the soil are no longer suitable for rice production.	2.237	1.5203
Overall Mean	2.781	1.5763

Table 4: Social Adaptation Index

Rank	Social Adaptation Domains	Mean	Weighted Index
1	Loyalty of Residency	4.528	5.805168
2	Loyalty to Agriculture	4.494	5.761578
3	Ability to Cope with Flood (Financial and Emotional)	4.129	5.293626
4	Environmental Awareness, Attitudes, and Beliefs	4.110	5.269270
...	...	...	...
16	Access to Source	2.581	3.308997
Social Adaptation Index		**71.2%**	

The Social Adaptation Index indicated a 71% capacity for adaptation among rice farmers, highlighting areas for improvement and strengths in current adaptive practices.

CONCLUSION AND RECOMMENDATIONS

The study provides evidence that climate change significantly affects rice agriculture in NorthCentral Nigeria. The Social Adaptation Index helps communities better prepare and respond to climate impacts. Policymakers and agricultural agencies should use these findings to formulate strategies for managing floods and improving the socio-economic stability of farmers.

REFERENCES

Ali, A., Akhtar, R., and Hussain, J. (2023). Unveiling high mountain communities' perception of climate change impact on lives and livelihoods in Gilgit-Baltistan: Evidence from peoplecentric approach. *Environmental Communication*, 17(6), 602-617.

Azril Mohamed Shaffril, H., Abu Samah, B., Lawrence D'Silva, J., Sulaiman, and Yassin. (2013). The process of social adaptation towards climate change among Malaysian fishermen. *International Journal of Climate Change Strategies and Management*, 5(1), 38-53.

Bedeke, S. B. (2023). Climate change vulnerability and adaptation of crop producers in sub- Saharan Africa: a review on concepts, approaches, and methods. *Environment, Development and Sustainability*, 25(2), 1017-1051.

Firdaus, R. R., Leong Tan, M., Rahmat, S. R., and Senevi Gunaratne, M. (2020). Paddy, rice and food security in Malaysia: A review of climate change impacts. *Cogent Social Sciences*, 6(1), 1818373.

Nguyen, T. T., Grote, U., Neubacher, F., Do, M. H., and Paudel, G. P. (2023). Security risks from climate change and environmental degradation: implications for sustainable land use transformation in the Global South. *Current Opinion in Environmental Sustainability*, 63, 101322.

Ojo, T. O., and Baiyegunhi, L. J. S. (2020). Determinants of climate change adaptation strategies and its impact on the net farm income of rice farmers in south-west Nigeria. *Land Use Policy*, 95, 103946.

Schlaepfer, M. A., and Lawler, J. J. (2023). Conserving biodiversity in the face of rapid climate change requires a shift in priorities. *Wiley Interdisciplinary Reviews*: Climate Change, 14(1), e798.

Performance Analysis of the Cassava Processors in Abia State, Nigeria

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Abstract
The study analyzed the performance of the cassava processors in Abia State, Nigeria. A multi-stage random sampling procedure was used to select 120 cassava processors with the use of a structured questionnaire, to collect primary data. Data collected were analysed with cost and returns model and ordinary least square (OLS) regression model. The cost and returns result shows that variable costs accounted for a very large proportion (99%) of the total cost of cassava processing. The OLS regression result showed that depreciation, market information access, cooperative membership, distance to the nearest market and transportation cost, quantity sold of cassava, education, credit use and household size influenced the profit level of the cassava processors at 10%, 5% and 1% levels of significance respectively. The study recommends cassava processors to form more cooperatives in order to enjoy credit facilities, increase their performance in cassava production and high profit in the cassava business.

Keywords: Cassava processors, performance analysis

INTRODUCTION

Cassava is valued for its food security and its versatility in converting it into traditional and novel foods, livestock feed, ethanol, starch, and derivatives (Alocha and Umeh, 2017). Cassava can be made into garri, starch, flour, tapioca, beverages, and animal feed chips. Cassava production and marketing are difficult for smallholder farmers. This could help smallholder farmers overcome obstacles along the cassava value chain. According to Achem et al. (2013), cassava root processing and value addition are required to extend shelf life (rots within 3-4 days of harvest), improve nutritional content (low in other nutrients, particularly proteins), and convert cassava root into other goods (FAO and IFAD, 2013). Even in years of normal rainfall, some farmers are net purchasers of food, while others are neither buyers nor sellers. There is a price disparity between rural and urban consumers and producers. This implied that although cassava processing needs huge capital investment in the processing equipment at the initiation of the enterprise, however, once established, processors normally operate at optimum level hence enjoying the economies of scale. Despite farmers' difficulties in reaching markets, few studies on analyzing the performance of cassava producers in Nigeria and Abia state have been conducted. The specific objectives of the study were to determine the performance of the producers regarding their cost and returns and examine factors influencing the profit level of the cassava producers

METHODOLOGY

This study was carried out in Abia State. This study's population included all cassava farmers who processed tubers for market. The respondents for the study were chosen using a multi-stage sampling technique. First, one local government area from each of the three agricultural zones was chosen. Four autonomous communities were chosen from each of these local government areas, for a total of twelve communities. Two villages were chosen from each community, for a total of 24 villages. Five cassava farmers processing for market were chosen from these villages, resulting in a total of 120 processors. As a result, a total of 120 respondents were used in the study. The primary data were collected directly from the field survey using well-structured questionnaires. In the data analyses, cost and returns model was used to analyze objective one (1) which is to estimate the cost and returns associated with cassava processing. The cost and returns model is given as:

$$NR = TR - TC \qquad (1)$$

Where,
NR = Net Returns (₦)
TR = Total Revenue (returns) from the cassava enterprise
TC = Total Costs (₦) (TC = TVC + TFC)
TVC = Total Variable Cost;
TFC = Total Fixed Cost
N/B: Equation (1) was analyzed for cassava processors

Objective Two (2**)** which is to examine the factors influencing cassava processors' level of performance was realized using the multiple regression analysis. The four functional forms (Linear, Semi-log, Cobb-Douglas and Exponential) of the model were tried and the best fit selected. The model is specified implicitly below:

Implicit Form:

$$Y = F (X_1, X_2, X_3, X_4, X_5, X_6, X_7 .... X_{11},) \qquad (2)$$

Where,
Y = Net return in Naira
X_1 = Age of respondent in years
X_2 = Level of education in years
X_3 = Processing experience in years
X_4 = Credit used (dummy)
X_5 = Depreciation in Naira
X_6 = Household size in Number
X_7 = Market information (dummy)
X_8 = Cooperative membership (dummy)
X_9 = Distance to market in kilometer
X_{10} = Transportation cost in Naira
X_{11} = Quantity of products supplied/month
ei = Error term
b_o = Slope
b = Co-efficient

RESULTS AND DISCUSSION

Performance analysis of the cassava processors

The result on the cost and returns in processing showed that roots accounted for about 59% of the total cost of processing. In a similar study conducted by Achem *et al*., (2013), the authors noted that cassava root cost took the largest percentage of the total processing cost. Labour costs about 16% of the total processing cost. The second key element that needed huge investment in cassava processing, as noted by (Ajok, 2016) was the element of labour. Costs comprising the labor component are one of the most important contributors to the total production costs in cassava processing. Depreciation cost was only 1% of the total processing cost. This implied that although cassava processing needs huge capital investment in the processing equipment at the initiation of the enterprise, however, once established, processors normally operate at optimum level hence enjoying the economies of scale. The economies of scale enable processors to enjoy better prices (Saediman *et al*., 2015; Emerole *et al*., 2014).

Table 1: Performance analysis of the cassava processors

Cost items	Amount (₦)	%
Variable costs		
Roots (₦)	209910.5	59
Bags (₦)	6036.67	2
Labour (₦)	58120	16
Firewood (₦)	42226	12
Transportation (₦)	35595.83	10
Total variable cost (TVC)	351,889	99
Depreciation (₦) **(TFC)**	2973.33	1
Total cost, TC = TVC+TFC	**354,862.33**	
Quantity sold (kg) (Q)	18308.5	
Average price/kg (₦)	50	
Total Revenue, TR = (Q*P)	**915,425**	
Profit (TR – TC)	**560,562.67**	

Source: Field survey, 2022

Factors Influencing the Profit level of the Cassava Processors

In Table 2 the Ordinary Least Square (OLS) was used to estimate the performance (profit) determinants of cassava processors and exponential was selected as the lead equation with the model coefficient of multiple determinations (R^2) of 0.712 which implies that about 71.2% variation in the profit level of the cassava processors was explained by the independent variables included in the model. The F-ratio was significant at 1%, indicating the model's goodness-of-fit. The result showed that depreciation had a positive coefficient on the profit level of cassava processors. This is a strong deviation from *a priori* expectation since depreciated inputs are the bulk of fixed-cost items in a conventional production/processing enterprise. Market information access was positively signed, suggesting that processors with adequate access to prevailing market information are more profitable than those with no or limited market information. This finding is consistent with Lagat and Maina, (2017) who found that knowledge of prices prior to selling was significant among milk producers. Cooperative membership showed a positive relationship with the profit level of cassava processors in the study area. The result entails that cooperative members have higher profits than non-cooperative members. This association is expected to increase the farmer’s interactions with his fellow farmers and other entrepreneurs, increasing his capacity to access current information on economic opportunities within his locality and even beyond (Echebiri and Nwaogu, 2017). Distance to market and transportation cost all had a positive effect on cassava processors' profit level. In some cases, transportation is a proxy for distance and vice-versa. This could be why the variables returned similar signs, though contrary to expectations. However, when processors sell at distant markets, they may likely transport large quantities of their products, thereby enjoying large economies of scale. It is expected that farmers who are nearer to the market can market regularly than those situated far away from the markets, thereby making higher profits (Ajok, 2016). Quantity sold of the cassava processed products was positively signed and implied that the more quantity sold, the more profits received. This is logical because the products' availability (place utility) will encourage constant sales. The coefficient of education was negatively signed. This implies that as these processors acquired education, their profit levels decreased. While it is unexpected as education is a strong catalyst to profit-making, the negative relationship could have arisen due to disinterest in processing and acquiring more education. Also, while these processors could gravitate towards more lucrative activities as they acquire education, Mohammed (2016) posited that this deviation could be attributable to the fact that they do not have content-related education. That is, they may lack cassava processing technicalities. In addition, the result revealed that credit use had a negative sign, implying that processors who used credit returned lower profits than those who did not use credits. This is highly unexpected since credits serve as extra funds to offset firm costs. Household size was negatively signed, implying that the higher the household size, the lower the profits of the cassava processors. This confirms Odor *et al*. (2022) results, who argued that with large family sizes, most of what the family produced is consumed.

Table 2: Factors influencing the profit level of the cassava processors

Variables	Linear	Exponential (+)	Semi-log	Double log
Constant	-22426.710	10.976	-14600000.000	3.707
	(-1.240)	(13.282)***	(-1.981)*	(179.012)***
Age of processor	691.686	0.017	2034538.000	-0.007
	(1.332	(0.712)	(1.054)	(-1.228)
Years of education	-724.117	-0.069	944438.100	0.005
	(-1.229	(-2.574)***	(1.714)*	(3.224)***
Processing	157.471	0.024	-1282045.000	0.003
experience	(0.429	(1.419)	(-2.526)**	(2.040)**
Credit use	-5224.202	-1.404	1785591.000	0.002
	(-0.444)	(-2.610)**	(1.495)	(0.630)
Depreciation	-0.807	0.000	-46477.900	-0.001
	(-1.079)	(2.003)***	(-0.176)	(-0.996)
Household size	-925.857	-0.168	276201.100	-0.002
	(-0.701)	(-2.777)***	(0.595)	(-1.295)
Market information	8914.085	1.007	-806566.000	-0.003
	(1.158)	(2.861)***	(-1.011)	(-1.313)
Cooperative member.	-991.606	0.974	-1742530.000	0.002
	(-0.102)	(2.196)**	(-1.775)*	(0.713
Distance to market	-110.543	0.136	-416533.600	-0.001
	(-0.147)	(3.959)***	(-1.597)	(-1.004)
Transport cost	0.111	0.000	-163774.200	0.001
	(3.938)***	(2.383)**	(-0.906)	(2.191)***
Quantity supplied	39.388	0.000	1336878.000	0.998
	(1263.945)***	(7.324)***	(7.313)***	(1943.029)***
Adjusted R^2	0.999	0.683	0.441	1.000
R^2	1.000	0.712	0.493	1.000
F-ratio	8.121***	24.250***	9.540***	4.133***

Source: Field survey, 2022. ***,** and * = 1, 5 and 10% levels of significance

CONCLUSION AND RECOMMENDATIONS

The study concluded that profit of 560,562.67 was made under cost and the variable costs accounted for a very large proportion (99%) of the total cost of cassava processing. The OLS regression result also showed that depreciation, market information access, cooperative membership, distance to the nearest market and transportation cost, quantity sold of cassava, education, credit use and household size influenced the profit level of the cassava processors at 10%, 5% and 1% levels of significance respectively. The study recommends cassava processors to form more cooperatives in order to enjoy credit facilities, increase their performance in cassava processing and high profit in the cassava business.

REFERENCES

Achem, B., Mohammed, B., Aduba, J., Muhammad_Lawal, A. and Abdulquadr, F. (2013). A Comparative Assessment of the Profitability of Cassava Processing Enterprises in KwaraState, Nigeria. *Global Journal of Current Research*, *1*(2), 57–61.

Ajok, W. (2016). Market Participation of Smallholder Cassava Processors in North and North Eastern Uganda. Dissertation paper, submitted submitted to Agri-Enterprises Development of Gulu University.

Alocha, O.C and Umeh, O.C. (2017). Use of Information Communication Technologies among Female Block Extension Agents in South-East Agro-Ecological Zone, Nigeria. *Journal of Agriculture and Veterinary Science, 10(2),* Pp.40-46*.*

Echebiri, R.N. and Nwaogu, D.C. (2017). Health Status and Productivity Analysis of Rural Farming Households in Abia State, Nigeria. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, Vol. 17, Issue 1, 2017.

Emerole, C. O., Nwachukwu, A. N., Anyiro, O., Ebong, V., & Osondu, C. K. (2014). Cassava Entrepreneurship And Gender Participation In Udi Local Government Area Of Enugu State, Nigeria. *Scientific Papers Series Management, EConomic Engineering in Agriculture and Rural Development*, *14*(1), 127–138.

FAO/IFAD. (2013). *A Review of Cassava in Africa with Country Case Study on Nigeria, Ghana, the United Republic of Tanzania, Uganda and Benin*. Rome: International Fund for agricultural DEvelopment Food and Agriculture Organization of the United Nations

Lagat, J.K. and Maina, M.C. (2017). A gender and decent work analysis of cassava production and on-farm processing, in Kuria west subcounty, Kenya. *African Journal of Agricultural Research*Vol. 12(31), pp. 2533-2544.

Mohammed, M.A. (2016). Technical Efficiency of Cassava Production in the Savannah Zone of Northern Ghana: Stochastic Frontier Analysis. *Journal of Biology, Agriculture and Healthcare,* Vol.6, No.20, 2016

Odor, P.C, Amadi, P.E, Mgbeahuru, C and Onuegbu, I. (2022). Socio-Economic factors influencing the utilization of Information and Communication Technologies (ICTs) among cassava farmers in Abia State, Nigeria. Journal of Community and Communication Research Vol. 1 No.1, June 2022. Pp.88-93

Saediman, H., Amini, A., Basiru, R., & Nafiu, L. O. (2015). Profitability and Value Addition in Cassava Processing in Buton District of Southeast Sulawesi Province, Indonesia, *8*(1).

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Evaluation of Different Stake Planting Methods for Increased Cassava Stem Production in Nigeria

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Abstract
This study was conducted at the National Root Crops Research Institute, Umudike experimental field in the 2023 cropping season to evaluate the effects of different stake planting methods on cassava stem production. The design of the experiment was a randomized complete block design (RCBD) in a split-plot arrangement. The experiment contained twelve possible combinations of treatments replicated 3 times. The main plot consists of four varieties of cassava Dixon, Game charger, NR87/184, and TME 419 while the subplot consists of 3 cassava stake planting methods, 30 cm length (slant planting), 30 cm length (horizontal planting), and 15cm length (slant planting). The field was maintained using good agronomic management practices. Data were collected on growth attributes: percentage establishment count at 4 weeks after planting (WAP), average number of leaves/plant, average plant height/plant, average number of branches/plant at 9 months after planting (MAP), and average number of bundles/ha at harvest at 10 MAP. Results obtained showed that TME 419 had the highest percentage of establishment, plant height, highest number of bundles/ha at harvest, and least number of leaves and branches. The variety Game changer had the highest number of branches followed by NR87/184, and TME 419 gave the highest number of bundles.

Keywords: Cassava variety, Stake, Seed production, planting, methods

INTRODUCTION

Cassava (*Manihot esculenta*) is an important staple food for half of Nigeria population and about 60.8 million tons of cassava is produced annually in Nigeria (FAOSTAT, 2022). In Nigeria, cassava is serving as a primary food source and income generation for millions of people. Even though cassava is a durable crop, it has certain husbandry requirement and responsive to favour crop management (Ekanayake *et al*, 1997). However, its production is often constrained by inadequate availability of high-quality planting materials. Planting patterns of cassava stems is crucial for increasing production and meeting the demands of growing population. Improved cassava varieties cuttings are highly demanded by peasant farmers and private companies who engaged in food production, to ensure food security. Obtaining clean cassava cuttings/seed in the right quality and quantity has remained a challenge in cassava production in Nigeria. Cassava being vegetatively propagated has a relatively low multiplication ratio of 1:10 (IITA, 1998) and competes highly with cereals and legume crops which have high multiplication ratios. Another problem is the long period of maturity of planting materials (10 – 12 months) which has a comparative cost disadvantage over that of grain seeds which is produced in 3-5 months. Healthy, fresh stem cuttings from mature cassava plants are the best planting materials which depend on the moisture conditions of the soil. High quality cassava cuttings for planting are often in short supply especially during dry season, COSCA (1996) had therefore posited that farmers and industrialist require access to healthy stems as planting materials. Planting patterns affect cassava yield. The orientation of the cutting influences growth characteristics like vertical and horizontal planting (Ekanayake *et al*, 1997). Many planting pattern technologies have been developed, like the 2 nodes and 3 nodes technology. However, these technologies are often not practiced by farmers due to procedures involved. The objective of this study was to evaluate the best planting pattern of cassava varieties for seed/stem production in Umudike, south-eastern Nigeria. This research aimed to enhance cassava seed/stem production and productivity, thereby improving food security and boasting the livelihood of farmers in the region.

MATERIALS AND METHODS

This study was conducted at the National Root Crops Research Institute, Umudike experimental field in the 2023 cropping season. Umudike is located at longitude 07˚ 33' E and latitude 05˚29' N and sits at an elevation of 122 m above sea level in the rainforest zone of Nigeria. The soil is loamy sand, acidic with low buffering capacity and multiple nutrient deficiencies (Nwokocha *et al*., 2019). The experiment was set up in a split-plot treatment arrangement in a randomized complete block design (RCBD). Four varieties of cassava (Dixon, Game charger, NR87/184, and TME 419) occupied the main plots while three stake planting methods (30 cm slant planting, 30 cm horizontal planting, and 15 cm slant planting) occupied the sub-plots. Plot size was 4 m x 4 m (16 $m^{2)}$). Treatments were replicated 3 times. Planting was done with a plant spacing of 1.0 m between the ridge and 0.5 m within the ridge. Good agronomic management practices were carried out. Fertilizer application was done at 6 weeks after planting (WAP) at the rate of 400kg/ha NPK 15:15:15 and harvesting of stems was done 10 months after planting (MAP). Data were collected on growth attributes (establishment count in percentage at 4 WAP, plant height (cm), number of leaves per plant, number of branches per plant (9 MAP), and number of bundles per hectare at (10 MAP)). Data collected were subjected to analysis of variance for a split-plot in RCBD using GenStat Discovery Edition 1. Significant treatment means were separated using Fisher's LSD at a 5% alpha level.

RESULTS AND DISCUSSION

The result of the study as presented in the Table showed that variety significantly influenced the sprouting percentage at 4 WAP. TME 419 recorded the higher sprouting percentage with 99.8%, followed by Game changer with a value of 94%, and then NR87184 with a value of 87.5% while Dixon lowest of 80.4 % which did not differ significantly from one another. The result obtained in this work is similar with the work by (Udounang *et al*, 2021) where TME 419 had the highest establishment percentage.
Plant height differ significantly (P<0.05) 19.6 among the varieties planted. The cassava variety TME 419 had the highest plant height with mean value of (184.1 cm), NR87184 (162.4 cm), Dixon (151.7 cm) and Game changer (132.7 cm) respectively. Katuromunda *et al*, 2021 reported similar result on his work on cassava where TME 419 had highest plant height.

The result from the table showed that number of leaves/plant differ significantly (P<0.05) 54.9 among the varieties planted. NR87184 produced the highest number of leaves with average value of (95.6) followed by Game changer (174.7) then Dixon 109 while TME

419 (64.5) which was the lowest. This observation agreed with the report of (Udounang *et al*, 2021).

The number of branches/plant had significant effect ($P<0.05$) 2.02, Game changer produced the highest number branches with mean value of (20.8), NR87184 (19.3), Dixon 2.54 while TME 419 had lowest number of branches with (0.28) which means that TME 419 hardly branch, which is line with work of (Aiyelari et al, 2019) which confirmed that TME 419 is non branching cassava variety.

From the Table, number of bundles produced differ significantly among the varieties planted ($P<0.05$) 43.3. The variety TME 419 produced the highest number of bundles/ha with mean value of (620.6) which could as a result of its height, followed by Game changer with mean value of (503.8/ha), then NR87184 (455/ha) while Dixon had lowest (335.7) bundles/ha.

Planting methods: Results obtained from the table showed that planting methods did not significantly affect sprouting percentage, Plant height/plant and number of branches/plant. While number of leaves/plant differ significantly among the planting methods ($P<0.05$) 30.3. Slant planting had mean value of (155.6) leaves/plant, then horizontal planting (140.3) while 15 cm had lowest of (112.6). Number of bundles/ha had high significant effect on the planting methods ($P<0.05$) 38.4. Slant planting had a mean value of (547.8) bundles/ha, horizontal planting (465.2) bundles/ha while 15 cm (423.8) bundles/ha. Planting methods affects cassava yield, the orientation of the cuttings influences growth characteristics. Slant/angle planting produced the highest number of bundles/ha, this observation agrees the earlier study by (Ekanayake *et al*, 1997).

Interaction effect of variety x planting methods on sprouting percentage, plant height (cm) and number of leaves/plant had no interaction effect. Interaction effect of variety x planting methods on the number of branches from the table showed that there was significant effect on number of branches/plant ($P<0.05$) 2.3, the Game changer produced the highest number of branches (Game changer x HP) 22.3, (NR87184 x SP), 21.1 which did not differ significantly from each other while the lowest number of branches were obtained from Dixon and TME 419 (3.50 – 0.13) across all the planting methods. Interaction effect of variety x planting methods on the number of bundles/ha showed significant differs among the varieties used (71.2), TME x slant planting produced the highest number of bundles/ha (950), followed by Game changer x SP (611.3), then NR87184 (600) while Dixon x 15 cm (250) which depends on growth methods of the cuttings (Ekanayake *et al*, 1997).

CONCLUSION AND RECOMMENDATIONS

The following conclusions were drawn from this work: TME 419 had the highest sprouting percentage, highest the plant height, with highest number of bundles/ha at harvest with least number of leaves. The variety Game changer had the highest number of branches followed by NR87184 and TME 419 produced least number of branches. All the varieties used in this study are good for cassava seed/stem production, but TME 419 is the best among them.

REFERENCES

Aiyelari, P.O., Odede, A.N. and Angele, S. (2019).Growth, yield and Varietal Responses Cassava to Time of Planting into Plantain stands in Plantain/cassava Intercrop in Akure in South-west Nigeria. Journal of Agronomy. 2(2). 1-6 DOI: 10.14302/issn.2639-3166 https://www.researchgate.net.

Collaborative Study of Cassava in Africa (COSCA). (1996). COSCA working paper NO: 20.IITA, Ibadan Nigeria.

Dickson, D. (2003). South-South Collaborative Picks Up Steam. Editorial sciences and development. Network 17 November. http://www.socidev.net/en/editorials/southsouth collaboration-picks-upsteam.html.

Food and Agricultural Organisation (FAO). (2014). Statistical database of the Food and Agricultural Organisation of the United Nations. Online. Rome http://faostat.org

Indira, J. Ekanayake, David, S.O Osiru and Marcio C.M Port (1997). IITA Research guide 60. Agronomy of cassava Production. http://www.iita.org/cms details/trn_mat/irg60/irg604.html

International Institute of Tropical Agriculture (IITA). (1990). Cassava in Tropical Africa, Cassava Reference manual. IITA' Contribution, IITA Publication, Ibadan, Nigeria, 1 7

International Institute of Tropical Agriculture (IITA). (1998). IITA Annual Report and highlight 1987-1988, .Ibadan, Nigeria

Katuromuda, S., Ekwaro, B. and Wanaku, B. (2021). Yield Performance Newly Developed Cassava Varieties in Response to Inorganic Fertilizer. Modern Applied Science 15(4) ISSN 1913-1844 E-Science and Education https://www.researchgate.net.

Nwokocha, C.C., Ironkwe, A.G. and Njoku, N.R. (2019). Evaluation of NPK Fertilizer Requirements of Livingstone Potato (Rizga) Production on a Loamy Sand Ultisol of Southeastern Nigeria. *International Journal of Agriculture and Rural Development,* 22(2):4366-4370 www.ijard.com

Udounag, P.I., Ekwere, O.J. and Ofonime, R.A. (2021). Evaluation of Morphological Characters and Yield Variability of Some Elite Cassava ((*Manihot esculenta*) in Uyo, South-eastern Nigeria American Journal of Agricultural Science Engineering and Technology. DOI: https://doi.org/10.5281/zenodo.5449188 StemVol. 5 Issue.2 http://journals.e-palli.org

Table 1: Effects of variety and stake planting method on some growth indices of cassava grown on a loamy sand at Umudike southeastern Nigeria

Treatments	Sprouting (%) 4 WAP	Plant height (cm)/plant (9 MAP)	No leaves/plant (9 MAP)	No of branches/plant (9 MAP)	No of bundles /ha (10 MAP)
Variety					
Dixon	80.2	151.7	109.8	2.54	335.7
Game changer	94.0	132.7	174.7	20.08	503.8
NR87/184	87.5	162.4	195.6	19.28	455.7
TME 419	99.8	184.1	64.5	0.28	620.6
LSD (0.05)	**12.2***	**19.6****	**54.9****	**2.02****	**43.3****
Planting Patterns					
15 cm	85.9	157.9	112.6b	10.36	423.8c
HP	91.6	165	140.3ab	10.72	465.2b
SP	93.7	150	155.6a	10.77	547.8a
LSD (0.05)	**NS**	**NS**	**30.3***	**NS**	**38.4****
Variety x Stake Planting Method Interaction					
Dixon x 15 cm	75	161	133.2	2.50d	250d
Dixon x HP	85.4	154.8	118	1.63d	433def
Dixon x SP	80.2	139.2	78	3.50d	324h
Game chg x 15 cm	94.6	113.7	188.5	19.50b	517c
Game chg x HP	88,5	153.8	185.2	22.38a	383fgh
Game chg x SP	99.0	130.4	150.4	18.38c	611.3b
NR87/184 x 15 cm	74	159.8	241	19.13b	367gh
NR87/184 x HP	92.7	175.5	192.2	18.50c	400defg
NR87/184 x SP	95.8	151.8	153.8	21.08ab	600b
TME 419 x 15 cm	100	197.1	59.6	0.38e	467cde
TME 419 x HP	99.7	175.5	65.6	0.38e	444.7def
TME 419 x SP	99.7	179.4	68.1	0.13e	950a
Interaction LSD$_{(0.05)}$	**NS**	**NS**	**NS**	**2.3****	**71.2****

*, ** = Significant at 5 and 1% probability levels, respectively; NS = Not significant at 5% probability level.

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Fortification of Sweet Potato Flour with Ground Soya Beans and Crayfish for Healthy Baby Food in Nigeria

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Abstract
This study focuses on fortifying sweet potato flour with ground soya beans and crayfish to develop a nutritious baby food. The aim is to enhance the nutritional content of the sweet potato-based baby food to support the growth and development of infants. The nutritional content of ground sweet potato flour, soya beans, and crayfish can vary slightly depending on the specific variety and preparation methods. Sweet potato flour contains calories, carbohydrates, proteins, fiber, vitamins(A and C), calcium, iron and potassium while soya beans contains calories, carbohydrates, proteins, fats, fiber, vitamin C, calcium, iron, and potassium. Further, crayfish has the nutritional contents of calories, proteins, vitamin C, calcium, iron and potassium. The blending provides a balanced combination of macronutrients and micronutrients, such as proteins, essential amino acids, iron, zinc, and vitamins. This fortification approach holds the potential to improve the nutritional quality of baby food and contribute to the overall health and well-being of infants.

Keywords: Sweet potato flour, soya beans, crayfish, Minerals, micro- and-macronutrients

INTRODUCTION

Fortification of sweet potato flour blended with ground soya beans and crayfish presents a promising opportunity to create nutritious and wholesome baby foods. Their nutritional composition can provide a healthy and balanced option for baby foods (Amagloh *et al*, 2012). Sweet potatoes are rich in vitamins A and C which support immune function and promote healthy skin and eyes; contains minerals such as potassium which is essential for maintaining proper heart and muscle functions; and are high in dietary fibre which aids digestion and promotes a healthy guts; Sweet potatoes also provide complex carbohydrate for sustaining energy (Astawan *et al,* 2011; Haile *et al,* 2015). Soya beans are excellent source of plant-based/ high-quality protein which is essential for growth and development; provides essential fatty acids including omega-3 fatty acids which support brain development; and contains micronutrients and essential amino acids which are the building blocks of proteins (Ugwuona *et al*, 2012). Crayfish, on the other hand, is a good source of high-quality protein; contain essential minerals such as calcium phosphorous, and magnesium which are important for bone development; and provides micronutrients, vitamins B_{12} and niacin which support energy production and brain function; contains omega-3 fatty acids which are beneficial for brain and eye development. Crayfish further enhances the nutritional value of the blend. This combination of sweet potato flour, ground soya beans and crayfish offers a well- rounded meal that could contribute to the healthy growth and development of infants (WFP, 2004 WHO/UNICEF,1998). To create a healthy baby food mixture, sweet potato flour, soya beans and crayfish ingredients are combined in the following proportions like one cup of sweet potato flour, half cup of ground soya beans, one quarter cup of crayfish (WHO, UNICEF, & World Bank Group,2015). By incorporating such essential vitamins, minerals and protein, this fortified flour aims to support healthy growth and development in infants, providing a convenient and tasty option for parents seeking balanced nutrition for their babies.

MATERIALS AND METHODS

To fortify sweet potato flour blended with ground soya beans and crayfish for healthy baby foods, the following materials are used, and this procedures are followed. Materials are sweet potatoes which was obtained from National Root crop research Institute, Umudike, Abia state, while soya beans and crayfish were bought in an open markets. Other materials used are blender or food processor, cooking utensils, and storage containers**.**

Preparation of Sweet Potatoes and Soya Beans

Sweet Potatoes: The crops were peeled and washed thoroughly to remove any dirty. They were cut into small sizes for easier blending. They were steamed or boiled until soft and cooked. As soon as they were cooked, any excess water were drained and allowed the sweet potato to cool. Later mashed into a smooth consistency with blender (Oke *et al*, 2013).

Soya Beans: The crops were sorted and cleaned to remove any impurities and stones. They were rinsed under running water, and soaked in a water for 8 hours to soften them. After soaking, the water was drained and the skin of the beans was removed. The peeled beans were thoroughly washed. Thereafter, the peeled soya beans were grounded into a fine powder using food processor (Grinder) and was free of lumps (PAHO and WHO, 2001).

Crayfish: The crayfish was cleaned and washed to remove any dirt or impurities and was ground into a fine powder using grinder. The powdered crayfish was added to the sweet potato and soya bean blend.

*Blending***:** The ground soya beans and ground crayfish were added to the mashed sweet potatoes in the desired proportions. The mixture were blended until smooth and well combined. The Combination was mixed thoroughly well to ensure even distribution of the crayfish. Small quantity of water was added to achieve desired consistency (AOAC, 2000).

*Cooking***:** The mixture was transferred into a cooking pot. Medium heat was applied, and the mixture was continuously stirred to prevent sticking and burning. They were cooked for a few minutes until the mixture thickens and reaches a porridge-like consistency. Thereafter, the mixture was removed from the heat and allowed to cool before storing (CAC, 1991).

Storage: After the fortified sweet potato flour blend was allowed to cool down, they were immediately stored in airtight containers. They were kept and stored in a cool, dry place to maintain freshness for a reasonable time frame pending its readiness for use to ensure the nutritional quality (Brooks *et al,* 2006).

RESULTS AND DISCUSSION

This research study aimed to evaluate the potential benefits and challenges associated with this fortification approach. The results showed that the fortification of sweet potato flour with ground soya beans and crayfish significantly increased the nutritional content of the final product (Table 1). Sweet potatoes are rich in dietary fiber, vitamins A and potassium while soya beans are a good source of protein, essential fatty acids, and minerals, Cray fish on the other hand provides additional protein minerals such as calcium and phosphorous(Dhingra *et al,*2012; Omodamiro *et al*, 2013; Ötles *et al*,2014). The fortification with these ingredients could potentially address malnutrition issues in infants and young children. The extra protein and essential nutrients from soya beans and crayfish can support healthy growth and development during this critical stage of life (Williams,1995).

However, challenges in the fortification process need to be considered. The study observed that the proportion of soya beans and crayfish should be carefully adjusted to prevent overpowering the natural taste of sweet potatoes. Additionally, proper processing techniques should be employed to ensure the retention of nutritional components during the fortification process (Brooks *et al*, 2006).

Table 1: Nutritional composition of the sweet potatoes, soya beans and crayfish

	Energy (Kcal)	Carbohydrate (%)	Protein (%)	Fats (%)	Dietary fiber(%)	Vitamins present	Calcium (%)	Iron (%)	Potassium (%)
Sweet potato flour	322.00	80.00-85.00	7.00-10.00	0.50-1.00	8.00-10.00	A and C	3.00	9.00	5.00
Ground Soya bean	173.00	30.00-40.00	35.00-40.00	20.00-25.00	10.00-15.00	B	11.00	19.00	15.00
Ground Crayfish	82.00	< 1.00	50.00	5.00-7.00	< 1.00	B	7.00	22.00	6.00

(Dhingra et al, 2012; Omodamiro et al, 2013). NB: These values are approximate values and can vary based on factors such as variety, processing and preparation methods, and storage conditions.

Benefits of combining sweet potato flour, soya beans and crayfish as baby foods

Consumption of a mixture of ground sweet potato flour, soya beans and crayfish can provide several benefits such as:

1. Nutrient-rich: Sweet potatoes are a good source of vitamins, including vitamin A and C, as well dietary fiber. Soya beans are a rich source of protein, healthy fats and minerals such as calcium and iron. Crayfish is high in protein and iron. The combination of these ingredients provides a wide range of essential nutrients for a growing baby (WHO/UNICEF,1998).

2. Energy-dense: The combination carbohydrates from sweet potatoes and protein from soya beans and crayfish can provide a good amount of energy for growth and development (WHO/UNICEF,1998).

3. Digestive health: The high fiber content in sweet potatoes and the presence of fiber in soya beans can contribute to good digestion and prevent constipation in babies (Williams,1995).

4. Growth and Development: Protein is crucial for a baby's growth and development, and both soya beans and crayfish provide quality protein. Protein is essential for building and repairing tissues, enzymes and hormones in the body.

5. Iron absorption: Iron is important for babies as it supports healthy brain development and oxygen transport in the body. Crayfish and soya beans are both good sources of iron and when combined with vitamin C from sweet potatoes, it can enhance iron absorption (WFP, 2004).

6. Allergy-friendly: Sweet potatoes and soya beans are both considered non-allergenic foods, making this mixture a suitable choice for babies with food allergies or sensitivities (Williams,1995).

CONCLUSION AND RECOMMNENDATIONS

Fortifying sweet potato flour with ground soya beans and crayfish can provide numerous health benefits for baby foods. The combination offers a rich source of essential nutrients such as protein, vitamins, minerals and antioxidants. These nutrients are crucial for promoting healthy growth and development in infants. Additionally, incorporating such fortification can enhance the nutritional value and diversity of baby food options. However, it is important to consider individual dietary needs, allergies and cultural preferences when introducing these fortified blends. It is important to note that introducing solid foods to a baby's diet should be done gradually and under the guidance of a healthcare professionals. Overall, fortifying sweet potato flour with ground soya beans and crayfish is a promising strategy to ensure healthy and nutritious baby foods.

REFERENCES

Amagloh, F. K., Hardacre, A., Utukumira, A. N., Weber, J. L., Brough, L., & Coad, J. (2012). A household-level sweet potato-based infant food to complement vitamin A supplementation initiatives. *Maternal and Child Nutrition*, *8*(4), 512-521. https://doi.org/10.1111/j.1740-8709.2011.00343.x

Anderson, J. W., Baird, P., Jr, R. H. D., Ferreri, S., Knudtson, M., Koraym, A., Williams, C. L. (2009). Health benefits of dietary fiber*, Nutrition Reviews*, *67*(4), 188-205. https://doi.org/10.1111/j.1753-4887.2009.00189.x

AOAC International. (2000). *Official Methods of Analysis* (18th ed.). Washington, DC: Association of Official Analytical Chemists.

Astawan, M., & Widowati, S. (2011). Evaluation of nutrition and glycemic index of sweet potatoes and its appropriate processing to hypoglycemic foods. *Indonesian Journal of Agricultural Science 12*(1), 40-46.

Brooks, S. P. J., Mongeau, R., Deeks, J. R., & Lampi, B. J. (2006). Dietary fibre in baby foods of major brands sold in Canada. *Journal of Food Composition and Analysis*, *19*, 59-66.https://doi.org/10.1016/j.jfca.2005.02.002

Codex Alimentarius Commission. (1991). *Guidelines on formulated supplementary foods for older infants and young children: CAC/GL 08-1991*. Rome, Italy.

Dhingra, D., Michael, M., & Rajput, H. (2012). Dietary fibre in foods: a review. *Journal of Food Science and Technology*, *49*(3), 255-266. https://doi.org/10.1007/s13197-011-0365-5

Haile, F., Admassu, S., & Fisseha, A. (2015). Effects of pre-treatments and drying methods on chemical composition, microbial and sensory qualities of orange-fleshed sweet potato flour and porridge. *American Journal of Food Science and Technology*, *3*(3), 82-88. https://doi.org/10.12691/ajfst-3-3-5

Oke, M. O., & Workneh, T. S. (2013). A review on sweet potato postharvest processing and preservation technology. *African Journal of Agricultural Research*, *8*(40), 4990-5003. https://doi.org/10.5897/AJAR2013.6841

Omodamiro, R. M., Afuape, S. O., Njoku, C. J., Nwankwo, I. I. M., & Echendu, T. N. C. (2013). Acceptability and proximate composition of some sweet potato genotypes:

Implication of breeding for food security and industrial quality. *International Journal of Biotechnology and Food Science*, *1*(5), 97-101.

Ötles, S., & Ozgoz, S. (2014). Health effects of dietary fiber. *Acta Scientiarum Polonorum Technologia Alimentaria*, *13*(2), 191-202.

Pan American Health Organization (PAHO) and World Health Organization (WHO). (2001). *Guiding principles for complementary feeding of the breastfed child*. *Global consultation on complementary feeding*. Washington, D.C.

Ugwuona, F. U., Awogbenja, M. D., & Ogara, J. I. (2012). Quality evaluation of soy-acha mixes for infant feeding. *Indian Journal of Scientific Research*, *3*(1), 43-50.

WFP (2004). *Fortified blended food: Good manufacturing practice and HACCP principles. A handbook for processors in partnership with the U.N. World Food Programme*.

WHO/UNICEF. (1998). *Complementary feeding of young children in developing countries: A review of the current scientific knowledge. WHO/NUT/98.1.* Geneva: World Health Organization. https://doi.org/10.1017/CBO9781107415324.004

WHO, UNICEF, & WORLD BANK GROUP. (2015). *Levels and trends in child malnutrition: UNICEF-WHO World Bank Group joint child malnutrition estimates*. https://doi.org/10.1016/S0266-6138(96)90067-4

Williams, C. L. (1995). Importance of dietary fibre in childhood. *Journal of the American Dietetic Assosciation*, *95*(10), 1140-1149.

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UNIVERSITY OF ABUJA, NIGERIA
21-25 OCT. 2024
PROCEEDINGS

Strategies for Soil Health Restoration to Reduce Risks of Soil Degradation for Crop Productivity: A Review

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Abstract

The demand for food, coupled with the increased number of people in the world which is targeted to be 9.5 billion by 2050, compels a rise to agricultural productivity by 70%. To sustain and achieve the desired improvement in agricultural productivity, degradation of the soil needs to be curtailed. Soil degradation has led to decrease in soil health, reduced productivity of crops and farm profitability. The major degradation processes include accelerated erosion, decline in soil organic carbon, reduced biodiversity, soil fertility loss and nutrient unavailability as well as acidification and salinization. The issue of soil degradation can be ameliorated through a restorative land use and adoption of soil health recommended management practices. Strategies for restoration of soil quality to reduce risks of soil degradation are to curtail soil erosion, improve organic carbon of the soil, nitrogen budgets, enhance the activity and biodiversity of soil biota and increase structural stability and pore geometry. Factors enhancing the health of the soil include improved soil organic carbon, soil structure and soil fertility which could reduce the risks of any forms of degradation thereby improving the environment. Enhancing soil organic carbon to the critical level ranging from 10 to 15 g/kg is significantly important to begin the restorative trends. There are some techniques accepted to restore the quality of soil such as conservation agriculture, integrated nutrient management, residue mulch and cover cropping, and controlled grazing. Therefore, the paper seeks to address the impact of soil degradation, by reducing losses and improving the soil, water, and nutrient use efficiency for sustainable agricultural productivity.

Keywords: soil quality, soil degradation, desertification, soil carbon sequestration

INTRODUCTION

Over the years developing countries has experienced a tremendous increase in population which led to a greater percentage of them depend on agriculture for their livelihood (Van *et.al*, 2014). More than a billion people who are farmers utilize less than two hectares of agricultural farm land (IFAD 2010). With respect to dearth of resources and inability to access agricultural inputs, there is need to manage and sustain soil quality for improved ecosystem services. Soil degradation has remain a big threat to the world especially tropical and subtropical region with its attendant consequences to lower productivity. A change in soil quality affects the soil ecosystems to provide its goods and services (Leon *et.al*, 2014). Soil deteriorations have affected many agricultural lands which impacts negatively on crop productivity, reducing economic growth and development (Bini, 2009). In addition, soil degradation is simply defined as the loss of soil's capacity with respect to loss of soil fertility, soil microbiota, and deteriorations with their attendant decrease in ecosystem functions and services (Lai, 2009). Most soil degradations occur due to land and soil mismanagement, climate change and its related factors. Hence, soil degradations are grouped into the following degradations; physical, chemical, biological and ecological degradations.

Soil physical degradation involves the destruction of soil structure, dispersion of soil particles, crusting, sealing, compaction, low water infiltration, reduced root penetration, water logging and increased surface runoff, accelerated water/wind erosions, endangered soil, un-optimal soil temperature which fluctuates, and inhibited aeration. These degradation processes increase desertification. Chemical degradation of the soil simply leads to the loss of nutrients or organic matter, acidification, salinization, reduction in cation exchange capacity, increased Aluminium or Manganese toxicities, Calcium or Magnesium deficiencies, elemental imbalance, leaching of nitrates, essential nutrients or contaminated industrial wastes and decline in soil fertility. Leaching of nutrients affect negatively the soil capacity to enhance crop growth and production which may cause acidification. Biological degradation of the soils lead to lower soil organic matter, reduction in soil microbial, decrease in soil carbon storage capacity, as well as high greenhouse gas emissions from the soil to the atmosphere. The major threat occasioned by biological degradation of the soil is the carbon dioxide and methane gas emissions from the soil instead of the carbon sink. Ecological degradation of the soil lead to the combine effects of soil physical, chemical and biological deterioration, which affect disruption in nutrient cycling, nutrient and carbon losses, decrease in use efficiency of inputs, infiltration and purification of water , perturbations of the hydrological cycle, and reductions in net biome productivity and inhibited denaturing of pollutants. The overall low soil quality has strong positive feedbacks which cause a decline in ecosystem functioning, services and decline in nature conservancy. Therefore, the review seeks to highlight the impacts of soil resources in provisioning ecosystem functions and services together with soil deterioration impacts on decline in ecosystem services, and identify strategies for soil health restoration to reduce the risks of soil degradation for crop productivity.

A. Soil and its Ecosystem Services

Soil is a non-renewable resources which harbour all the terrestrial life and cultural heritage (Bini et.al, 2015). The Soil is threatened by degradation via natural and anthropogenic factors. Soils perform a large function in the ecosystem which linked between the air, water, rock, and organisms. The soils are responsible for many different functions in the natural world which includes the quality and composition of air, temperature control, cycling of carbon and nutrient, water quality and cycling, natural waste decomposition management and recycling, and habitat for most living things and their food. Human beings and other living things could not function and survive without these soil functions. In order words, soil quality /health need to be restored to increase these services (Robinson *et. al*, 2012). Soils support seeds germination, and made available the provision of heat, nutrients, and water to nurture plants and crops. These plants form association with other living things and microbial organisms to create an ecological niche. Thereby, these plants provide essential and valuable habitat and food sources for the growth of animals, microorganisms etc. A well protected soil curtails erosion. A wind blow across the surface of the soils create wind erosion and as such suspended the soil particles or debris in the air. These are easily inhaled, consequently resulting to major respiratory challenges. Soil particles may have contain some minute microorganisms which cause infections and diseases. Soils play a role in temperature control which is important in many chemical and biological processes. Soils is also a storehouse of carbon and nutrient cycling. Soil contains great quantity of stored carbon as carbon is stored in fossil fuels, soils, oceans and rocks. Soil processes affect the balance of organic carbon which results to carbon dioxide release in the atmosphere. These processes also happen with nitrogen, phosphorus and other chemical materials. Soil serves as filtration medium which allows water to filter through the soil for plants, microbes and other living things use. In addition, excessive nitrogen and phosphorous fertilizer applications can sieve through the soils to contaminate ground water bodies. With this, most freshwater systems having contaminated with either phosphorous or nitrogen can breed the growth of photosynthetic organisms. Soils have the ability to convert waste products to a better reusable materials. Humans and other living organisms use soils to decompose waste materials to a new products (Robinson *et. al*, 2012).

B. Impacts of soil organic carbon on Soil health

Soils consist organic carbon which remains an indicator for checkmating erosion (Krupenikor *et.al*, 2011; Rayan *et.al*, 2010). Erosion decimates the soil organic Carbon, together with other nutrients such as nitrogen, phosphorous and sulphur. In addition, loss in organic carbon of the soil results to soil degradation. To reduce the risks of soil degradation, soil organic carbon should be above the critical level which range from 10 to 15 g/kg (i.e.1.0% to 1.5%) and by so doing, degradation trends could be reversed. Soil organic carbon levels could be maintained through the adoption of integrated nutrient management which sequester more carbon dioxide into the organic carbon of the soil for better soil fertility and crop productivity (Vanlauwe *et.al*, 2012). The agricultural soil organic carbon could be affected by over-exploitation in natural resources (Lar, 2004). In addition, soil moisture content remains another indicator to climate change which could affect the rate of decomposition of soil organic carbon (Eaton *et.al*, 2012). The combination of soil erosion with loss in soil organic carbon pose a big threat to climate change and its associated changes in temperature and moisture contents (Melillo *et.al,* 2010).

C. Soil Health Index

The organic carbon of the soil remains an important factor of soil health and agricultural sustainability. Other parameters of soil health indicators are soil organic carbon depth, distribution, attributes and the turnover rate of soil organic carbon. Soil health indicators may be either physical, chemical or biological. Soil physical qualities are aggregates, seal crusting and compaction, porosity, water infiltration rate, water transmission and retention, soil aeration, depth of root, soil heat capacity and temperature content while that of chemical indicators are pH of the soil, cation exchange capacity, nutrient availability, and elemental balance and reduction in any deficiency (Gugino, 2009). Further, soil biological indicators are microbial biomass carbon, soil biodiversity, lack of harmful pathogens and pests. The whole soil health indicators may affect crop productivity, water use efficiency, nutrient availability. These indicators may vary among soil types, climates and land uses. To assess the soil health status, reflectance spectroscopy may combine the soil physical, chemical and biological attributes as well as using the state of soil functions for a particular purpose (Paz-kagan *et.al*, 2014).

D. Conservation Agriculture and Soil Health

Lar (2015) stated that there are four basic principles that associate with conservation agriculture which are crop residue mulch retention, integration of crop rotation and integrated nutrient management practices with combination of inorganic and bio fertilizers, and reduction of soil mechanical disturbances. Conversation agriculture has many benefits such as decrease in consumption of fuel and high soil carbon sequestration which can be properly implemented on suitable suitable soil types. Use of tractors to till the soil, if the usage is reduced can properly eliminate the consumption of fossil fuels. There is need to incorporate the acceptable tillage systems which can restore soil health, reduce soil erosions , increase water use efficiency and fertilizers; reduce soil organic carbon and deplete nutrient availability.

The following factors can degrade soil health, low organic carbon which increases soil erosion, indiscriminate use of tillage practices such as plowing, plant residues removal, and inappropriate synthetic fertilizer applications (So,2001). However, conversion of plow tillage practice to conservation agriculture could increase soil health restoration. Incorporation of crop residue mulch, cover crops and reduction of fallows could preserve the soil as well as improving soil organic carbon. According to Pittelkow *et.al*, 2015, soil aggregates can be improved, and soil carbon encapsulated with micro aggregates by improving soil biodiversity, increasing the activity of earthworms and termites. Enhancing the elemental cycling, and increasing the cycling of carbon and water, could improve soil carbon levels and depth of soil profile via established use of some rooted plants. With adequate improvement of soil health, there will be improved total biome productivity, increased water and nutrient use efficiencies, and enhanced biomass carbon.

E. Soil Fertility Management.

The ability to sustain and improve crop productivity is only achievable by improvement of soil quality. The adoption and application of integrated nutrient management increases soil fertility and serves as an effective method for achieving sustainable crop production. Low crop productivity occurs as a result of reduction in nutrient availability and loss of soil fertility. Abiven *et.al*, 2008 reported that one of the major strategy to increase soil fertility as well as improving the soil physical attributes i.e structural stability or aggregates is the application of soil organic amendments, in conjunction with recycling urban wastes. Though, application of nitrogen fertilizer is vital to improving soil fertility and crop production. Its overuse can results to soil and water pollution.

F. Soil Health and Water Resources

Healthy soil is the bedrock for sound and sustainable economy. There is correlation existing among health of a soil and water resources, perhaps the health of coastal ecosystems. Tsatsaros *et.al*, 2013 reported that land use transformation have an effect on the quality of water and pollutant. Chemical waste materials of agricultural origin, when released to the environment find its way to the water bodies leading to contamination, water pollution and eutrophication problems. Atapattus *et.al*, (2009) stated that there is adverse effect of chemical inputs on the soil. These chemical inputs may leach to the water bodies to cause river desiccation, surface and ground water pollution, accelerated erosion, sedimentation, salinization, and nutrient reduction. Agronomic practices such as irrigation remains one of the vital management strategy for improved crop productivity. Improper use of irrigation waters has heightened the challenges which affect the irrigated lands. In addition, some soils are threatened by wastes contaminants. These soils are affected by chemical toxicity problems in aquatic life and other animals due to water contaminants which drained through the soil sub-surface to the water bodies. Dakoure *et.al*, 2013 pointed out that saline challenges are complicated by the reapplication of untreated waste gray water) in agriculture, where water shortages are marginally of low quality. So, the ability to restore the quality of soil within ecosystems remain critical in improving water quality. To achieve that, there is need to improve integrated management of soil and water resources because of the soil-water-waste interconnectivity. In as much as integrated water management practices remain useful, the soil-water interconnectivity cannot be overlooked. Apitz *et.al*, 2002 showed that there is need to manage contaminated sediments which is one of the crucial component of the soil-water interconnectivity.

G. Strategies for restoring soil health

Soil health restoration is very important process in reducing the risks associated with soil degradation and ensuring sustainable crop productivity. Lar, 2015 reported that there is need to decarbonise soil organic carbon levels. This needs the continuous application of carbon and essential mineral elements. Some basic strategies to restore soil health and eliminate soil degradation are minimizing losses from soil, creating adequate soil carbon contents, and at same time, enhances biodiversity, and strengthening elemental cycling. Others include cover cropping, No-Till or reduced tillage, organic matter management, Mulching, Reduction of over application of chemical fertilizers and pesticides, Conservation tillage, Terracing and contour farming, companion planting, Soil testing and balanced fertilization, water management, Agro forestry and windbreaks, and Bio-char application.

1. Soil erosion Management

Soil erosion causes soil degradation and as such should be handled. Erosion reduces organic carbon and nutrient availability. The ratio of soil organic carbon, clay and other essential plant nutrients are far more greater one, and most cases more than five because of the removal of these mineral constituents. Helman *et.al*, 2014 revealed that conversion of plow tillage to conservation agriculture reduces the threat posed by soil erosion and nutrient loss. The two key effects of soil erosion are land and soil mismanagement. Other effects could be over-grazing of animals which can degrade soil structure, reduce water infiltration and also increase runoff. Soil erosion can cause adverse loss to economic development.

2. Enhancing Soil diversity

Microorganisms in the soil are very crucial to the improvement of soil health. Their activity decrease the risks of degradation and desertification. Soil biota such as bacteria, fungi, nematodes, earthworms, insects especially termites are major component of soil biodiversity. They are critical for the following ecosystem services such as decomposition of biomass, cycling of nutrients and carbon dioxide moderation in the air. They can assist the soil to suppress diseases. To restore and promote soil health status, reducing the threat associated with soil degradation, soil microbial agents such as soil fauna and flora needs to be improved by practicing a good agricultural management activity (Bastida *et.al*, 2006). Biotic and a biotic factors have an effect on the soil biological resources. Some seasonal changes as well as moisture content of the soil influence soil microbiological processes like microbial biomass content and activity. Earthworm and termites activities play significant role to the soil by ensuring the improvement of soil fertility. Agricultural activities are conversion of plow tillage practices to conservation agriculture, residue mulch and cover cropping. These influence earthworm activities, and also improve physical structural properties. The conversion of plow tillage practises to conservation have its own implications with respect to transportation of pollutants into the drainage water. To mitigate the threat associated with the degradation of the soil health, there is need to adopt land use and management system that can enhance soil biological processes, thereby, introduce beneficial microbial agents through inoculation. The presence of nematodes, insects such as termites and other soil microorganisms are significant indicators of soil quality (Ayuke *et.al*, 2012).

3. Soil restorative farming Practice

Crop rotations, soil fertility and soil erosion management, control of grazing rate, and water management have significant effect on the severity challenges of soil degradation which can alter soil organic carbon, soil aggregates, compaction and other soil properties. Efficiently managed irrigation practices prevent soil erosion and nutrient leaching. There is need to adopt water-saving technologies like drip irrigation or rainwater harvesting. Planting a diverse range of crops in rotation can break pest and disease cycles, improve nutrient cycling and enhance soil structure. Different crops have varying root structures and nutrient requirements, which can help maintain soil and reduce soil degradation. Ryan *et.al*, 2008 reported that crop rotations and grazing, particularly have great impact to the organic carbon levels of the soil and its attendant soil properties. Increase in compaction and reduction of soil organic carbon are challenges that need to be resolved. To reduce the threat of degraded soils, there is need to efficiently manage and conserve the soil-water efficiency.

4. Cover Cropping

Planting of cover crops during fallow periods or between cash crops help to protect the soil from erosion, suppress weeds, and enhance organic matter content when incorporated into the soil. They can fix nitrogen as well as improve water retention capacity of the soil. Cover crops also improve the soil structure, increase nutrient availability for subsequent crops (Helma et al 2014).

5. Organic Matter Management

Incorporation of organic matter through the addition of compost, manure, or other organic materials enhances soil structure, nutrient availability together with water holding capacity. Practices such as incorporating crop residues, cover cropping, and introduction of compost or manure can contribute to higher organic carbon levels (Berazzneva et al, 2014).

6. Mulching

Application of organic mulches e.g straw, wood chips can protect the soil from accelerated erosion, temperature fluctuations, and weed growth. Mulching also introduces organic matter to the soil as they decompose (Govaerts et al, 2006).

7. Nutrient management

Application of inorganic inputs and pesticides can have adverse effect on the beneficial soil organisms and disrupt the soil ecosystem services. Applying fertilizers judiciously/ based on soil nutrient analysis and crop requirements prevents over application, which can contribute to nutrient runoff and soil degradation. Balanced nutrient management promotes optimal crop growth. It minimizes the risk of nutrient imbalances (Diacono *et al*, 2010).

8. Integrated Pest Management (IPM)

Implementation of Integration Pest Management practices helps to reduce the reliance on synthetic pesticides, which can negatively impact on soil health. Integrated pest management combines biological control, rotation of crops, and habitat manipulation to manage pests efficientlys while minimizing environmental harm. Hence, incorporation of integrated pest management practices reduce the rate of chemical inputs in the soils (Leon et al, 2014).

9. Conservation Tillage

Eliminating tillage helps to minimize erosion in the soil and compaction, preserve structure of the soil and organic matter. Conservation tillage practice can be employed to retain crop residues on the surface of the soil, improve water infiltration, and enhance microbial activity. Therefore, conservation tillage practices disturb the soil minimally, maintain soil structure, improve water infiltration, and reduce erosion (Diacono et al, 2010).

10. Windbreaks, terracing and contour farming

Integration of trees and shrubs into agricultural landscapes, along field edges helps to provide windbreaks, curtail soil and wind erosion, and thereby reducing nutrient loss and enhance soil fertility. During contour farming, crops are planted on the contour lines of the land, helps slow down water runoff, preventing soil erosion and retaining moisture on the soil (Bastida *et.al*, 2006).

11. Companion planting

Compatible plant species are grown together to reduce and eliminate pests, improve nutrient uptake, and support a diverse soil micro biome (Diacono et al, 2010).

12. Soil Testing and Monitoring.

Regular soil testing allows farmers to assess or determine the soil health parameters such as nutrient levels, pH of the soils and organic matter content. Unbalanced nutrients attract application of fertilizers in a balance manner to meet the crop requirements without over application. Monitoring soil health over time helps to identify degradation risks, make informed management decisions, and track the effectiveness of restoration efforts (Bastida *et.al*, 2006).

13. Bio-char Application

A stable forms of charcoal called bio-char are added to the soil to improve the nutrient retention and enhance soil structure (Greenland *et.al*, 1994)

H. Soil Resilience

Soil resilience refers to the ability of the soil to withstand and recover from various disturbances or stresses, while maintaining its essential functions and productivity. Greenland *et.al*, 1994 defined soil resilience as an elastic attributes of the soil which enables any soil to regain its functional and structural quality with regards to alleviating destabilizing influence. It involves the soil's capacity to handle changes in environmental conditions, such as drought, flooding, pollution, or land management practices, without undergoing substantial degradation or loss of functions. Soil resilience is vital for sustainable agriculture, ecosystem health, and mitigating the impacts of climate change. It is influenced by factors like soil organic matter, nutrient content, microbial, and soil structure. Implementing sustainable soil management practices, such as crop rotation, cover cropping, reduced tillage, and adequate nutrient management, can enhance soil resilience and promote long-time soil health. Lynch (2002) indicated that quality of soil organic carbon is important in identifying soil management practices which can improve soil resilience and thereby decrease the threat of soil degradation. There is a relationship existing between soil organic carbon and the quantity of microbial biomass content inputs. The continual input of the biomass content regulate moderates microbial biomass content, and provides plant nutrients such as nitrogen, phosphorous and sulphur , affects cycling of nutrient, and stabilizes soil aggregates, compaction etc and pore sizes. There are also some organic management options such as bio-char, a carbon enrichment soil amendment that can reduce the risks of soil degradation as well as promote soil resilience, and reduce climate change (Brevlman *et.al*, 2015).

CONCLUSION AND RECOMMENDATIONS

Soil resources are significantly important to all terrestrial life. It threatened by soil degradation due to land misuse and mismanagement. Soil degradation can occur as a result of decrease in soil structure, crusting, compaction, erosion, anaerobiosis, water imbalance which are physical attributes while acidification, salinization, elemental imbalance, nutrient deficiency remain the chemical attributes of soil degradation. The third aspect is biological degradation of the soil which include reduction in soil organic carbon, decrease of soil biodiversity and microbial biomass carbon While distortion in elemental cycling, decreased carbon levels remain the ecological aspect of soil degradation. Degradation of soil results with decrease of ecosystem services. The organic carbon of the soil is an important component of soil health and ecosystem services. Soil degradation reduces the soil organic carbon content, and restore soil quality, it has to reach at least 11 to 15 g kg^{-1}. There are important ways or strategies to enhance soil health and reduce soil degradation risks which include controlling soil erosion, maintaining and creating sound ecosystem carbon budget, improving nutrient availability, be it macronutrients such as nitrogen, phosphorous, sulphur and micro-nutrients such as zinc, iron, copper etc, enhancing the microbial processs. Hence, there is need to adopt an integrated soil resource management approach for the improvement and restoration of soil health.

REFERENCES

Van Pham, L and C. Smith, C. Drivers of agricultural sustainabilsity in developing countries: A review. *Environmental System Decision, vol. 34*, 2014, pp. 326–341.

IFAD. International Fund for Agricultural Development*. The Rural Poverty Report 2011*: Rome, Italy.2010

Leon, J and Osorio, N. Role of Litter Turnover in Soil Quality in Tropical Degraded Lands of Colombia. *Science World Journal.* 2014, *13*, doi:10.1155/2014/693981.

Berazneva, J., Conrad, D., Guerena, Lehmann. Agricultural productivity and soil carbon dynamics: A bio-economic model. In Proceedings of the Agricultural and Applied Economics Association 2014 Annual Meeting, Minneapolis, MN, USA, 27–29 July 2014.

Bini, C. Soil: A precious natural resource. In *Conservation of Natural Resources*; Kudrow, N.J., Ed.; Nova Science Publishers: Hauppauge, NY, USA; 2009 pp. 1–48.

Diacono, M. and Montemurro, F. Long-term effects of organic amendments on soil fertility: A review. *Agronomy Sustainable Development.* 2010, *30*, 401–422.

Lal, R. Soil degradation as a reason for inadequate human nutrition. *Food Sec*.; vol. *1*, 2009, 45–57.

Robinson, D., Emmett, B., Reynolds, B., Rowe, E., Spurgeon, D., Keith, A., Lebron, I., Hockley, N., Hester, R. and Harrison, R. Soil Natural Capital and Ecosystem Service Delivery in a World of Global Soil Change. *Soils Food Security; vol. 35*, 2012, 41–68.

Manlay, R.; Feller, C.; Swift, M. Historical evolution of soil organic matter concepts and their relationships with the fertility and sustainability of cropping systems. *Agricultural Ecosystem Environment.* 2007, *119*, 217–233.

Govaerts, B.; Sayre, K.; Deckers, J. A minimum data set for soil quality assessment of wheat and maize cropping in the highlands of Mexico. *Soil Tillage Reources.* 2006, *87*, 163–174

Vanlauwe, B., Hester, R. and Harrison, R. Organic Matter Availability and Management in the Context of Integrated Soil Fertility Management in sub-Saharan Africa. *Soils Food Security; vol.35*, 2012, 135–157.

Eaton, W., Roed, M, Chassot, O. and Barry, D. Differences in soil moisture, nutrients and the microbial community between forests on the upper Pacific and Caribbean slopes at Monteverde, Cordillera de Tilaran: Implications for responses to climate change. *Tropical Ecology; vol. 53*, 2012, 235–240.

Melillo, J.M., Steudler, P.A., Tian, H. and Butler, S. Fertilizing change: Carbon-nitrogen interactions and carbon storage in land ecosystems. In *Handbook of Climate Change and Agroecosystems: Impact, Adaptation and Mitigation*; Hillel, D., Rosenzweig, C., Eds.; Imperial College Press: London, UK; 2010, pp. 21–36.

Paz-Kagan, T., Shachak, M., Zaady, E. and Karnieli, A. A spectral soil quality index (SSQI) for characterizing soil function in areas of changed land use. *Geoderma*, vol. *230*, 2014, 171–184.

Gugino, B.K. *Cornell Soil Health Assessment Training Manual*; New York State Agricultural Experiment Station Cornell University: New York, NY, USA.2009

Lal, R. On Sequestering Carbon and Increasing Productivity by Conservation Agriculture. *Journal of Soil Water Conservation.* in press.2015

So, H., Kirchhof, G., Bakker, R. and Smith, G. (2001). Low input tillage/cropping systems for limited resource areas. *Soil Tillage Resources;* vol. *61*,2001, 109–123.

Pittelkow, C., Liang, X., Linquist, B.,van Groenigen, K., Lee, J., Lundy, M., van Gestel, N., Six, J., Venterea, R. and van Kessel, C. Productivity limits and potentials of the principles of conservation agriculture. *Nature;* vol.*517*, 2015, pp.365–482

Abiven, S., Menasseri, S. and Chenu, C. The effects of organic inputs over time on soil aggregate stability. *Soil Biological Biochemistry vol. 41*,2008,pp. 1–12.

Tsatsaros, J., Brodie, J., Bohnet, I. and Valentine, P. Water Quality Degradation of Coastal Waterways in the Wet Tropics, Australia. *Water Air Soil Pollution; vol. 224*, 2013 doi:10.1007/s11270-013-1443-2.

Schaffner, M., Bader, H. and Scheidegger, R. Modeling the contribution of point sources and non-point sources to Thachin River water pollution. *Science of Total Environmen; vol. 407*, 2009,pp. 4902–4915.

Atapattu, S. and Kodituwakku, D. Agriculture in South Asia and its implications on downstream health and sustainability: A review. *Agricultural Water Management; vol. 96*, 2009,pp.361–373.

Dakoure, M., Mermoud, A., Yacouba, H. and Boivin, P. Impacts of irrigation with industrial treated wastewater on soil properties. *Geoderma; 200*, 2013, pp. 31–39.

Apitz, S.E., Brils, J., Marcomini, A., Critto, A., Agostini, P., Micheletti, C., Pippa, R., Scanferla, P., Zuin, S. and Lanczos, T. Approaches and frameworks for managing contaminated sediments—A European perspective. In *Assessment and Remediation of Contaminated Sediments*; Springer: Berlin/Heidelberg, Germany. 2006

Kohli, R.V., Singh, H.P., Batish, D.R. and Jose, S. Ecological interactions in agroforestry: An overview. In *Ecological Basis of Agro forestry*; Kohli, R.V.S., Batish, D.R., Jose, S., Eds.; CRC Press: Boca Raton, FL, USA; 2008, pp. 3–14.

Helman, D., Lensky, I, Mussery, A. and Leu, S. Rehabilitating degraded dry lands by creating woodland islets: Assessing long-term effects on aboveground productivity and soil fertility. *Agricultural For. Meteorological; 195*, 2014, pp.52–60.

Bastida, F., Moreno, J., Hernandez, T. and Garcia, C. Microbiological degradation index of soils in a semiarid climate. *Soil Biological. Biochemistry; 38*, 2006, pp.3463–3473

Ayuke, F., Karanja, N., Okello, J, Wachira, P., Mutua, G., Lelei, D., Gachene, C., Hester, R. and Harrison, R. Agro-biodiversity and Potential Use for Enhancing Soil Health in Tropical Soils of Africa. *Soils Food Security* vol. *35*, 2012, pp. 94–134.

Greenland, D.J. and Szabolcs, I. (1994) Eds. *Soil Resilience and Sustainable Land Use*; CAB International: Wallingford, UK.

Breulmann, M. and van Afferden, M.and Fühner, C. Biochar: Bring on the sewage. *Nature* vol. *518*, 2015, pp. 483.

Sortino, O.; Montoneri, E.; Patane, C.; Rosato, R.; Tabasso, S.; Ginepro, M. Benefits for agriculture and the environment from urban waste. *Science Total Environment.* 2014, *487*, 443–451

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Potentials and Benefits of Hausa Potato (*Solenostemon Rotundifolius (Poir*) J. K. Morton): A Review

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Abstract
Hausa potato (Solenostemon rotundifolius (Poir) J.K. Morton) is an opportunity tuber crop in most parts of Africa and Asia. On world scale, the crop is the most widespread of the cultivated lamiaceae and multipurpose crop with different economic values. Its productivity is, however, low in terms of fresh tuber yield in the accessions available for cultivation in Nigeria. Consequently, many farmers are not encouraged to cultivate the crop, thereby limiting its popularity, it is believed to be of more economic importance. Other names of Hausa potato are Fra-fra potato (Gh.); Innala (Sri La.); Kembili (Mal.); Ketang (Indon.); Koorka (Ind.); Madagascar potato (Fr.); Ratala (Sri La.); Saluga (Nig.); Sudan potato, Tumuku (Nig.); Vatke (Eth.). Its tubers contain significant rate of carbohydrates, proteins, fibers, vitamins and antioxidants. Besides its nutritional attributes, S. rotundifolius has also strong agronomic and economic potentialities and could be financially rewarding to the farm economy. It has been reported to be one of the best staple tuber crops in terms of its distinctive fragrance, peculiar taste, medicinal, nutritional and economic values.
Key words: Hausa potato, Health Benefits, Potentials, Agricultural benefits

INTRODUCTION

Hausa potato *(Solenostemon rotundifolius* Poir) is a member of the Family Lamiatae (Labiatae) (Mint family) which consists of heterogeneous assemblage of over 300 plants. (Nkansah *et al* 2004) is amongst the lesser known tropical root crops in Nigeria, (Ukpabi, 2009). Hausa potato is a tropical, multipurpose, minor tuber crop. It has been reported to be one of the best staple tuber crops in terms of its distinctive fragrance, peculiar taste, and medicinal nutritional and economic values (Olojede, 2013). *S. rotundifolius* is known as Chinese potato, Sudan potato, country potato, Fra Fra potato, tumuku, hausa potato, Zulu round potato, innala, fabirama, or pessa (Olojede, 2013). Hausa potato is a small herb that has prostrate or ascending succulent stems and branches. It attains a height of 15-30 cm and presents a distinctive fragrance due to the presence of volatile oils in the glands or sacs of leaves (Allemann, 2002). The flowers are small and may be white, blue, pinkish or pale-violet in colour. They are borne on distal inflorescences with slender false spikes measuring up to 15 cm in length. It has small dark brown edible tubers produced at the base. It grows well in regions receiving annual rainfall between 700 and 1,000 mm, Yield under favorable condition may reach 30 t/ha or 45 t/ha (Nkansah, 2004). In Nigeria Hausa potato (*Solenostemon rotundifolius* Poir), is one of the underutilized species, they are important components of subsistence farming systems in their native areas of production; they serve as means of preserving cultural heritage and have a myriad of uses such as food, animal feed, medicines, cosmetics and income generation to rural households (Allemann, 2002).

Agronomic Practices of Hausa Potato

Agronomic practices of Hausa potato include Land preparation, which involve clearing, ploughing, ridging and plot mapping which is done manually and sprayed with pre emergence. The recommended net plot size is 3 m x 3 m (9 m^2). Randomized complete block design (RCBD) is also recommended with three replicates .Fresh and healthy tubers of hausa potato is also recommended to be planted at inter- and intra-row spacing of 1 m and 0.3 m, respectively, The plots is weeded manually at 21 days after planting and earthed up on the same day to avoid the exposure of the tubers to sunlight. Further weeding will be done at 45 and 90 days after planting to control weeds. Fertilizer application (NPK 15:15:15) at the rate of 200 kg ha at 8 weeks after planting is recommended (Akinpelu *et al*., 2011) Harvesting is done at four to five months after planting.

Its Potentials and Benefits

Solenostemon. rotundifolius tubers possess elite flavour and taste and have medicinal properties due to the presence of flavonoids that help to lower the cholesterol level of the blood (Schipper, 2000). The tubers can also be used as a potato substitute and are usually cooked in a curry and eaten with rice, but they can also be boiled, baked or fried similarly to potato chips. The tubers of the crop provide essential dietary and energy requirements to the populace during the lean periods (Namo *et al* 2018.) The tubers taste similar to Irish potato and trifoliate yam, and can be eaten as the main starchy staple or part of it in combination with legumes and vegetables. It can also be prepared in Indian and African cuisines as boiled, baked or fried (Schipper, 2000). Some workers reported that the tubers of Hausa potato can be used to make aromatic, alcoholic beverages (Schipper, 2000) while the leaves sometimes may also be eaten as pot-herbs (PROTA, 2013). Compared to other tuberous staples in Nigeria, The tubers contain significant rate of reducing sugar (26 mg/100g), protein (13.6 to 14.6 mg/100g), crude fat (1.2%), crude fiber (1.6%), phosphorus (36 mg/100g), calcium (29 mg/100 g), vitamins A and C, respectively 13.6 mg/100 g and 10.3 mg/100g, and antioxidants

(PROTA, 2013). The potential yield reported in West Africa ranged from 7 to 20 T/ha (Enyiukwu *et al.,* 2014).Other specific potentials include: **Health Benefits:** Its tubers and leaves are edible and offer several health benefits, which include, the leaves has dietary fiber, which aids digestion and promotes satiety(Namo *et al*., 2018). It Anti-diabetic properties may help regulate blood sugar levels and improve insulin sensitivity, It can support healthy gut bacteria through the prebiolia fiber in the tuber .It is a good source of essential minerals like potassium, magnesium and iron. It has antimicrobial activity against certain pathogens. It is rich in minerals like calcium, magnesium, and phosphorus support bone health (PROTA, 2013) .It has nutrition low calories which is a food option for those managing weight. In traditional medicine, it's used to treat various ailments, such as fever, phenmetism, digestive issues (Nkansah *et al.,* 2013), **Anti-cancer properties:** some studies suggest that the plants extracts have anti-poliferative are anti-cancer effect Nkansah *et al*., 2013. The plant may help reduce anxiety and stress it extracts have been shown to have anxiolytic and stress-reduce effects. The leaves is used in traditional medicine for various purposes such as. Treating skin condition. Some studies suggest that plants extracts have anti- HIV activity. The plants contain isoflavones which may help alleviate menopausal systems .The plants adaptogenic compounds may help alleviate chronic fatique. **It's Anti -oxidants properties** may help against kidney and liver damage. It may help boost the immune system, it help protect against cell damage and reduce inflammation, it may also contribute to healthier cholesterol levels Sandhya and Vijayalakshmi, (2015).The plants antioxidants and other compounds may also help protect against neurodegenerative disease, the fibre in the plants may help support heart health, other compounds in the plant may help reduce the signs of aging, lutein and zeaxanthin in the plant may help protect eye health Sandhya and Vijayalakshmi, (2015). The plant's Anti-inflammatory compounds may help alleviate asthma symptoms, alleviate allergic reaction, migraine symptoms, alleviate pain and reduce inflammation (Namo *et al*., 2018.)In Africa, the hausa potato is sometimes used in the treatment of dysentery and in the treatment of certain eye disorders. **Agricultural Benefits**: The plants extensive root systems helps to prevent erosion. The ornamental value of S. rotundifolius has attractive leaves and stem, making it a decorative addition to gardens (Abraham and Radhakrishnan (2005) The extract of S. rotundifolius has insecticide properties which has been shown to repel certain insects, making it a potential natural insecticide Allemann (2002).The plant root help improve soil structure and fertility. It is relatively drought tolerant and can thrive in challenging environmental conditions. As a food source and habitat for various animals, it contributes to maintaining ecosystem balance (Olojede, 2013). Cultivating and marketing S. rotundifolius can generate income and stimulate local economies (Abraham and Radhakrishnan (2005). For food security. It is a valuable food source in many African and Asian communities providing sustenance during times of scarcity. The leaves and stems can be used as nutrition's feed for livestock. **Industries:** In industries, the plants extracts are used in some cosmetics and skincare products due to their antioxidant and anti-inflammatory properties which may help protect against skin damage and reduce wrinkles, Ukpabi (2009), the leaves can be used as a natural dye for fabric.

CONCLUSION

Hausa potato has the potential of increasing the food bank, solving malnutrition problems, improving food security and increasing yield per unit area of land because of its higher biological efficiency and adaptation to different environments. It also has the potential and prospects for enlarged adoption into other agro-ecological zones in

Nigeria, thereby contributing to food security, diversification of the local food base and sustaining livelihood (Namo *et al*., 2018). In Africa, the hausa potato is sometimes used in the treatment of dysentery and in the treatment of certain eye disorders, The Hausa potato has the potential of increasing the food bank, solving malnutrition problems, improving food security and increasing yield per unit area of land because of its higher biological efficiency and adaptation to different environments. It also has the potential and prospects for enlarged adoption into other agro-ecological zones in Nigeria, thereby contributing to food security, diversification of the local food base and sustaining livelihood. The Hausa potato (*Solenostemon rotundifolius* (Poir)) J. K. Morton is a multipurpose crop with different economic values. More research is needed to fully understand the extent of these benefits and needed to fully explore and confirm these benefits. There is need also to understand the plants full potential

REFERENCES

Abraham, M. and Radhakrishnan V.V. (2005) Assessment and induction of variability in coleus (*Solenostemon rotundifolius*). Indian Journal of Agricultural Sciences. 2005; 75(12): 834-836.

Akinpelu, A.O, Olojede, A.O, Amamgbo, E.F and Njoku, S.C. (2011). Response of Hausa potato to different NPK 15:15:15 Fertilizer Rates in NRCRI, Umudike, Abia State, Nigeria. Journal of Agriculture and Social Research. 2011; 1(11):22-25

Allemann, J. (2002). Evaluation of *Plectranthus esculentus* N.E.Br. As a Potential Vegetable Crop. PhD Thesis, University of Pretoria, Pretoria, South Africa. p.273

Namo O. A. T. and Opaleye S. A.(2018) Productivity of Some Hausa Potato Accessions (*Solenostemon rotundifolius* (Poir) J. K. Morton in Jos-Plateau Environment Article in Journal of Agriculture and Ecology Research International April 2018 DOI: 10.9734/JAERI/2018/40758See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/324798867

Nkansah, 2004; Blench and Dendo, 2004; PROTA, (2013). In ethnobotany, preparation of boiled leaves of Hausa

Nkansah, G.O (2004). *Solenostemon rotundifolius* (Poir) J.K. Morton) in: internet Record from PROTA 4U. Grubben, G.J.H and Denton, O.A. (Editors). PROTA 2: vegetables/plant resources of Tropical Africa. p.204.

Olojede, A. O. (2013). Sugar beets and minor root and tuber crops.www.nrcri.gov.ng/pages/sugar.htm Retrieved November 10, 2013

Plant Resources of Tropical Africa (PROTA). *Solenostemon rotundifolius* Poir (Synonyms: Germania rotundifolius Poir, *Plectranthus rotundifolius* Sims) database; 2013. PROTA.org/db/wwpd/exec/db Retrieved November 9

Safwan, I.I. and Mohammed, U.A. (2016) Review on the nutritional value, cultivation and utilization potential of some minor and under-utilized indigenous root and tuber crops in Nigeria. Int J Adv Res. 2016; 4(3):1298– 1303. http://www.journalijar.com

Sandhya, C. and Vijayalakshmi, N.R. (2015) Antioxidant activity of flavonoids from *Solenostemon rotundifolius* in rats fed normal and high fat diets. Food Research International. 2005; 38(6):615-629.

Schipper, R.R. (2000). African indigenous vegetables: An overview of the cultural species, Natural Resources Institute, Chattam, UK. Pp 214

Ukpabi, U.J. (2009). Roots and Tubers in Nigeria as sources of Industrial Raw-Materials. In: Nigerian Agro Raw Materials Development. Some Industrial Crops and Salient Issues (Onwualu PA, Obasi SC and Ukpabi UJ Eds), RMRDC Publications, Abuja, Nigeria, 1: 1-19

Impact Assessment of Farmers' Use of Improved Sweetpotato Production Technologies on Vine Yield and Income in South-East, Nigeria

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Abstract
*This study assessed impact of farmers' use of improved sweetpotato production technologies on vine yield and income in South-East, Nigeria. Multi-stage sampling and proportionate sampling methods were used to collect data for the study. Three States were purposively selected for cultivation of sweetpotato and were involved in the dissemination of the technologies, two agricultural zones were randomly selected from the States, two (2) blocks were randomly selected from each of the zones and finally, proportionate sampling technique was used to select farmers from the circles to give a sample size of 364 sweetpotato farmers. List of sweetpotato farmers from Sweetpotato Farmers' Association, Abia State, Extension Services Programme office of NRCRI Igbariam outstation, Anambra State and Sweetpotato farmers' Association, Ebonyi State served as sampling frame. Data for this study were collected using structured questionnaire and analyzed using descriptive statistic such as mean while inferential statistics used were Z-test and Ordinary Least Square regression model. The result shows that mean of age was 37.3 years, mean education was 12 years and mean of farm size was 0.6ha. The value of Z-calculated (50.166**) and (82.525**) respectively were greater than the value of Z-tabulated (1.67), indicating increased farmers' vine yield and income from vines produced. The study, concluded that the improved sweetpotato production technologies disseminated to farmers had positive impact on the farmers' income. Therefore, it is recommended that sweetpotato farmers should continue to use the production technologies disseminated to them to improve their vine production and income.*
Keywords: Farmers, Use, Sweetpotato production technologies, Vine and Income.

INTRODUCTION
Rapid increase of human population on the national scale has necessitated a high demand for food. According to African Development Bank (AfDB) (2015), transforming agricultural sector will have greatest impact on economic growth of the continent, given that 70 – 80 % labour force of Africa is engaged in agriculture. In Nigeria, agriculture is still the main stay of the economy as majority of the rural dwellers are into farming (National Bureau of Statistics (NBS), 2018). The need to produce enough food crops to meet the ever-growing population demands have necessitated research for improve varieties of various crops including root and tuber crops.

Sweetpotato (*Ipomoea batata (L) Lam*) is an important tropical staple food crop, belonging to the morning-glory family known as *convolulaceae.* It originated from Latin

America (Low *et al*., 2017). It is a root crop mostly grown in many parts of the globe, is native to tropical America and is commonly called a yam in parts of the United States. Nigeria is the third largest producer of sweetpotato in the world with China leading, followed by Uganda (FAO, 2015). Sweetpotato is regarded as early maturing crop, has relatively little labour requirement and ability to thrive under Sub-Saharan Africa's climate (Uzoigwe *et al*., 2019). It offers significant potential for increasing food production and income in Nigeria like other crops (Udemezue, 2019). Its ease of cultivation and ability to thrive even under harsh conditions promote its spread in Africa. Sweetpotato is mainly propagated by vine-cuttings, planted on mounds and ridges and in single or double rows. It can be cultivated twice a year (i.e. April to August and August to December (Ehisianya *et al.,* 2014). In general, planting takes place from February through July in the central and south, where rainfall is heavier. The crop is grown for multipurpose, its roots and vines are used both for human food and for animal feed. Sweetpotato is used in a variety of ways for food, feed and processed (Walker *et al.,* 2014). There is need to investigate the impact of use of improved sweetpotato production technologies disseminated to farmers on the vine yield and income to see if there is positive or negative impact on the use of these technologies to vine production and income from the sales of sweetpotato vines. Hence, the study, impact assessment of farmers' use of improved sweetpotato production technologies on vine yield and income in South –East, Nigeria. Hypothesis 1 states that there is no significant difference between the vine yield before and after use of improved sweetpotato production technologies disseminated; and hypothesis 2 states that there is no significant difference between the income obtained from vine yield before and after use of improved sweetpotato production technologies disseminated.

METHODOLOGY

The study was conducted in South-East, Nigeria. The Zone is made up of five States, namely: Abia, Anambra, Ebonyi, Enugu, and Imo States. A multi-stage stratified and proportionate sampling technique was used to elicit data for the study. Three States, namely Abia, Anambra, and Ebonyi, were purposively selected, two agricultural zones were randomly selected from each of the States to give a total of six (6) zones, two (2) blocks were randomly selected from each of the zones to give a total of twelve (12) blocks, Finally, proportionate sampling technique was used to select farmers from the circles to give a sample size of 364 sweetpotato farmers. A list of sweetpotato farmers from sweetpotato farmers' association, Abia State, the Extension Services Programme office of NRCRI Igbariam outstation, Anambra State, and the Sweetpotato farmers' association, Ebonyi State served as the sampling frame. Data for this study were collected from primary sources using a structured questionnaire. Data were analyzed through descriptive and inferential statistics such as frequency, percentages, and mean.

RESULTS AND DISCUSSION

Socioeconomic Characteristics of the Farmers

Table 1 shows that the mean age was 37.3 years. This implies that a good number of the farmers were in their active age. The finding is in agreement with Ibeagwa, Nnamerenwa and Anorue (2012) who succinctly observed that farmers within the age brackets of 30-49 years have more innovative ability and capacity to do farm work. The mean education was 12 years, indicating that greater number of them had secondary education level and are considered literate farmers. Education has always been known to play a positive role in the utilization of improved technologies among farmers. Tijani and Sanusi (2019) stated that education is an important socioeconomic factor that influences farmers' awareness, perception, reception and transfer of innovations that can bring about increase in production. The mean of annual income was ₦579,395.6. The value of dollar during this study in August, 2021 was fixed at an average of ₦500.00 per dollar. This implies that majority of the respondent earned lower than I.9 dollar per person per day which is the World Bank rate for poverty line. This implies that they are resource poor farmers. Based on the most recent official household survey data from Nigeria National Bureau of Statistics (NNBS), 39.1 percent Nigerians lived below the international poverty line of 1.9 dollar per person per day (World Bank, 2018). This finding is in agreement with Gate (2014) who stated that poverty and lack have been on the increase in the society. The mean of household size was 6 persons. The result shows that there are good numbers of people living under the same roof and eating in the same pot. This implies that larger household size tends to increase sweetpotato cultivation and possible utilization of its production technologies. It is expected that large number of persons in a household will increase the level of sweetpotato cultivation and use of sweetpotato production technologies. Onubuogu *et al.* (2014) reported a similar result that most farm families have large household size of 6-10 persons. The mean years of farming experience was 10.6 years. This implies that the farmers had enough farming experience on sweetpotato farming. It is expected that the more experience one had in farming of any crop, the more the person will likely get involved and more committed in the use of such crop's production technologies. The result also shows that the mean farm size was 0.6ha, indicating that the sweetpotato farmers were small holder farmers. The result corroborates with finding of Abugu *et al.* (2013) who reported that majority of farmers in the South-East Nigeria were small scale farmers, on the average cultivate less than 2 hectares of land.

Table 1: Distribution of farmers according to their socioeconomic characteristics (n=364)

Variables	Mean
Age	37.3 years
Educational level	12 years
Income	₦579,395.6
Household size	6 persons
Farm size	0.6ha
Farming experience	10.6 years

Source: Field Survey, 2021

Difference between Vines Produced Before and After Use of Improved Sweetpotato Production Technologies

Table 2 shows the difference between vine yield before and after use of improved sweetpotato production technologies disseminated. The Z-test statistic in Table 2 shows significant difference ($P< 0.05$) in vine yield before and after use of improved sweetpotato production technologies in South-East, Nigeria. From the result, vine mean yield before use of improved sweetpotato production technologies was 78.1823 bundles/ha, while vine mean yield after use of improved sweetpotato production technologies was 123.8804 bundles/ha. There was sweetpotato vine yield difference of 45.70 bundles/ha between vine yield before and after use of improved sweetpotato production technologies. This finding is in agreement with Agbarevo and Mazza (2018), who reported that increase in farmers' yield as a result of application of better technologies can be used to measure the success of agricultural development programme.

The value of Z-calculated (82.525**) is greater than the value of Z-tabulated (1.67). This implies that improved sweetpotato production technologies increased farmers vine yield. Hence, the Z-test rejects null hypothesis which stated that there is no significant difference between vine yield before and after use of improved sweetpotato production technologies. Use of improved sweetpotato production technologies has significantly increased sweetpotato vine yield.

Table 2: Z-test analysis of difference between vine yield before and after use of improved sweetpotato production technologies

Source of Variation	N	Mean (bundle/ha)	Standard Deviation	Standard Error	Difference Bundle/ha	Z-cal	Z-tab
Vine yield before	364	78.1823	26.41433	1.3845	45.70	82.525**	1.67
Vine yield after	364	123.8804	65.18784	3.4168			

Source: Field Survey, 2021. *Significant at 5% level. Null Ho Rejected.*

Difference between Income from Vines Produced Before and After Use of Improved Sweetpotato Production Technologies

The Z-test statistic in Table 3 shows significant difference (P< 0.05) in income obtained from sweetpotato vines produced before and after use of improved sweetpotato production technologies disseminated. From the result, income obtained from sweetpotato vines produced before use of improved sweetpotato production technologies disseminated was ₦19,276.82/ha, while income obtained from sweetpotato vines produced after use of improved sweetpotato production technologies disseminated was ₦64,493.50/ha. There was income difference of ₦45,216.68/ha between income obtained from sweetpotato vines produced before and after use of improved sweetpotato production technologies. This finding is tandem with Agbarevo (2012) who stated that use of improved farming technologies increases farmers yield which translated into increased farmers' income.

The value of Z-calculated (50.166**) is greater than the value of Z-tabulated (1.67). This implies that use of improved sweetpotato production technologies increased farmers' income obtained from vine yield. This finding agrees with Agbarevo and Okereke (2015) who reported that agricultural technologies were effective in increasing farmers' income. Hence, the Z-test rejected null hypothesis which stated that there is no significant difference between income obtained from vines produced before and after use of improved sweetpotato production technologies. Use of improved sweetpotato production technologies has significantly increased income obtained from sweetpotato vine yield.

Table 3: Z-test analysis of difference between income from sweetpotato vines produced before and after use of improved sweetpotato production technologies

Source of Variation	N	Mean	Standard Deviation	Standard Error	Difference ₦/ha	Z-cal	Z-tab
Income from vine yield before	364	₦19,276.82	14496.0196	759.79788	₦45,216.68	50.166**	1.67
Income obtain after	364	₦64,493.50	41374.8796	2168.6329			

Source: Field Survey, 2021. *Significant at 5% level. Null Ho Rejected.*

CONCLUSION AND RECOMMENDATIONS

The study concluded that use of improved sweetpotato technologies had positive impact on farmers vine yield and there was increase income from the vine sales. Therefore, it is recommended that sweetpotato farmers should continue to use the improved sweetpotato technologies to improve vine yield and increase their income.

REFERENCES

Abudu, S., Haruna, S. K., Idehen, O. E. and Jamilu, A. A. (2014). Adoption of Recommended Cassava Production Practices among Farmers in Edo State, Nigeria. Proceedings of the 19 Annual National Conference of the Agriculture Extension Society of Nigeria, held at Owerri, Imo State, 27 -30 April. p. 23-29.

African Development Bank (AfDB) (2015). Nigeria agricultural transformation agenda support programme. Retrieved from http://www.afdb.org/projects-andoperations/project-portfolio/project/p-ng-aab-003.

Agbarevo, M. N. B, and Mazza, M. (2018). Effect of National Special Programmeand Food Security (NSPFS) on farmers' income for yam production in South-East, Nigeria. *International Journal of Applied Research and Technology.* 7(7): 1-8.

Agbarevo, M. N. B. (2012). Evaluation of relevance of packages of agricultural extension recommendations on cassava production to farmers felt needs in Cross River State Nigeria: implication for the attainment of millennium goal on food security. *Journal of Agricultural Extension and Rural Development. http://www.academicjournals.org.*DOI

Agbarevo, M.N.B and Okeke, S.O. (2015). The Effect of adoption of cassava value added technologies on farmers' production in Abia State, Nigeria. *European Journal of Physical and Agricultural Sciences,* 3(1): 48-53.

Ehisianya, C. N., Lale, N. E. S., Umeozor, O. C., Amadi, C. O. and Zakka, U. (2014). Evaluation of effectiveness of variety, tillage method and time of harvest on sweetpotato yield and the population of sweetpotato weevil, Cylas puncticollis (Boheman) (Coleoptera: Brentidae). *International Journal of Advanced Scientific and Technical Research*, 2(1): 165–183.

Food and Agriculture Organization (FAO) STAT (2015). FAO STAT. Food and Agriculture Data base www.fao org.free press.

Gate, B. (2014). Agricultural development strategy overview. Annual letter. Accessed on April 2, 2014. Available on www.gatesfoundation.org/What-We-Dwww.gatesfoundation/GlobalDevelopment/Agricultural-Development.

Ibeagwa, O.B., Nnamerenwa, G.C. and Anorue, P.C. (2012). Analysis of returns on investment of cassava processing in Kwara State, Nigeria. Proceeding of the 26th annual conference of Farm Management Association of Nigeria. Michael Okpara University of Agriculture, Umudike. Held October 15th-19th. p. 58-67.

National Bureau of Statistics (NBS) (2018). Demographic statistics bulletin. nigerianstat.gov.ng.

Onubuogu, G. C., Esiobu, N. S., Nwosu, C. S. and Okereke, C. N. (2014). Resource use efficiency of smallholder cassava farmers in Owerri Agricultural Zone, Imo State, Nigeria. *Scholarly Journal of Agricultural Science*s, 4(6): 306-318.

Tijani, S. A. and Sanusi, M. K. (2019). Level of Involvement of Shea butter processors in processing activities in North-central, Nigeria. Nigerian Journal of Rural Sociology, 19(1): 55 – 60.

Udemezue, J. C. (2019). Profitability and constraints to sweetpotato production in Nigeria. *Current Trends Biomedical Engineer and Bioscience*, 19(2): 14-24.

Uzoigwe, D. A., Muoneke, C. O., Nwokoro, C. C. and Ene, C. O. (2019). Benefit-cost analysis of orange fleshed sweetpotato (Ipomoea batatas L.) varieties under varying planting density. *Notulae Scientia Biologicae,* 11 (1): 145 – 148.
Walker, T., Thiele, G., Suarez, V. and Crissman, C. (2014). Hindsight and foresight about sweetpotato production and consumption. Lima, Peru.
World Bank (2018). Data bank. Poverty and equity brief, Nigeria.

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Comparative Analysis of Nutrient Media on *Agrobacterium* Growth Dynamics

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Abstract
The choice of a suitable growth medium is critical for optimizing bacterial growth, assuring the reproducibility of experimental data, and obtaining high biomass production. The main aim of this research is to examine the growth rates of two Agrobacterium strains in Yeast extract peptone (YEP), Luria-Bertani or lysogeny broth (LB), and Yeast extract mannitol (YEM) medium. This study evaluated the different nutrient media for the best fit in increasing bacterial growth and biomass yield, which is critical for applications in plant genetic transformation activities. Two Agrobacterium strains (LBA4404 and AGL-1) were used for this experiment, results of the optical density (OD) were recorded at three hourly intervals for a period of 24 hours, the results of the mean OD showed that LBA4404 performed best in LB media (0.417±0.30-0.517±0.32), followed by LBA4404 cultured in YEP media (0.342±0.22-0.395±0.25). AGL-1 performed best in YEP media (0.461±0.28-0.502±0.29) followed by LB (0.423±0.31-0.451±0.28), in all, cultures of YEM had the least growth performance, the same trend was observed for the midi culture experiments. Our findings, suggest that the growth rate of Agrobacterium is dependent on the media type and possibly, strain type.

Keywords: Agrobacterium strains, genetic transformation, optical density (OD), nutrient media, bacterial growth

INTRODUCTION

Culture media are essential tools developed to support the growth and reproduction of microorganisms by meeting their nutritional needs. The two most commonly used types are liquid and solid media for cultivating bacteria. The advent of culture media in the 19th century paved the way for significant advancements in microbiology. In 1881, Robert Koch demonstrated that bacterial growth could be optimized by incubating them in a broth composed of meat extract or fresh cow serum (Atmanto *et al*., 2022). Since then, culture media have been widely employed in bacterial research. Studies show that bacterial growth in a closed system typically follows a predictable pattern, known as a growth curve, which comprises four distinct phases: lag, exponential (log), stationary, and decline. Understanding the specific growth conditions of bacteria enables more accurate control of their proliferation under given conditions (Iqbal *et al*., 2021). Different bacterial species require different growth conditions, and optimal growth is necessary for subsequent steps like DNA extraction or genetic transformation. One prominent bacterium, *Agrobacterium tumefaciens*, is a gram-negative, aerobic, motile, rod-shaped soil bacterium that typically measures 1.5-3.0 x 0.6-1.0 µm. This bacterium is known for causing crown gall disease in plants by integrating its *T-DNA* into the host genome (Petrovicheva *et al*., 2017), a process that has been harnessed for the production of transgenic plants. By using *Agrobacterium*, plant breeding times can be significantly reduced, and new genes can be introduced into crops efficiently. Microbial growth and metabolism are heavily dependent on the composition of the growth medium used. Therefore, selecting the right medium is crucial for maximizing bacterial growth, ensuring the reproducibility of results, and achieving high biomass yields. This study focuses on three common microbiological media: yeast extract peptone (YEP), lysogeny broth (LB), and yeast extract mannitol (YEM). YEP consists mainly of yeast extract and peptone, providing a rich source of vitamins, amino acids, and nutrients. It is commonly used for cultivating various bacteria, including *Agrobacterium* species, due to its ability to promote rapid growth and high cell densities (Sambrook & Russell, 2001). YEM is specifically designed to support the growth of nitrogen-fixing bacteria, such as *Rhizobium* and *Agrobacterium*, and contains yeast extract, mannitol, and essential minerals, creating a balanced environment for both growth and nitrogen fixation. This study evaluates the growth patterns of two different *Agrobacterium* strains, each with potentially distinct physiological and metabolic needs. Gaining insights into how these strains respond to different media can help optimize growth conditions for various applications (Gao *et al*., 2013). The main objective is to compare the growth of the two strains in YEP, LB, and YEM media to identify the best medium for maximizing bacterial growth and biomass production. Such findings are crucial for improving the efficiency of *Agrobacterium*-mediated plant transformations and will benefit researchers in plant genetic engineering (Kong *et al*., 2014).

MATERIALS AND METHODS

Bacterial Strains

Two strains of *Agrobacterium tumefaciens* were used in this study, LBA4404 derived from a less virulent strain Ach5 and AGL-1. These two strains are being used in the genetic transformation of monocots and dicot plant species.

Nutrient Media

Three selective complex media broths were used to test their efficiency in supporting the growth of Agrobacterium under similar conditions with respective antibiotics specific for each strain. Ready to use Yeast Extract Mannitol (YEM), Yeast Extract Peptone (YEP), Luria Bertani Broth (LB), were obtained from Biotech lab of NRCRI, Umudike, 11.80 grams of mixture for YEM, and 25 grams of mixture for YEP media is suspended in 1000 ml of distilled water then the medium was buffered to pH 7.0 and sterilized by autoclaving at 15 psi pressure and 121°C for 15 minutes. Rifampicin (10 mg/ml) and streptomycin (30 mg/ml) specific for *LBA4404*, Rifampicin and carbenicillin (250mg/ml) for AGL-1 were added in the medium after sterilization to allow growth of only desired bacterial strain.

Place and Duration of Study

This study was conducted at cloning Laboratory in Biotechnology unit of National Root Crops Research Institution, Umudike, Abia State, Nigeria between June and August 2024.

Culture Conditions

A single colony from the fresh plate of each Agrobacterium strains: *LBA4404*, and *AGL-1* were inoculated in 5 ml of all nutrient broth containing respective antibiotic (mentioned above) in falcon tubes and allowed to grow under the same condition at 28°C with continuous shaking at 180 RPM over orbital shaker (Incubator with Shaker T100L Techmel & Techmel USA). Three replicates of each strain over each medium were set up for experimentation.

Growth Curve

Optical Density (O.D) is a measure of the turbidity of the bacterial growth and was measured as absorbance at 600 nm, at every 3hourly interval for each of the nine cultures using a UV/VIS spectrophotometer (yoke instrument) and their three replicates and mean of all three replicate readings ± standard error (SE) were plotted against media type to analyze the growth of bacterial strains over different nutrient broths.

Statistical Analysis

The growth analysis experiments were performed with three replications per treatment. Each experiment was repeated at three times, and the reported data are the means of these experiments. All data presented as mean ± standard error (SE). Data were analyzed with RStudio version 4.4.1. Differences were determined by two-way analysis of variance (ANOVA), and significant ($P < 0.05$) differences among mean values were estimated using the *dplyr* library function in R.

RESULTS AND DISCUSSION

As presented in table 1, results of the mean optical density (OD) showed that LBA4404 performed best in LB media (0.417±0.30-0.517±0.32), followed by LBA4404 cultured in YEP media (0.342±0.22-0.395±0.25). AGL-1 performed best in YEP media (0.461±0.28-0.502±0.29) followed by LB (0.423±0.31-0.451±0.28).

Table 1: Optical density of *Agrobacterium* strains (*LBA4404 and AGL-1*) cultured

MEDIA/REP	LB+R/C/ AGL-1	YEM+R/C/ AGL-1	YEP+R/C/ AGL-1	LB+R/S/ LBA4404	YEM+R/S/ LBA4404	YEP+R/S/ LBA4404
			GROUP ONE			
1	0.423±0.31	0.185±0.08	0.461±0.28	0.459±0.28	0.184±0.08	0.353±0.24
2	0.451±0.28	0.273±0.25	0.502±0.29	0.517±0.32	0.182±0.08	0.395±0.25
3	0.431±0.258	0.186±0.07	0.479±0.28	0.417±0.30	0.159±0.09	0.342±0.22
			GROUP TWO			
1	0.403±0.25	0.172±0.08	0.396±0.24	0.444± 0.25	0.180±0.08	0.389±0.25
2	0.472±0.26	0.161±0.08	0.443±0.24	0.433±0.29	0.188±0.08	0.365±0.23
3	0.441±0.261	0.159±0.08	0.393±0.24	0.473±0.27	0.186±0.07	0.373±0.22
			GROUP THREE			
1	0.423±0.26	0.195±0.08	0.417±0.27	0.434±0.26	0.172±0.08	0.336±0.23
2	0.392±0.23	0.187±0.07	0.479±0.28	0.439±0.26	0.193±0.09	0.466±0.34
3	0.406±0.24	0.177±0.08	0.484±0.28	0.435±0.28	0.169±0.07	0.411±0.30

Luria-Bertani (LB) Medium is one of the most frequently used general-purpose media for bacterial growth. It has been widely used for culturing various bacteria, including *Agrobacterium* species, due to its balanced nutrient content. Studies have shown that *Agrobacterium* strains exhibit rapid exponential growth in LB medium, often reaching maximum cell density within 24-48 hours (Rao & Dasgupta, 2020). This corroborates our result as presented in figures 1 and 2, where it can be observed that LB media gave a substantial mean growth performance after YEP media. YEM medium contains yeast extract, mannitol, K_2HPO_4, $MgSO_4$, and NaCl, which provide a rich environment for the growth of *Agrobacterium*. The mannitol in YEM serves as a carbon source that enhances bacterial growth, while the yeast extract supplies vitamins and growth factors essential for cellular activities. Several studies have reported that *Agrobacterium* strains show enhanced growth performance in YEM compared to LB, due to the additional carbohydrate source in YEM (Khan *et al*., 2021).The low performance of YEM cultures from our result was expected since the media is nutrient deficient. YEM is commonly used when preparing *Agrobacterium* cultures for inoculation during plant transformation experiments, as it supports high-density growth while providing a moderately balanced nutrient composition (Chatterjee & Roy, 2021).

The role of mannitol in enhancing bacterial growth has been well documented, making YEM a preferred medium for experiments that require extended bacterial proliferation (Smith *et al*., 2020). On the other hand, YEP medium is particularly effective for growing *Agrobacterium* to high cell densities, making it suitable for applications that require large quantities of bacterial cells, such as plant transformation protocols (Mullins *et al*., 2019).Our results showed that the foregoing is true, since, the overall performance of the cultures was higher in YEP. Research has shown that *Agrobacterium* strains grow more efficiently in YEP compared to LB and YEM, particularly when high biomass is required (Kumar & Singh, 2021). The combination of yeast extract and peptone in YEP results in better nutrient availability, promoting faster growth and higher cell yields (John & Smith, 2019). Therefore, YEP is typically used in conjunction with *vir* gene inducers when preparing *Agrobacterium* for plant transformation. When comparing the three media types, LB, YEM, and YEP, studies indicate that all three media support robust growth of *Agrobacterium* strains. However, YEP is often preferred for achieving high cell densities due to its richer nutrient content. YEM also supports efficient growth, particularly in experiments that require an additional carbon source, while LB is widely used due to its availability and ease of preparation (Mullins *et al*., 2019). The major difference between these media lies in their ability to induce virulence gene expression. LB and YEP support rapid bacterial growth but do not naturally induce the expression of virulence genes. YEM, while not inducing *vir* genes itself, can be combined with inducers to facilitate efficient plant transformation (Kumar & Singh, 2021).

Our results therefore, suggest that the content of media as well as concentration of the contents are key factors contributing to the variation in growth dynamics of *Agrobacterium* in general, furthermore, our results showed that different bacteria strains grow differently in different media types it was observed that AGL-1 and *LBA44404* performed best in YEP and LB media respectively this finding is in tandem with the report of Mullins *et al*. (2019).

CONCLUSION AND RECOMMENDATIONS

The choice of nutrient media has a significant impact on the growth performance of *Agrobacterium* strains. While LB, YEM, and YEP all support bacterial proliferation, their effectiveness in plant transformation protocols depends on the specific needs of the experiment, including the requirement for *vir* gene expression. YEP, with its rich nutrient content, is optimal for biomass production as can be seen from our result, while YEM provides an additional carbon source for enhanced growth. LB remains a widely used general-purpose medium but may require supplementation with chemical inducers for virulence gene activation.

REFERENCES

Chatterjee, M., & Roy, P. (2021). Minimal media impact on *Agrobacterium* virulence gene expression. Microbiology Letters, *38*(1), 112-119.

Gao, R., Cheng, Z., Li, J., & Zhang, Y. (2013). Growth kinetics and production of 3-indoleacetic acid by *Agrobacterium tumefaciens*. Biotechnology and Bioprocess Engineering, *18*(3), 559-566.

Gelvin, S. B. (2017). Integration of Agrobacterium T-DNA into the plant genome. Annual Review of Genetics, *51*, 195-217.

John, P. R., & Smith, D. K. (2019). Growth dynamics of *Agrobacterium* in nutrient-rich and minimal media. Plant Biotechnology Research, *24*(3), 245-260.

Khan, A. S., Das, P. K., & Li, H. (2021). Influence of media composition on *Agrobacterium* growth and transformation efficiency. Journal of Applied Microbiology, *34*(4), 215-227.

Kong, W. L., Han, X. X., Zhang, C. X., Song, Y. L., & Guo, J. H. (2014). Effect of different media on the growth and biological control activity of *Agrobacterium* strains. Current Microbiology, *69*(2), 227-234.

Kumar, A., & Singh, R. (2021). Comparative analysis of nutrient media on *Agrobacterium tumefaciens* growth performance. Bacterial Physiology, *12*(2), 145-159.

Mullins, L., Bailey, R., & Williams, J. (2019). Yeast extract peptone medium for high-density *Agrobacterium* culture. Journal of Microbial Techniques, *28*(3), 289-300.

Rao, A. L., & Dasgupta, S. (2020). Comparative analysis of bacterial growth media. Journal of Microbial Sciences, *45*(2), 134-140.

Sambrook, J., & Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual. Cold Spring Harbor Laboratory Press.

Sezonov, G., Joseleau-Petit, D., & D'Ari, R. (2007). *Escherichia coli* physiology in Luria-Bertani broth. Journal of Bacteriology, *189*(23), 8746-8749.

Singh, T., & Kumar, A. (2018). Growth and transformation efficiency of *Agrobacterium tumefaciens* in various nutrient media. Biotechnology Advances, *12*(4), 432-439.

Smith, D. J., Lee, T., & Zhou, X. (2020). Effects of carbon sources on bacterial growth performance. Journal of Applied Microbiology, *38*(3), 312-321.

Vincent, J. M. (1970). A Manual for the Practical Study of Root-Nodule Bacteria. Blackwell Scientific.

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21-25 OCT. 2024
PROCEEDINGS

Microbial Load Evaluation of Chickens Fed Dietary Supplement of Ginger (*Zingibe officinale*) Meal and Synthetic Premix

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Abstract

This study was conducted to evaluate the effect of dietary inclusion of ginger meal (Zingiber officinale) on the microbial load of broiler compared with the synthetic premix. One hundred and twenty arbor acre day old broiler chicks were used. They were divided randomly into 5 treatment groups designated as T_1, T_2, T_3, T_4 and T_5 comprising twenty-four birds each in three replication. Each group was fed one of 5 formulated diets containing ginger meal at levels of 0.0, 0.05, 0.10, 0.15 and 0.2g/100kg, for eight weeks in a completely randomized design. At the termination of the experiment, three birds per treatment were used for the evaluation of microbial load. Results showed significant ($P < 0.05$) effects of dietary ginger meal inclusion on microbial load in favour of T_3 than in T_2, T_4 and T_5, whereas higher inclusion (T_5) was deleterious to all the evaluated indices. The result of this study showed that the total coliform count (TCC**)** and the total viable count (TVC) were significantly ($p<0.05$) higher in T_1 than in T_2, T_3, T_4, and T_5. This suggest that ginger at increasing inclusion level behaved as probiotics by reducing the total coliform count in the caecum, while no significant ($p>0.05$) difference occurred in the TVC across the ginger groups (T_2 and T_3) compared with the non-ginger group (T_1) in the gizzard. There was reduction in the TCC and TVC of the microbial load in the duodenum across the treatment group, although not significant compared with the control which showed an increase in the TCC and TVC although not significantly ($p>0.05$) different from the ginger group. It can be concluded that ginger could be an alternative growth promoter for antibiotics, and can also be used to improve feed utilization when included at moderate dose of 0.1g/100kg. It is therefore recommended for use in formulating poultry diet for optimal production benefit.

Key words: Ginger, Vitamin/Mineral Premix, Microbial load and broiler chicken

INTRODUCTION

The major importance of poultry production is for the production of egg, meat etc. and for the provision of protein to the human. Feeding constitutes up to 75%-80% of the total cost in monogastric production and is a major factor limiting production of livestock. Minerals and vitamins supplements may contribute up to 2-3% of total cost of feed. The essence of animal protein will be compromised if livestock production is limited to synthetic mineral/vitamin which is basically for vitality, acid-base balance, proper metabolism, and muscle contraction and relaxation etc. Synthetic vitamin and mineral supplements in the diet contains synthetic antibiotic which possess negative effect on the farm animal and beneficial microorganism, and its residues in the carcass of animal could be detrimental to the human system, as well as contributes to cost of production in animal husbandry. (Bamidele and Adejumo, 2012; Attia *et al*., 2014; Sa'aci *et al*., 2018). Therefore, on this note, the interest of nutritionist, Veterinarian, farmers, and other key players in recent years are directed towards the search for cheaper, locally and organic mineral/vitamins additive that will be nutritionally viable, non-toxic to beneficial microbes as well contribute to health benefits to the animal for optimum production. (Al-Kassie and Witwit, 2010). Ginger (*Zingiber officinale*) is an important spice. It is a monocotyledonous herbaceous perennial plant that lives longer than two years, belonging to the family of *Zingiberaceae*, its flavouring type is classified as *Zingiber officinale* which is the most popular hot spice in the world (Dhingra and Kumar, 2005). The main important compounds of ginger (*Zingiber officinale*) are Gingerol, gingerdiol, borneol, conphel, citfral, penllandiene and resin. These compounds have the ability to stimulate digestive enzymes, affect the microbial activity (Dieumou *et al*., 2009). Also it acts as an antioxidant, antimicrobial and has various pharmacological effects (Ali *et al.,* 2008). It enhances animal nutrient digestion and absorption because of the positive effects on the gastric secretion of enterokinesia, and digestive enzyme activities (Platel *et al.*, 2000). Furthermore, ginger compound have shown various pharmacological effects including Immuno-modulatory, Anti-lipidemic, Anti-inflammatory, Anti-hyperglycemic and antiemetic effects (Ali *et al.*, 2008). However information is lacking on effect of ginger in comparison to synthetic vitamin/minerals premix on the microbial load. This study is designed to investigate the response of broiler fed dietary supplement of ginger in comparison to synthetic vitamin/mineral premix, and its assessment in terms of microbial load count and the growth performance.

MATERIALS AND METHODS

Location of the study

This study was done at the Poultry section of the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, which is located at Latitude 5^0 28' N and Longitude 7^0 32' E lines at an altitude of 122 meters above sea level. The environment of study is situated within the rainforest zone of Nigeria and is characterized by annual rainfall of about 2167. 8mm in 148 to 155 days, average relative humidity during the rainy season is over 72%. It's has environmental temperature average 22^0C to 30^0C (National Root Crops Research Institute-NRCRI, 2004).

Experimental birds, design and management

A total of 120 day-old broiler chicks were purchased locally within Nigeria for this experiment. Prior to the arrival, the experimental pens and equipment were washed and disinfected. On arrival, the broiler chicks were vaccinated then allocated to experimental pens for brooding for 4 weeks, then, they were allocated to five (5) dietary treatment T_1, T_2 T_3, $T_4$and T_5. The birds were fed diets with ginger meal at 0.00, 0.05, 0.10, 0.15 and 0.20 g/100kg which was supplemented with the synthetic vitamin-mineral premix at 0.25, 0.20, 0.15, 0.10 and 0.05 kg/100 kg, respectively.

During the brooding stage, heat was supplied with the use of brooding devices such as kerosene stove and lanterns. The temperature was regulated by the rule- of- the- thumb (watching the broilers behavior whether to increase or decrease the heat source), routine vaccinations and medications were given across the groups. The experimental design was a completely randomized design. During the brooding stage, the broiler chicks were fed *ad-libitum* with the formulated mash in rubber feeding stray for 4 weeks to enable the chicks have access on the feed. After brooding the feeders were changed to metallic container and raised using ropes to a certain height such that they do not have the chance to spill the feed on the litter. Water was given *ad-libitum* throughout the period of brooding in plastic drinkers. The broiler birds were randomly distributed to five (5) treatments. Each treatment diets was replicated 3 times.

Processing of ginger meal

The ginger was purchased fresh from National Root Crops Research Institution, (NRCRI) Umudike, their rings and husks was peeled off using knife. The peeled ginger was washed and dried (air and sun dried). The essence of air drying was basically to preserve the aromatic compounds, vitamin/mineral nutrients and later ground and sieved the meal that was incorporated into the diets.

Microbial load determination

The method of serial dilution as described by Aneja, (2005) and modified by Booth, (2006) was used for microbial load determination. On day 42, three chickens were randomly selected from each treatment, stunned and slaughtered. The effluence from the gizzard, duodenum, and caecum were gently stripped into sterile sample tubes and immediately transferred on ice to the laboratory for microbial load and culture study. Procedure: 2.5g each of the gizzard, duodenum and caecum samples from each chicken were collected immediately after slaughter, cut into small sizes with a flame sterilized knife under aseptic conditions and transferred into sterile screw-capped bottles and appropriately labeled. 22.5ml of sterile physiological saline solution was added to each sample bottle. The bottles were shaken vigorously to homogenize its contents before being diluted in the serial dilution technique. Test tubes of 9ml sterile physiological saline were set up and labeled from10^{-1} to$10^{-4.}$ Ten-fold serial dilutions were performed by pipetting 1ml from the original bottle containing the respective samples into the tube labeled 10^{-1}. From this tube, 1ml was transferred to the next tube labeled 10^{-2} and mixed properly. This was repeated until the 4^{th} tube for all the samples. After the dilutions, standard microbiological technique was used to spread the inoculums from each sample into freshly prepared nutrient agar plates. A sterile bent glass rod was used to spread out each inoculum. The plates were labeled accordingly and incubated at 37^0c for 72 hours. The colony count was performed after 48 hours of incubation. The total aerobic count was expressed as Colony Forming Unit per gram (CFU/g).

RESULTS AND DISCUSSION

Table 1: Microbial load count of broiler chickens fed diets replacement with ginger

			Caecum		
Colony Count	**T1**	**T_2**	**T_3**	**T_4**	**T_5**
TCC (cfu/mL $\times 10^6$)	6.37 ± 4.19^a	2.83 ± 0.48^b	0.00 ± 0.00^c	0.00 ± 0.00^c	0.00 ± 0.00^c
TVC (cfu/mL $\times 10^6$)	8.37 ± 0.69^a	2.43 ± 0.81^b	0.00 ± 0.00^c	0.00 ± 0.00^c	0.00 ± 0.00^c
Sig. df	0.035			0.339	

Note: Values are presented as Mean ± SEM. Means with different superscripts across rows are significantly different at p<0.05.TCC: Total Coliform Count; TVC: Total Viable Count.

The result of the microbial load of the cecum harvested from the experimental birds fed with the treated diet is presented in Table 1. There were significant ($p< 0.05$) differences in the total coliform count (TCC) and total viable count (TVC) across the ginger groups compared with the non-ginger group (T_1). The TCC and TVC were significantly ($p<0.05$) higher in T_1 than in T_2, T_3, T_4, and T_5. This suggest that ginger at increasing inclusion behave as probiotics, reduced the total coliform count in the caecum significantly from 6.37 ± 4.19

cfu/mls in T_1 to 2.83 ± 0.48cfu/mls (55.57% reduction in bacterial load) in T_2, and 0.00 ± 0.00cfu/mls (100% elimination) in T_3, T_4 and T_5, which means complete destruction of the coliform bacteria in the ginger group (as the inclusion level was increased). Similarly, the viable bacteria count was significantly ($p<0.05$) reduced by 70.97% in T_2 and 100% in T_3, T_4, and T_5. This effect could be attributed to the fact that the susceptibility of coliform bacteria to the antibacterial components of ginger are higher than that of the physiological desirable intestinal bacteria. This bactericidal effect at increased inclusions, strongly agreed with Reeds *et al.,* (1993); Amanduruonye *et al.* (2018), who reported simultaneous decrease in *Escherichia coli* populations, and Faghani *et al.,* (2014) who reported significant decrease in *Lactobacillus* spp. counts. Also, the inclusion of ginger in diet produced a remarkable inhibition of duodenal coliform bacteria, yeast and mold in the caecum and all viable microbes in the ileum (Samarasinghe *et al.,* 2003), and this in agreement with our finding. Windisch *et al.* (2007) reported a significant decrease in caeca microbial loads for birds fed 1.5% and 3.0% ginger supplemented diets compared to the control. This strongly confirms the antimicrobial property of ginger. These antimicrobial property of ginger might be attributed to the presence of Alkaloids, Camphene, Glycosides, Saponins, Terpenoids, Methoxymethyl, Propionate, Phenllandrene, gingerol, borneol, gingerdiol and many more compounds found in ginger-- phenolic compounds that have antiseptic, bactericidal and disinfectant properties as reported by Gong *et al.*(2004); Zhan *et al*. (2008).

The antimicrobial mode of action is considered to arise mainly from the potential of the hydrophobic essential oils in these plants to intrude into the bacterial cell membrane, disintegrate membrane structures and cause ion leakage (Lee *et al.,* 2004; Windisch *et al.,* 2007) thus suggesting that ginger can effectively be used in animal production to reduce the population of pathogenic micro-organisms thereby reducing the prevalence of disease occurrence. Auta *et al.* (2011) and Ibrahim *et al*. (2011) also reaffirmed the efficacy of ginger as an effective antimicrobial agent against the growth of both gram-positive and gram-negative bacteria, such as *Salmonella, E. coli, Salmonella typhinurium, Shigella spp, Proteus vulgaris, Haemophilus influenzae, Pseudomonas aeruginosa and Streptococcus* species. In contrast, Amaduruonye *et al.* (2018) reported that ginger did not have any detrimental effect on the intestinal micro flora resident at the caecum, but supported the activities of the micro-organisms that aid digestion in the gastro-intestinal tract, hence, not in line with our findings.

Table 2: Microbial load count of broiler chickens fed diets replacement with ginger

	Gizzard				
Colony count	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
TCC (cfu/mL X 10^6)	3.20 ± 0.60^a	3.53 ± 0.29^a	3.23 ± 0.29^a	2.57 ± 0.74^a	5.17 ± 1.79^a
TVC (cfu/mL X 10^6)	6.93 ± 0.38^b	4.57 ± 0.81^b	3.63 ± 0.58^b	1.07 ± 0.61^b	3.53 ± 0.60^b
Sig. df	0.293	0.129	0.388	0.527	0.276

Note: Values are presented as Mean ± SEM. Means with the same superscripts across rows are not significantly ($p>0.05$) different. TCC: Total Coliform Count; TVC: Total Viable Count

There was no significant ($p>0.05$) difference in the total viable count (TVC) across the ginger groups (T_2 and T_3) compared with the non-ginger group (T_1). The result of the colony count in the gizzard harvested from the experimental birds showed that although there were reduction in the TCC and TVC across the treatment groups compared with the control, the reduction observed were not significant ($p>0.05$) compared with the control. This suggest that coliform resident at the gizzard did not respond (bacteria resistance) to the ginger included diet significantly. This is in agreement with Yarru *et al.* (2009); Ahmadi (2010); Zhang *et al.* (2009) and Amaduruonye *et al.* (2018) who in different study locations reported that ginger at 5, 10, 15 and 20% had no detrimental effect on the coliform bacteria resident on the gizzard and duodenum, but supported the activities of the micro-organisms that aid digestion in the gastro-intestinal tract. This observations supported our findings.

Table 3: Microbial load count of broiler chickens fed diets supplemented with ginger

	Duodenum				
Colony count	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
TCC (cfu/mL X 10^6)	7.70 ± 0.38^a	4.97 ± 1.27^a	3.13 ± 0.42^a	3.93 ± 1.49^a	3.53 ± 1.10^a
TVC (cfu/mL X 10^6)	7.17 ± 1.24^b	2.53 ± 0.73^b	1.63 ± 0.17^b	2.70 ± 1.15^b	1.47 ± 0.09^b
Sig. df	0.221	0.295	0.094	0.721	0.033

Note: Values are presented as Mean ± SEM. Means with the same superscripts across rows are not significantly ($p>0.05$) different. TCC: Total Coliform Count; TVC: Total Viable Count

The result presented in Table 4.1c showed that there was reduction in the TCC and TVC of the duodenum across the treatment group, although not significant compared with the control. In the control group, the microbial load in the duodenum showed an increase in the TCC and TCV although not significantly ($p>0.05$) different from the ginger group. This implies that there is no observable antimicrobial activity of the included treatment in the duodenum. This bacterial resistance effect could be also attributed to the fact that the susceptibility of coliform bacteria to the antibacterial components of ginger were lower than that of the physiological desirable duodenal bacteria, hence supported by Cullen *et al.,* (2005) and Chen *et al.* (2010).

CONCLUSION AND RECOMMENDATIONS

The result of this study revealed that replacing some vitamins with ginger at moderate (T_3: 0.1g/100kg) inclusion significantly improved the growth parameters and carcass characteristics evaluated in this study better than the low (T_2) and higher (T_4, T_5) inclusions, which also generated higher revenue and gross margin profit as a result of the significantly higher weight gain per kilogram. This could be attributed to increased feed efficiency and utilization in T_3due to increased activity of digestive enzymes such as trypsin, chymotrypsin, and amylase which increased the digestibility of the nutrients contained in the formulated feed. The implication is that considering the very high demand for better carcass quality of broiler chicken, formulating poultry diet with ginger at 0.10/100kg could reduce the cost of production and enhance the growth performance as little quantity of the diet consumed will improve the carcass quality (more meat) of the broiler chicken. It can be concluded that ginger could be an alternative growth promoter for antibiotics, and can be used to increase growth, survival rate, improve feed utilization, with better meat quality and higher income generation at low production cost, hence, highly recommended for use in broiler production.

REFERENCES

Ahmadi, F. (2010). Effect of Turmeric (*Curcuma longa*) Powder on Performance, Oxidative Stress State and Some of Blood Parameters in Broiler Fed on Diets Containing Aflatoxin BI. *Global Veterinary,* 5, 312-317.

Ali, B.H., Blunden, G., Tanira, M. O. and Nemmar, A. (2008). Some Phytochemical, Pharmacological and Toxicological Properties of Ginger (*Zingiber officinale*

Roscoe): A Review of Recent Research. *Food and Chemical Toxicology*, 46, 409-420.

Al-Kassie, G.A.M. and Witwit, N.M. (2010). A comparative study on diet supplementation witha mixture of herbal plants and dandelion as a source of perbiotics on the performance of broilers. *Pakistan Journal of Nutrition*, 9(1), 67-71.

Amaduruonye, W., Ikwunze, K. and Oguike, M. A. (2018). Impact of ginger (*Zingiber officinale*) on Intestinal, caeca microbial loads and growth performance of broilers. *Nigerian Journal of Animal Science,* 20 (1), 123-133.

Aneja, K.R., (2005). *Experiments in microbiology, plant pathology and Biotechnology*. New Age publishers, pp. 69- 81.

Attia, Y. A., Abd Al-Hamid, A. E., Ibrahim, M. S., Al-Harthi, M. A., Bovera, F. and El-Naggar, A. (2014a). Productive performance, biochemical and hematological traits of broiler chicks supplemented with propolis, bee pollen, and mannanoligosaccharides continuously or intermittently. *Livestock Science*, 164, 87–95.

Auta, K.I., Galadima, A.A., Bassey, J.U., Olowoniyi, O.D., Moses, O.O. and Yako, A.B. (2011). Antimicrobial Properties of the Ethanolic Extracts of *Zingiber officinale* (Ginger) on *Escherichia coli* and *Pseudomonas aeruginosa*. *Research Journal of Biological Sciences,* 6 (1), 37-39.

Bamidele, O. and Adejumo, I. O. (2012). Effect of garlic (*Allium sativum* L.) and ginger (*Zingiber officinale* Roscoe) mixtures on performance characteristics and cholesterol profile of growing pullets. *International Journal of Poultry Science*, 11, 217-220.

Booth, C., (2006). *Methods in microbiology* 35.Academic press.pp.543

Chen D.Y., Shien, J.H., Tiley, L., Chiou, S.S., Wang, S.Y., Chang, T.J., Lee, Y.J. Chan, K.W. and Hsu, W.L. (2010). Curcumin inhibits influenza virus infection and haemagglutination activity. *Food Chemistry*, 119, 1346–1351.

Cullen, S.P., Monahan, F.J., Callan, J.J. and Doherty, J.V.O. (2005). The Effect of Dietary Garlic and Rosemary on Grower-Finisher Pi Performance and Sensory Characteristics of Pigs. *Irish Journal of Agriculture and Food Research,* 44, 57-67.

Dhingra, S. and Kumar, P. N. (2005).*Export of spices from India.* The Agriculture and Industrial Survey, New Delhi, pp. 136.

Dieumou, F.E., Teguia, A., Kuiate, J.R., Tamokou, J.D., Fonge, N.B. and Dongmo, M.C. (2009). Effects of ginger (*Zingiber officinale*) and garlic (*Allium sativum*) essential oils on growth performance and gut microbial population of broiler chickens. *Livestock and Research for Rural Development*, 21, 25-34.

Faghani, M., Rafiee, A., Namjoo, A.R. and Rahimian, Y. (2014). Performance, Cholesterol Profile and Intestinal Microbial Population in Broilers Fed Turmeric Extract. *Research Opinion on Animal Veterinary Science*, 4: 500–503.

Gong, F., Fung, Y. S. and Liang, Y. Z. (2004). Determination of volatile components in ginger using gas chromatography-mass spectrometry with resolution improved by data processing techniques. *Journal of Agriculture and Food Chemistry,* 52, 6378-6383.

Ibrahim, H.M., Abou-Arab A. A. and Abu Salem F.M. (2011). Antioxidant and antimicrobial effects of some natural plant extracts added to lamb patties during storage. *Grasas Y Aceites* 62, 139-148.

Lee, K. W., Everts, H. and Beynen, A. C. (2004). Essential oils in broiler nutrition.*International Journal of Poultry Science,* (12), 738-752.

Marai, I. F. M., Ayyat, M. and Abdel-Monem, U. M. (2006). Growth Performance, Blood Components and Slaughter Traits of New Zealand White Male Rabbits as Affected by Dietary Supplementation with Calcium, Sodium or Potassium in Subtropical Egypt. *Tropical and Subtropical Agro ecosystems,* 6, 149 – 156.

National Root Crops Research Institute-NRCRI. (2004). Agro-meteorological Unit, National Root Crop Research Institute Umudike, Umuahia, Nigeria.

Platel, K. and Srinivasan, K. (2000) Influence of dietary spices and their active principles on pancreatic digestive enzymes in albino rats. *Nahrung/Food*, 44, 42–46.

Reeds P. J., Burrin D. G., Davis T. A. and Fiorotto M. L. (1993). Post-natal growth of gut and muscle: competitors or collaborators. *Proceedings of the Nutrition Society*, 52,57-67.

Sa'aci, Z. A., Alabi1, O.J., Brown, D. and Ng'ambi, J.W. (2018). Effect of Aqueous Ginger (*Zingiber officinale*) Extract on Growth Performance, Nutrient Digestibility and Economy of Feed Conversion of Broiler Chickens. *Animal Nutrition and Feed Technology*, 18, 225-231.

Samarasinghe, K., Wenk, C., Silva, K.F.S.T. and Gunasekara, J.M.D. M. (2003). Turmeric (*Curcumalonga*) Root Powder and Mannanoligosaccharides as Alternatives to Antibiotics in Broiler Chicken Diet. *Asian-Australian Journal of Animal Science,* 16, 1495-1500.

Windisch, W., Schedle, K., Plitzer, C. and Kroismayr, A. (2007), Use of phytogenic productsas feed additives for swine and poultry. *Journal of Animal Science,* 86, 140-148.

Yarru, L. P., Settivari, R. S., Gowda, N. K. S., Antoniou, E., Ledoux, D. R. and Rottinghaus, G. E. (2009). Effects of Turmeric (*Curcuma longa*) on the Expression of Hepatic Genes Associated with Biotransformation, Antioxidant, And Immune Systems in Broiler Chicks Fed Aflatoxin. *Poultry Science*, 88, 2620–2627.

Zhan, K., Wang, C., Xu, K. and Yin, H. (2008). Analysis of volatile and non-volatile compositions in ginger oleoresin by gas chromatography mass spectrometry. *Se. Pu,* 26, 692-696.

Zhang, G. F., Yang, Z. B., Wang, Y.,Yang, W. R., Jiang, S. Z. and Gai, G. S. (2009). Effects of ginger root (*Zingiber officinale*) processed to different particle sizes on growth performance, antioxidant status, and serum metabolites of broiler chickens. *Poultry Science*, 88, 2159-2166.

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Agricultural Livelihood Enhancement through Utilization of Improved Selected Seeds among Women and Youth Farmers in Ebonyi State, Nigeria

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Abstract

The study was carried out to assess the agricultural livelihood enhancement through utilization of improved selected seeds among women and youth farmers in Ebonyi State. Data were collected from a sample of 120 farmers with the use of structured questionnaire. Twenty (20) farmers (10 Women and 10 Youths) was randomly selected from each agricultural cooperatives. Frequencies, percentages and means were used for data analysis. The result show that majority of the respondents (42.5%) were still at their productive stage, majority have farm size of (2.0-2.9h), (27.5%) of the respondents had farming experience of 11-15 years, (49.2%) of the respondents had secondary education, (43.3%) of the respondents are full time farmers. The result also shown that White cassava roots variety TME 419 emerges as the most widely adopted variety with (60.0%) of the pooled sample utilizing this variety followed by yellow root cassava variety (35.8%), Improved White fleshed sweetpotato varieties such as 87/0087 are the most prevalent, with 46.7% of the pooled sample utilizing this variety followed by Orange fleshed sweet potato varieties, such as Umuspo 2 (10.5%) and Umuspo 3 (7.5%), also exhibit moderate adoption rates,. Improved ginger varieties, particularly UG1, demonstrate significant adoption among respondents, with (12.5%) of the pooled sample utilizing this variety. However, adoption rates for ginger varieties are relatively lower compared to other crops. White yam varieties emerge as the most popular choice, with (51.7%) of the pooled sample utilizing these varieties. Crop production emerges as the predominant livelihood activity among respondents, with (92.5%) of the pooled sample engaging in this agricultural practice followed by Trading (17.5%) of the pooled sample, particularly among women respondents. Livestock (11.7%) of the pooled sample while artisanal work (13.3%).

Keywords: Agricultural livelihood, improved selected seeds, women and youth farmers

INTRODUCTION

Agricultural Livelihood enhancement refers to initiatives, programs, and strategies aimed at improving the economic and social well-being of individuals and communities that depend on agriculture for their livelihoods. Seed is critical to food security as the first link in the food value chain and can be a powerful agent of change. Agricultural livelihood enhancement through the utilization of improved selected seeds among Women and Youth Farmers is a critical strategy aimed at boosting agricultural productivity, income, and food security for these vulnerable groups. The focus on improved seeds is particularly important because they can significantly enhance crop yields, improve resistance to pests and diseases, and contribute to more sustainable farming practices, (Agarwal 2018).

In Nigeria, as noted by (IFAD, 2017) women and youths play a particular important role in crop production, including land preparation, planting of crops, maintaining of crops, harvesting, transporting, processing, storing and marketing of produce. Women's fundamental activities in agriculture cannot be underestimated. Among the 70% of the total agricultural work force in the world, 80% of food producers and 10% of those who process basic foodstuffs are women and they also undertake 60 to 90% of the rural marketing. Thus making up more than two-third of the workforce in agricultural production. This study assesses the agricultural livelihood enhancement through utilization of improved selected seeds among women and youth farmers in Ebonyi State. The objectives of this study were to examine the socioeconomic characteristics of respondents, assess improved seeds or planting materials used by the farmers and examine their Agricultural livelihood activities in Ebonyi State.

METHODOLOGY

The study was be conducted in Ebonyi State. The State have three Agricultural zones with 38 extension blocks and 27 circles (Ebonyi State government, (2020). Multi stage and purposive sampling techniques was used to elicit information for the study. Three Agricultural zones of the state was involved in the selection of the respondents for the study. One block in each zone was purposively selected because of their involvements in agricultural production and those technologies have been disseminated to the area, giving a total number of three blocks. Two circles from each block was purposively selected for the same reason, 2 agricultural producer cooperatives societies from each circle were selected. Twenty (20) farmers (10 Women and 10 Youths) was randomly selected from each agricultural cooperative from the list of producers through their cooperative leaders giving a total of 120 farmers.

RESULTS AND DISCUSSION

Result from the pooled result in table1 shows that age distribution reveals that the majority of respondents fall within the 41-50 age group. The study area was therefore dominated by farmers who are still young, strong and agile. Notably, there is a slight variation in age distribution between women and youth respondents, with women generally being older on average. This age range shift could indicate underlying socio-economic factors and generational variations in involvement in agriculture. The finding is in agreement with Gbetibouo (2009) that majority of farmers within the age range of 41 to 50 years are still in there active age, more receptive to innovation and could withstand the stress and strain involved in agricultural production.

The result for farm size from the pooled factor indicated that 17.5% of the respondents cultivated between 0.1-0.9 hectare, 37.5% cultivated between 1.0-1.9 hectares of farm land, 40.8% cultivated between 2.0-2.9 hectares while 4.2% cultivated 3 hectares and above. Despite variations in individual farm sizes, the mean farm size for both women (1.828) and youth (1.625) respondent remains relatively consistent, suggesting comparable levels of agricultural land ownership across demographic groups. This is in agreement with Kainga (2013) which stated that farmers in Nigeria are mostly smallholders with average farm size of between 1 and 3 hecters.

Farming experience of the respondents from the pooled result indicated that 33.3% of the respondents had farming experience of 5-10 years, 27.5% had an experience of 11-15 years, 20.0% had farming experience of 16-20years, 13.3% had an experience of 21-25 % while 5.8% had farming experience of 26 years and above. The majority of respondents possess farming experience in the range of 5-10 years, indicating a considerable level of practical knowledge and skill acquisition. Also, this study support the finding of Esiobu et al. (2014) that previous experience in agribusiness enable farmers to set realistic time and cost targets, allocate, combine, utilize resources efficiently, identify production and marketing risks.

Occupational of the respondents indicates that the majority of respondents are engaged in full-time farming (43.3%) emphasizing the central role of agriculture in sustaining rural livelihoods and economic activities. Other occupational categories, such as civil servants (22.5%) traders (10.8%), and artisans (10.0%), reflect the diversification of income sources and livelihood strategies among respondents.

Table 1: Socio-economic Characteristics of the respondents

Socio-economic Characteristics	**Women F (n = 60)**	**%**	**Youth F (n = 60)**	**%**	**Pooled F (n = 120)**	**%**
Age						
21 – 30	9	15.0	10	16.7	19	15.8
31 – 40	10	16.7	23	38.3	33	27.5
41 – 50	26	43.3	25	41.7	51	42.5
51 – 60	11	18.3	2	3.3	13	10.8
61 – 70	4	6.7	-	-	4	3.3
Mean	**44.60**		38.33		**41.47**	
Farm size						
0.1 - 0.9	8	13.3	13	21.7	21	17.5
1.0 - 1.9	24	40.0	21	35.0	45	37.5
2.0 - 2.9	23	38.3	26	43.3	49	40.8
3.0 - 3.9	5	8.3	-	-	5	4.2
Mean	**1.828**		1.625		**1.727**	
Years of farming experience						
5-10	8	13.3	32	53.3	40	33.3
11-15	16	26.7	17	28.3	33	27.5
16-20	18	30.0	6	10.0	24	20.0
21-25	11	18.3	5	8.3	16	13.3
26 and above	7	11.7	-	-	7	5.8
Mean	**17.82**		12.15		**14.98**	
Education						
Non formal education	12	20.0	4	6.7	15	12.5
Primary	13	21.7	11	18.3	25	20.8
Secondary	28	46.7	31	51.7	59	49.2
Tertiary	7	11.7	14	23.3	21	17.5
Mean	**8.77**		11.03		**9.90**	
Occupation						
Farming full-time	31	51.7	21	35.0	52	43.3
Farming part-time	2	3.3	14	23.3	16	13.3
Civil Servant	11	18.3	16	26.7	27	22.5
Trader	11	18.3	2	3.3	13	10.8
Artisan	5	8.3	7	11.7	12	10.0

* = Multiple responses

Results from table 2 indicated that among the improved cassava root varieties, White cassava roots TME 419 emerges as the most widely adopted variety with 60.0% of the pooled sample utilizing this variety. Both women and youth respondents show significant adoption rates, indicating the popularity and widespread acceptance of TME 419 for its high yield potential and disease resistance, followed by 0505 cassava root variety 20.0% and Yellow cassava root variety 35.8% are also popular choices among respondents, although to a lesser extent this is in line with (Spielman, 2022) who stated that Farmers need to be aware of the potential benefits of using improved seeds, such as higher yields, disease resistance, and resilience to climate change. Improved sweet potato varieties, White fleshed varieties such as 87/0087 are the most prevalent, with 46.7% of the pooled sample utilizing this variety. Orange fleshed sweet potato varieties, such as Umuspo 2 10.5% and Umuspo 3 (7.5%), also exhibit moderate adoption rates, highlighting the importance of nutritionally rich varieties in addressing food security and dietary diversity challenges. Improved ginger varieties, particularly UG1, demonstrate significant adoption among respondents, with 12.5% of the pooled sample utilizing this variety. However, adoption rates for ginger varieties are relatively lower compared to other crops, suggesting potential opportunities for promoting ginger cultivation and value addition in the study area. White yam varieties emerge as the most popular choice, with 51.7% of the pooled sample utilizing these varieties. Both women and youth respondents show high adoption rates for White yam, indicating its preference and suitability for local agro-ecological conditions. Yellow yam varieties are also widely adopted, particularly among women respondents, reflecting the importance of yam as a staple food crop and income source in the study area. Water yam varieties exhibit moderate adoption rates, suggesting potential opportunities for promoting diversification and resilience in yam production systems.

Table 2: Distribution of respondents according to improved seeds or planting materials used by the farmers

Improved seeds or planting materials	Women		Youth		Pooled	
	*F (n = 60)	%	*F (n = 60)	%	*F (n = 120)	%
Improved cassava roots varieties						
Yellow cassava	15	25.0	28	46.7	43	35.8
White cassava TME 419	42	70.0	30	50.0	72	60.0
White cassava 0505	15	25.0	9	15.0	24	20.0
Improved sweet potato varieties						
Orange fleshed sweet potato Umuspo 1	2	3.3	7	11.7	9	7.5
Orange fleshed sweet potato Umuspo 2	1	1.7	11	18.3	12	10.0
Orange fleshed sweet potato Umuspo 3	3	5.0	6	10.0	9	7.5
White fleshed such as 87/0087	26	43.3	30	50.0	56	46.7
Improved Ginger						
UG1	26	43.3	10	16.7	15	12.5
UG2	-	-	6	10.0	6	5.0
Improved yam seeds						
Yellow yam	10	16.7	18	30.0	28	23.3
Water yam (Akuabata, Delight, wonder and Va)	12	20.0	12	20.0	24	20.0
White yam (favorite, Nagode, super, blessing, sunshine)	21	35.0	41	68.3	62	51.7

Table3: Indicates that crop production emerges as the predominant livelihood activity among respondents, with 92.5% of the pooled sample engaging in this agricultural practice. Both women and youth respondents show high participation rates in crop production, highlighting its central role in sustaining rural livelihoods and food security within the study area. This is in line with (UN 2022) who reported that Agriculture produces an average of 23.1 million tons of food everyday provides livelihoods for 2.5 billion people and is the largest sources of income and jobs for poor, rural households. Trading 17.5% of the pooled sample, particularly among women respondents. Livestock 11.7% of the pooled sample while artisanal work 13.3% especially among the youth respondents.

Table 3: Distribution of respondents according to their Agricultural livelihood activities

Livelihood activities	Women *F (n = 60)	%	Youth *F (n = 60)	%	Pooled *F (n = 120)	%
Trading	18	30.0	3	5.0	21	17.5
Crop production	57	95.0	54	90.0	111	92.5
Livestock rearing	8	13.3	6	6.7	14	11.7
Artisan	4	6.7	12	20.0	16	13.3
Fish farming	4	6.7	-	-	4	3.3

* = Multiple responses, source: field survey 2020

CONCLUSION AND RECOMMENDATIONS

The study investigated the Agricultural livelihood enhancement through utilization of improved selected seeds among women and youth farmers in Ebonyi State. The study reveals the respondents were in their productive age and most of the farmers (40.8%) cultivated farm land between 2.0-2.9 hectares. White cassava roots TME 419 emerges as the most widely adopted variety with 60.0% of the pooled sample utilizing this variety also crop production emerges as the predominant livelihood activity among respondents, with 92.5% of the pooled sample engaging in this agricultural practice. Both women and youth respondents show high participation rates in crop production. It was recommended that more awareness creation of the potential benefits of using improved seeds, such as higher yields, disease resistance should be created for women and youth respondents.

REFERENCES

Agarwal, B. (2018). Gender equality, food security and the sustainable development goals. Current Opinion in Environmental Sustainability, 34, 26–32.

Ebonyi State government (2020). Tourism in Ebonyi State. http://www.ebonyi state.gov.ng/tourism. Accessed May1,2020

Esiobu, N. S., Nwosu, C. S., & Onubuogu, G. C. (2014). Economics of pineapple marketing in Owerri Municipal Council Area, Imo State, Nigeria. International Journal of Applied Research and Technology, 3(5),

Gbetibouo, G. A. (2009). Understanding farmers' perceptions and adaptations to climate change and variability: The case of the Limpopo Basin, South Africa (IFPRI Discussion Paper No. 00849). International Food Policy Research Institute. Retrieved May 3, 2009.

IFAD. (2017). Smallholders, food security, and the environment. https://www.ifad.org/en/web/knowledge/publication/asset/38908739

Kainga, P. E. (2013). Budgetary analysis of banana (Musa sapientum, L) and plantain (Musa paradisiaca, L) production. Journal of Agriculture and Crop Residue, 1(14), 55-60.

Spielman, D. J., & Ma, X. (2022). The role of extension services in promoting improved seed technologies: A global review. World Development, 149, 105679.

United Nation (UN) environment programme (2022). Sustainable Agriculture Press Brief Traditional Knowledge, Innovations and Practices.

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Effect of Vine Length of Sweetpotato Genotypes at Different Growth Stages Grown in Degraded Ultisol in South-Eastern Nigeria

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A field experiment was conducted during the 2014 and 2015 cropping seasons at the National Root Crop Research Institute, Umudike. The aim was to investigate the effect of vine lengths on the growth and yield of some sweet potato (Ipomoea batatas(L) Lam) grown in degraded ultisol in southeastern Nigeria. The sweetpotato genotypes included Centennial, Umuspo 3 (Mother's Delight), TIS 8164, Ex-Igbariam, TIS 87/0087, and Umuspo 1 (King J), as well as Solomon 2. The experiment was arranged in a Randomized Complete Block Design and was replicated four times. Data were collected on vine length at different growth stages and on yield. The statistical analysis revealed significant differences in the parameters measured at a 5% level of probability. The results showed that, among the different growth stages, TIS 87/0087 and Solomon 2 significantly exhibited the highest vine lengths in both cropping seasons. Additionally, Umuspo 3 and Centennial exhibited shorter vine lengths. Umuspo 1(King J), provided the highest root yield in both the 2014 and 2015 cropping seasons, closely followed by the TIS 87/0087 genotype. Therefore, the study recommends Umuspo 1 (King J), and TIS 87/0087 for achieving the highest root yield, and TIS 87/0087 and Solomon 2 for optimal growth and yield in southeastern Nigeria.

Keywords: Sweetpotato, vein length, fresh storage root yield.

INTRODUCTION

Sweetpotato (Ipomoea batatas (L) Lam), is a perennial food crop, belonging to the family Convolvulacaea (Xiangsong, 2010; Aniekwe, 2014). It is widely grown as an important staple food crop in most parts of Nigeria (Njoku et al., 2007). Sweetpotato (Ipomoea batatas, L) is an important staple food crop worldwide due to its high yield and wide adaptation (Bouwkamp, 1985). It ranks as the world's seventh most important crop with an estimated annual production of 300 million metric tons grown over 19 million hectares of land (Amamgbo and Nwankwu, 2008). It ranked third in the production area among the root and tuber crops, following cassava and yam in Nigeria (Anyaebunam et al., 2008).

Vein length in sweetpotato can refer to the length and development of the vascular tissue in the plant's leaves. This vascular tissue is crucial for the plant's overall health as it facilitates the transport of water, nutrients, and sugars. Sweetpotato stems are usually long and trailing and bear lobed or unlobed leaves that vary in shape. The flowers, borne in clusters in the axils of the leaves, are funnel-shaped and tinged with pink or rose-violet. The edible part is the much-enlarged tuberous roots varying in shape from fusiform to oblong or pointed oval. Root colors range from white to orange and occasionally purple inside and from light buff to brown or rose and purplish red outside. At least four to five months of warm weather are required for large yields. Achebe et al. (2015) experimented on vine lengths of 20cm, 25cm, and 30cm and discovered that vine length of 30cm performed better than the others. A vine length of 20 – 40cm with at least 3 – 5 nodes was optimal for the storage root production in the different parts of India (Nair, 2006). In Cuba, 25 – 30cm long stem cuttings were found to be ideal (Sandchez et al., 1985) and studies on planting materials in Bangladesh showed that increasing the length of vine/nodes increases the number of vines, vine length, and yield.

Tuber is mature for harvest when leaves and stems/vines develop a yellow color and most vines die off. The tubers are used for many purposes.). Yields of more than 10 t ha-1 hectare have been recorded in various parts of the country (Njoku, 2000). The yield potential of sweet potatoes will increase more if new technology and production methods are introduced. The tubers are rich sources of carbohydrates and higher calories than yam, wheat, rice, or cassava. The tubers are rich in proteins of high biological value, containing many essential amino acids. They are used in glucose syrup, alcohol, starch, flour, and other pastries. The leaves are a rich source of minerals, vitamins, and proteins, as well as fodder (Woolfe 1992).

MATERIALS AND METHODS

The experiment was carried out at the National Root Crop Research Institute in Umudike during the 2014 and 2015 cropping seasons. Umuidke is located at Umudike is located on 07°0331E and 05°0291N, at an elevation of 122 m above sea level. In the cropping seasons, annual mean rainfall, maximum temperature, and relative humidity (0900 hours) were 209.2 mm, 31.0 ºC, and 80.6 %, respectively (2014) and 206.2 mm, 30.5 ºC, and 78.6 %, respectively (2015). The experimental site was plowed, harrowed, thinned, and one-meter ridges made with a disc-ridge. Planting was down on the crest of the ridges using one 20 cm vine per stand at a distance of 30 cm by 100 cm to give a plant population of 33,333 plants/ha (Collins, 1995). Planting, weeding, and fertilization details were recorded also, randomly, four sweet potato plants were selected from the net plots. Harvesting was done at 16WAP. The materials used were Centennial, Umuspo 3 (Mother's Delight), TIS 8164, Ex-Igbariam, TIS 87/0087, Umuspo 1 (King J), and Solomon 2. The experiment was arranged in a Randomized Complete Block Design (RCBD) with four replications. Data collection was taken on vein length at 2-week intervals from 2WAP to 8WAP while yield data were collected at the physiological maturity at 16WAP.

RESULTS AND DISCUSSION

The total rainfall from April to December was 1886.6 mm in 2014 and 1856 mm in 2015**(**Table 1). The highest rainfall in 2014 was between August and September, while in 2015 it was between August and October. The climate variability may have influenced the performance of sweetpotato varieties. The mean monthly maximum and minimum temperature, relative humidity at 0900 and 1500 hours, and sunshine hours also varied between the two years and could have affected the roots and yield performances of the sweetpotato varieties.

The vine length of the seven sweetpotato varieties showed significant differences at all sampled dates (Table 2). The results revealed that the growth stages of vine length in sweet potatoes involve initial short veins, progressive elongation and complexity, and eventual stabilization as the plant matures. Centennial had the lowest vine length in both years. TIS 87/0087 had the longest vine length, closely followed by Solomon 2 in both cropping seasons. Similar results were found by Chandra and Tiwari (1987), Nair and Nair (1992), and Kumar et al. (1993) in their studies on sweetpotato. Leopold and Kriedman (1975) noted that variations in vine length might be due to the genetic makeup of the varieties, influencing morphological expression through endogenous gibberellin levels. Vine length increased as the plant aged in both years. In 2014, TIS 87/0087 and Solomon 2 had the highest vine lengths of 289.20cm and 289.40cm, and in 2015, these varieties consistently increased in length at different growth ages at 8WAP to 140.70cm and 195.80cm, respectively.

The fresh root yield of sweetpotato showed significant variation ($P<0.05$) in both the 2014 and 2015 cropping seasons, as shown in Table 3. Umuspo 1 (King J) had the highest root yield in both seasons, closely followed by the TIS 87/0087 genotype. In 2014 and 2015, the root yield of Umuspo 1 (King J) was 93.26% and 87.6% higher, respectively, compared to the lowest-yielding genotype (Centennial). This finding is consistent with Wariboko and Ogidi (2014), who suggested that the higher root yield in sweetpotato could be attributed to the genetic makeup of the variety as well as its favorable exposure to growth resources.

CONCLUSION AND RECOMMENDATIONS

In this study, it was observed that the vine length of sweetpotatoes increases as the plant ages. The findings revealed significant variations in vine length and tuber yield. Varieties TIS0087 and Solomon 2 will benefit farmers aiming to grow sweetpotatoes for vine production, while varieties Umuspo 1 (King J) and TIS 0087 are better suited for tuber production. Vein length in sweetpotatoes is crucial for leaf development and reflects the plant's overall health and growth stages. From the early formation of short veins to the developing of a complex and efficient vascular network, vein length plays a significant role in nutrient and water transport. Understanding and optimizing vein development through proper cultivation practices can lead to healthier plants and better yields.

REFERENCES

Achbe, U.A; Udeorah,S. N and Ilodibia, G. V (2015).Effect of different vine length on The growth and yield of orange flesh sweet potato in utisol of South Easter Nigeria. Nig. J Agric. 46(1) 22-28.

Amamgbo, L. E. F and Nwanchukwu (2008), I Cultural factors influencing use of sweet potato Flour for confectionary in Imo and Ebonyi state of Nigeria. J. Agric. And Soc. Res. (JASR) 8(2):22-26.

Aniekwe, N. L. (2014). Influence of Pinching back on the growth and yield parameter of sweetpotato varieties in Southeastern Nigeria. Journal of Animal and Plant Sciences. 20(3). 3194 – 3201.

Anyaebunam, H. N; Aswugha, G. N and Nwosu, K. L (2008). Guide to improved sweet potato Production in Nigeria. Extension Guide 2: 1-2.

Bouwkamp, J. C (1985) Production requirement for sweet potato production. In: J. C Bouwkamp (ed) Nat. Res. for tropics. CRC press Boca Ralon, Florida pp 9-33.

Chandra, A., and Tiwari, J. P. (1987). Productivity potential of sweet potato (*Ipomoea batatas* Poir). . *Journal* Root Crops. 13(2): 95-101.

Collins, W. W. (1995). Sweet potato, New Crop face Sheet www.Hort. Purdue.edu/ New Crop/crop Fact sheets sweet potato.

Kumar, R., Sarkar, S. K., and Jain, B. P. (1993). Genotype Performance and their interaction with environment in sweet potato. . *Journal Root Crops*, 19(2): 89-94.

Leopold, A. C., and Kriedman, P. E. (1975). Plant Growth and Development. McGraw Hill Inc., New York. pp. 137-159.

Nair, D. B., and Nair, V. M. (1992). Nutritional studies in sweet potato. *Journal Root Crops*. 18(1): 53-57.

Nair, G. M (2006). Agro- techniques and planting material production in sweet potato. In: Byiju, G. (ed). Qaulity planting material in tropical tuber crops. Central crops res. Institute Thiruvanathapuram, India pp 55-58.

Njoku, J. C. (2000). Effect of inorganic nitrogen and potassium on yield of sweet potato (*Ipomea batatas* (L). Lam). In a tropical utisoil, M.sc project report. Department of Agronomy, College of Crop and soil sciences, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

Njoku, S. E., Muoneke, C. O., Okpara, D. A and Agbo, F. M. O. (2007). Effect of intercropping varieties of sweet potato and Okra on Ultisol of South Eastern Nigeria, African Jour

Sanchez, V. E. E; Morales, T. A and Lopez, Z. Y. M (1985).The influence of stem cuttings on Roots yield of sweet potato clone. CEMSACENSA. 74-76.

Wariboko C, Ogidi I.A. **(**2014). Evaluation of the performance of improved sweet potato (*Ipomoea batatas* (L.) Lam) varieties in Bayelsa state, Nigeria. *African Journal of Environmental Science and Technology* 8(1), 48-53.

Woolfe, J. A. (1992). Sweetpotato: An untapped food Resource. Cambridge University press, Cambridge, England, pp 643.

Xiansong, Y. (2010). Rapid production of virusfree plantlets by shoot tip culture invitro of purple- coloured sweet pototo (Ipomoea batatas (L) Lam). Pakistan Journal of Biology. 42 (3) 2069 – 2075.

Table 1: Agro-meteorological data of the experimental sites for 2014 and 2015 cropping seasons

Month	2014							2015						
	Rainfall (mm)		Temperature (ºC)		Relative Humidity (%)		Sunshine	Rainfall		Temperature (ºC)		Relative Humidity (%)		Sunshine
	Amt	Days	Max	Min	0900Hrs	1500 Hrs	Hrs	Amt	Days	Max	Min	0900 Hrs	1500 Hrs	Hrs
April	78.7	6	32.2	23.5	79	66	5.5	61.7	4	33.4	23.8	78	58	5.18
May	249.2	16	31.9	23.4	81	69	5.2	246.8	15	32.7	23.4	81	63	5.88
June	281.8	12	30.5	24.2	81	74	4.9	346.2	21	29.8	23.5	87	76	2.2
July	114.9	14	30.0	24.0	86	79	2.8	129.2	18	27.3	22.4	88	81	2.2
August	444.2	20	29.6	23.3	85	78	3.1	366.2	19	29.0	24.0	87	80	2.3
September	405.3	22	29.8	22.9	85	79	2.8	276	23	29.0	23.0	87	78	2.74
October	165.1	12	31.0	23.6	82	71	4.2	380.2	12	31.0	24.0	84	74	4.63
November	147.4	11	31.6	23.5	81	66	3.3	49.7	6	33.0	24.0	80	60	6.09
December	0.0	0	32.7	21.8	65	47	5.9	0.0	0	29.5	22.9	35	34	6.23
Total	1886.6	113	-	-	-	-	37.7	1856	118	-	-	-	-	37.5
Mean	209.2	12.6	31.0	23.4	80.5	69.9	4.2	206.2	13.1	30.5	20.7	78.5	67.1	4.2

Source: National Root Crops Research Institute Agro-Meteorological Station, Umudike, Abia State, Nigeria.

Table 2: Vine length (cm) of seven sweetpotato varieties at different growth ages in 2014 and 2015 cropping seasons

Treatment	Weeks after planting							
	2	4	6	8	2	4	6	8
	2014				2015			
Centennial	1.23	4.62	23.30	47.90	20.95	23.50	42.20	45.20
Ex-Igbariam	3.96	21.20	74.30	187.40	25.41	34.70	67.20	106.40
Solomon 2	6.04	23.90	96.50	289.40	27.89	43.70	113.00	195.80
TIS 8164	3.41	18.36	68.00	174.60	20.99	30.30	43.40	74.80
TIS 87/0087	3.96	22.66	84.80	289.20	26.03	38.30	72.30	140.70
*Umuspo*1(King J)	3.39	17.89	74.30	148.40	23.16	31.30	48.10	103.10
Umuspo 3	0.81	6.77	19.40	64.90	19.60	22.60	27.80	63.60
LSD(0.05)	2.48	5.37	31.33	78.34	5.84	12.12	39.88	66.82

Table 3: Yield (t/ha) of seven sweetpotato genotypes grown under degraded ultisol in 2014 and 2015 cropping seasons

Sweet potato genotypes	**2014**	**2015**
Ex-Igbariam	10.2	9.45
Solomon 2	16.5	15.52
TIS 8164	18.6	16.13
Umuspo 1(King J)	31.2	28.73
TIS 87/0087	27.4	25.01
Umuspo 3(Mother's Delight)	5.1	5.94
Centennial	2.10	3.55
S.e.d	3.77	3.6633
L.S.D $_{(0.05)}$	7.92	7.633

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Yield Performance of Some Selected Sweetpotato Genotypes for High Harvest Index Selection

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Abstract
Sweetpotato genotypes for high harvest index selection. The sweet potato genotypes include (*Centennial, Umuspo* 3 (Mother's Delight), TIS 8164, *Ex-Igbariam*, TIS 87/0087, *Umusp o* 1(King J), *Solomon* 2) were fitted into a randomized complete block design (RCBD) with four replications. Planting was at the spacing of 100cm × 30cm on the crest of the ridges. Data was collected on the total number of tubers per plot, fresh root tuber yield, and harvest index at 2, 4, 6,8,10, and 12 WAP. The results show that among the seven sweet potato genotypes evaluated, significant (P<0.05) variations were obtained. Total number of tubers/plot gave the highest (72.8kg/ha) and (57.8 kg/ha) by Umuspo 1 (King J) followed by TIS 87/0087 (41.2 kg/ha) and (41.5 kg/ha) in 2014 and 2015. Fresh root tuber yield shows the highest significance (P<0.05) was obtained under *Umuspo* 1 (King J) sweetpotato genotype (31.2 t/ha) 2014 and (28.73 t/ha) closely followed by TIS 87/0087 while *Centennial* had the lowest tuber yield (2.10 t/ha) in 2014 and 2015 (3.55 t/ha) cropping seasons. It indicates that Centennial tuber yield was lower by 93.26 % and 92.33 % compared to Umuspo 1(King J) in the 2014 and 2015 cropping seasons, respectively. Harvest index of the seven sweet potato genotypes varies from 2 WAP to 12 WAP (Weeks after planting) across the period. Uumsop 1(King J) and TIS 0087 have the highest at 10wap and tend to stabiles when compared with other varieties.
Keywords: Sweetpotato, total number of tubers, fresh root tuber yield, harvest index.

INTRODUCTION

Sweetpotato, scientifically known as Ipomoea batatas L. (Lam.), is a crucial economic crop globally, particularly for poor resource farmers. In the United States, the popular type is the orange-fleshed sweetpotato with low dry matter content, high β-carotene level, and a sweet and moist texture after cooking (FAO 2016). It is grown in marginal soils around the world, requires few inputs, and has good adaptability to marginal growing conditions, a short production cycle, and high yield potential (Manrique and Hermann, 2000). The maturity duration ranges from 3 to 9 months or longer, depending on the variety (Peru. 2003).

Climate significantly impacts agricultural production. Changes in temperature and precipitation directly affect crop production and agro-ecological zones. Increased CO2 could have a positive effect due to improved water use efficiency and plant photosynthesis. Water availability is critical, particularly in Africa. Agricultural losses can result from climate variability, including droughts and floods (Kurukulasuriya and Rosenthal, 2003).

Harvest index (HI) is used to determine crop performance in terms of yield quantity and plays a significant role in improving crop productivity to address the problem of food supplies for the rapidly increasing population. According to Wikipedia (2017), the Harvest index is used in agriculture to quantify the yield of a crop species versus the total amount of biomass produced by the plant. The commercial yield can be the grain, the tuber, or the fruit. Therefore, the harvest index is the ratio of yield to total plant biomass (shoots plus roots). It's important to note that the potential values for the harvest index of various crop and horticultural species are not the same Wikipedia (2017). The objective of this paper is to assess yield performance using the harvest index to improve crop productivity and yield.

MATERIALS AND METHODS

The experiment took place at the National Root Crop Research Institute in Umudike during the 2014 and 2015 planting seasons. The materials used were Centennial, Umuspo 3 (Mother's Delight), TIS 8164, Ex-Igbariam, TIS 87/0087, Umuspo 1 (King J), and Solomon 2. The trial followed a Randomized Complete Block Design with four replications. Planting, weeding, and fertilization details were recorded. Harvesting was done to collect data on total number of tubers/plots, fresh root tuber yield, and harvest index, which is the percentage ratio between the economic yield and total biological yield. HI = Economic yield/ Total biological yield x 100 (Nichiporovich,1951).

RESULTS AND DISCUSSION

The soil analysis results showed that the experimental sites had sandy loam soil in 2014 and sandy clay loam in 2015(Table 1). Nitrogen levels were low in both years, while available phosphorus was high. The pH was very strongly acidic in 2014 and strongly acidic in 2015. Organic matter was very high in 2014 and low in 2015. Cations (Ca and Na) were low, while cation (K) was very low in both years. Cation (Mg) was moderate in both 2014 and 2015.

The total rainfall from April to December was 1886.6 mm in 2014 and 1856 mm in 2015 (Table 2). The highest rainfall in 2014 was between August and September, while in 2015 it was between August and October. The climate variability may have influenced the performance of sweetpotato varieties. The mean monthly maximum and minimum temperature, relative humidity at 0900 and 1500 hours, and sunshine hours also varied between the two years and could have affected the roots and yield performances of the sweetpotato varieties.

Table 3 showed the fresh root tuber yield and total number of tubers per plot of seven sweet potato varieties were assessed for the 2014 and 2015 cropping seasons. Umuspo 1 (King J) consistently displayed the highest yields, while Centennial consistently had the lowest yields. These findings align with prior studies suggesting that yield differences among varieties could be attributed to variations in the number of leaves, vine length, and yield parameters (Ndaeyo and Ndon, 2001). Okorie and Okpala (2000) and Wariboko (2014), reported that TIS87/0087 had a superior higher root yield.

The Harvest Index (HI) at different growth stages (2 to 12 WAP) of seven sweetpotato varieties during the 2014 and 2015 cropping seasons (Fig 4) showed significant differences. The highest total was recorded for Umuspo 1 (King J), closely followed by

TIS 87/0087 across both cropping seasons, while the lowest was observed for Centennial in both 2014 and 2015. Generally, high-yielding varieties exhibited a higher harvest index compared to low-yielding varieties (Kays, 1985). The Harvest Index (HI) increased over time for all sweetpotato varieties. The Harvest Index of the seven sweetpotato varieties varied from 2 WAP to 12 WAP. Our findings are consistent with earlier studies (Goswami et al., 1995), which indicated that the harvest index of sweetpotato varieties ranged from 11% to 85% when harvested between 12-24 weeks. However, the highest Harvest Index (HI) was achieved at 10 WAP in both cropping seasons and tended to stabilize. According to Cox and Cherny (2001), increasing planting density led to a decrease in the harvest index.

CONCLUSION AND RECOMMENDATIONS

Umuspo 1 (King J) has the highest fresh root tuber yield and tuber count per plot among the selected varieties. It also shows high efficiency in storage root formation relative to its biological yield. Farmers should consider using Umuspo 1 (King J) and TIS 87/0087 to increase production and income generation, enabling commercialization and export of the crops for improved productivity.

REFERENCES

Cox, W. J. and D. J .R. Cherny, (2001)..Row Spacing, Plant Density And Nitrogen Effects On Corn Silage Agron.-2.

FAO, 2016. Climate change and food security: risks and responses. Rome.

Goswami S. B, Sen .H, Jana P. K (1995). Tuberization and yield potential of sweetpotato cultivar as influenced by water management practices. *Journal* of root crop 21,77-81.

Kays SJ (1985). The physiology of yield in sweetpotato. In. J.C. Bouwkamp, (eds). Sweetptota products: a natural resources for the tropics.CRC P. 77-132.

Kurukulasuriya, P. and Rosenthal, S. (2003) Climate change and agriculture. A review of impacts and adaptations. The World Bank Environment Department

Manrique, K. and Hermann, M. (2000) Effect of G × E Interaction on Root Yield and Betacarotene Content of Selected Sweetpotato (Ipomoea batatas (L) Lam.) Varieties and Breeding Clones. CIP Program Report 1999-2000-287.

Ndaeyo, N. U. and B. A. Ndon (2001). Evaluation on some crop cultivars adaptable to acid soils of Uyo south eastern Nigeria. *Global Journal of Pure and Applied science Volume* 7:3.No.35-41.

Nichiporovich A. A. (1951). *Light and Carbon Nutrition of plants* (*photosynthesis*) (Moskva: Acad. Nauk SSSR) 287pp (in Russian)

Okorie, P. E and Okpala, E. (2000). Effect of animal manure and organic fertilizer on growth flora development at two degraded soil in umudike, Nigeria. *Journal. Sustainable Agricultural, Envrionment*. 1 (2):84-89.

Peru, 2003. Sweetpotato: Treasure for the poor in sweetpotato main page,pp:25

Wariboko C, Ogidi I.A. (2014). Evaluation of the performance of improved sweet potato (*Ipomoea batatas* (L.) Lam) varieties in Bayelsa state, Nigeria. *African Journal of Environmental Science and Technology* 8(1), 48-53.

Wikipedia (2017). Wikipedia encyclopedia. Plant breeding. (Accessed on-line on 25th May, 2018).

Table 1: Soil physico-chemical properties of the experimental sites in 2014 and 2015 cropping season

Physical properties	**2014**	**2015**
Sand (%)	75.90	67.20
Silt (%)	11.60	9.00
Clay (%)	12.50	23.80
Textural class	Sandy loam	Sandy clay loam
Chemical properties		
pH	4.50	5.20
Available P (mg/kg)	43.60	67.80
Total N (%)	0.09	0.08
O.C (%)	1.29	0.50
O. M. (%)	2.22	0.87
Ca (Cmol/kg)	2.80	2.80
Mg (Cmol/kg)	2.80	1.60
K (Cmol/kg)	0.20	0.08
Na (Cmol/kg)	0.22	0.19
EA (Cmol/kg)	4.74	2.16
ECEC (Cmol/kg)	4.74	6.82
BS (%)	76.35	68.35

Source: Soil science laboratory, National Root Crops Research Institute Umudike, Abia State, Nigeria.

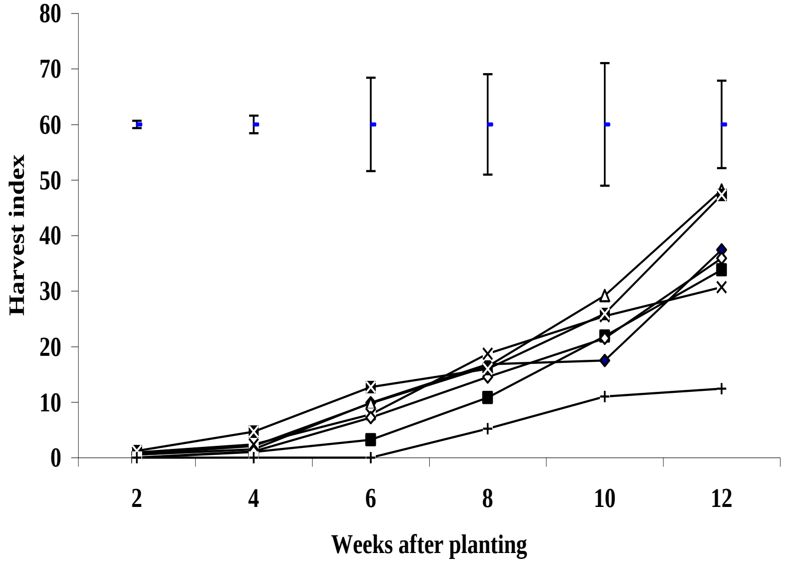
Table 2: Agro-meteorological data of the experimental sites for 2014 and 2015 cropping seasons

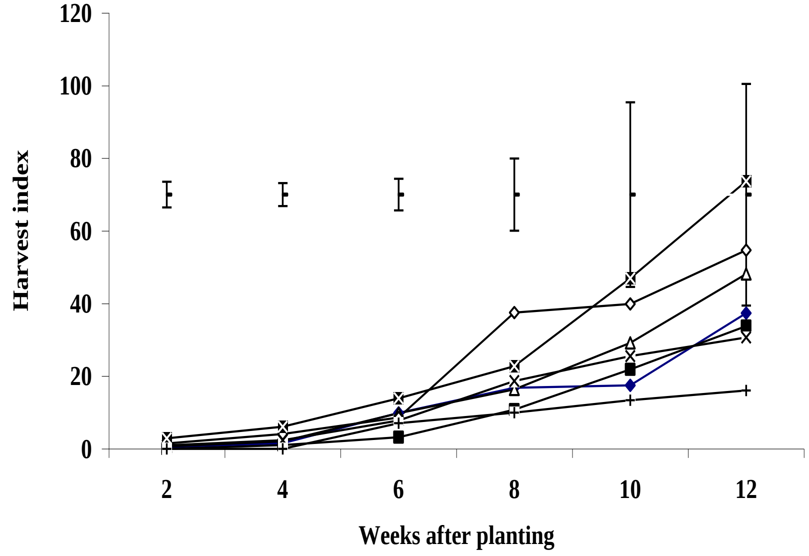
Month	2014							2015						
	Rainfall (mm)		Temperature (°C)		Relative Humidity (%)		Sunshine	Rainfall		Temperature (°C)		Relative Humidity (%)		Sunshine
	Amt	Days	Max	Min	0900Hrs	1500 Hrs	Hrs	Amt	Days	Max	Min	0900 Hrs	1500 Hrs	Hrs
April	78.7	6	32.2	23.5	79	66	5.5	61.7	4	33.4	23.8	78	58	5.18
May	249.2	16	31.9	23.4	81	69	5.2	246.8	15	32.7	23.4	81	63	5.88
June	281.8	12	30.5	24.2	81	74	4.9	346.2	21	29.8	23.5	87	76	2.2
July	114.9	14	30.0	24.0	86	79	2.8	129.2	18	27.3	22.4	88	81	2.2
August	444.2	20	29.6	23.3	85	78	3.1	366.2	19	29.0	24.0	87	80	2.3
September	405.3	22	29.8	22.9	85	79	2.8	276	23	29.0	23.0	87	78	2.74
October	165.1	12	31.0	23.6	82	71	4.2	380.2	12	31.0	24.0	84	74	4.63
November	147.4	11	31.6	23.5	81	66	3.3	49.7	6	33.0	24.0	80	60	6.09
December	0.0	0	32.7	21.8	65	47	5.9	0.0	0	29.5	22.9	35	34	6.23
Total	1886.6	113	-	-	-	-	37.7	1856	118	-	-	-	-	37.5
Mean	209.2	12.6	31.0	23.4	80.5	69.9	4.2	206.2	13.1	30.5	20.7	78.5	67.1	4.2

Source: National Root Crops Research Institute Agro-Meteorological Station, Umudike, Abia State, Nigeria.

Table 3: Total Number of tubers/plot and yield (t/ha) of seven sweetpotato genotypes grown under degraded ultisol in 2014 and 2015 cropping seasons

Genotype	2014		2015	
	Total No. of tubers/plot	Fresh root tuber yield(t/ha)	Total No. of tubers/plot	Fresh root tuber yield(t/ha)
Centennial	29.0	2.15	42.8	3.55
Ex-Igbariam	39.2	10.25	28.8	9.45
Solomon 2	49.0	18.57	40.8	15.52
TIS 8164	32.2	16.46	31.0	16.13
TIS 87/0087	41.2	27.45	41.5	25.01
Umuspo 1(King J)	72.8	31.1	57.8	28.73
Umuspo 3(Mother’s Delight)	30.8	5.14	28.0	5.94
LSD(0.05)	20.16	7.92	20.16	7.63





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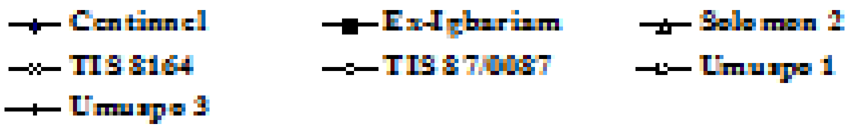

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Investigating the Factors Affecting Poultry Operators' Decision to Add Value in Abia State, Nigeria

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Abstract

The study assessed Value addition and factors affecting poultry operators' decision to add value in Abia state, Nigeria. Primary data were collected using a questionnaire from 120 poultry farmers selected using multistage sampling techniques. The data were analyzed using Simple descriptive tools, and probit regression models. The study revealed that 63% of the respondents were male with a significant proportion (72%) married with a household size of 1-5 persons. The majority (72 %) of the farmers had one form of education or the other. The result further showed that output size, years of experience, income level, and land availability positively affected this decision-making at 10%, 5%,5%, and 5% respectively while the amount of credit and cost of production negatively affected the same decision at 5% and 1% level of significance respectively.

INTRODUCTION

Agriculture in Nigeria has remained the largest sector contributing nearly 39% to the Gross Domestic Product for the past two decades and employing almost 60% of its workforce. Over 80% of the country's population living in rural areas is directly or indirectly dependent on agriculture for its livelihood (NBS. 2005). Agriculture provides a primary means of employment and accounts for more than one-third of the total Gross Domestic Product (GDP) and labor force in Nigeria (Evbuomwan, 2006). FOS (1996) reports that food production in Nigeria increased at a rate of 2.5% while food demand increased at a rate of more than 3.5% due to a high rate of population growth of 2.83%. Nigeria, like other developing countries, suffers from protein deficiency due to rapid population growth, low productivity in the agricultural sector, rural-urban migration, and a decline in productivity of the livestock subsector (Abubakar. 2000). Among livestock-based vocations, poultry occupies a pivotal position because of its enormous potential to bring about rapid economic growth. The importance of the poultry sub-sector is chiefly in the provision of meat and egg as well as the provision of employment either directly or indirectly and the contribution to the revenue (Gross Domestic Product) of the country. Recent studies have also added to this assertion. Thus, maximizing the production process to stabilize the economy, meet food security targets, and reduce poverty among practicing households will be a great development. To this effect, value addition has been discovered as a viable tool for reaching this height. From the definition of the value chain, it is easier to understand the value chain approach, which has been applied in different fields, especially very common in agriculture and rural development to analyze a certain commodity for management and development of the value chain (James *et al.,* 2010). Value chains allow operators to invest in different activities of a production process. As a result of large volumes of outcomes of output, the fixed and variable costs, when spread over the output of eggs, meat and other produced, hence achieving economies of scale. The producers are thus able to sell the produce at competitive prices (James *et al.,* 2010). The factors affecting poultry operators' decision to add value form the core of this research paper

METHODOLOGY

This research was conducted in Abia State, the Southeast geopolitical zone of Nigeria. Primary data were employed in this investigation. A well-structured questionnaire was used to extract primary data from 120 poultry operators in the study area. A multi-stage sampling procedure was adopted in this study. The first stage involved the purposive selection of three Local Governments Areas (LGA) with relatively high involvement in poultry and poultry-related activities. Ikwuano, Bende, and Aba South were chosen from Umuahia, Ohafia, and Aba respectively. The second stage involves a random selection of 40 operators from the list of poultry operators in the selected LGAs. Thus, the sample size of the study is 120 respondents.

Method of Data Analysis

Simple descriptive tools like tables, percentages, and the probit regression models were used in data analysis.

The probit model for factors affecting the decision to add value is stated as:

$$\text{Probit}\ (Y) = X^{I}\ B + E$$

Where EnN (0,1)
Y = 0 or 1
Y Prob (Decision to add value) = Yes or no. Yes = 1, No = 0.
X^1 = Vector of independent variables
X_1 = Size of output (No of eggs, broilers, layers)
X_2= Experience (Years)
X_3 - Income level (Above minimum wage = 1. otherwise = 0)
X_4 = Educational status (Sec School completed and above =1, otherwise = 0)
X_5= Amount of Credit used (Yes = 1, Otherwise = 0)
X_{76}— Cost of production

RESULTS AND DISCUSSION

The socioeconomic characteristics of the respondents

The result on the socio-economic characteristics of the respondents revealed that the majority of the poultry entrepreneurs in Abia state are married men in their active years with a form of education and experience in the poultry business. Table 1 indicates that the majority (48%) of the respondents were within 40-49 years, 28% were between 20-39 years and 23% were more than 50 years, implying that the poultry farmers were within their economically productive age. The result revealed that 63% of the respondents were male with a significant proportion (72%) married. The Table further indicates that 71% of the respondents had a household size of 1-5 members; implying that poultry entrepreneurs would require hired labor (other than relying on family labor) for poultry activities. A vast majority of the poultry farmers in the state were educated and experienced in the poultry business. A notable share of the respondents (46%) had secondary education, 29% had primary education, 13% had tertiary education, and 13% had no formal education. The Table shows that 37% of the respondents had work experience of 6 to 10 years. This implies that the poultry farmers were well-groomed and experienced in their business. A significant proportion of poultry operators (63%) were members of cooperatives.

Analysis of Factors Affecting Poultry Operators' Decision to Add Value
To determine the factors affecting poultry operators' decision to add value, seven (7) independent variables were chosen and six (6) of them were statistically significant at various levels. The result showed that output size, years of experience, income level, and land availability positively affected this decision-making at 10%, 5%, 5%, and 5% respectively while the amount of credit and cost of production negatively affected the same decision at 5% and 1% level of significance respectively. The sake of the sake of this study, value addition was captured by the number of poultry value chain-related activities carried out by a particular enterprise. The value of the intercept (Y = 0.620) means that 62% of the total changes in the dependent variable were accounted for by changes in the dependent variables included in the model while the remaining 38% occurred due to random variables not included in the model (error term).

The coefficient of variable output was positively signed at 10% indicating that the probability of adding value increased with an increase in output. This indicates that operators with higher outputs will seek to expand their frontiers as they would generate more income to do so. However, in certain conditions, an increase in output may not lead to an additional chain activity, but rather, an expansion of the existing arm. This is based on comparative and competitive advantage: thus, the fear of associated risks of introducing a new chain may scare off the operators from such decisions. This finding agrees with *a priori* expectations.

Years of experience on its own was positively signed and indicates that as operators advance in experience, the likelihood event of adding value to the existing enterprise increases. This follows that experience relates to knowledge about the intricacies of production and marketing, a proper understanding of seasons of glut and boom, correct decision-making, and others, thus, such farmers are in a better position to add more chain activities to the existing ones, especially related ones. Experience is deemed as one of the most important production factors as it relates to management. Experienced operators add flair and dynamism to their activities, make better profits, and can out-smart and out-compete less-experienced counterparts.

Income level was positively related to the operators' decision to add value at a 5% level of significance. This implies that as income increases, the probability of having an additional chain activity increases because the excess profit will be re-invested into the business and this time, a new and related activity in the poultry value chain. It is therefore clear that poultry operators who have a bogus income level would add value to the existing enterprise either by expansion of the existing one or by the introduction of a new one.

Poultry operators with access to land would most likely increase their frontiers. This is given by the positive sign of the variable's coefficient at a 5% level of significance. Land as a major production factor is an expensive asset and accounts for about 30% of the initial start-up money of any business except in the case where land is owned by the entrepreneur. When this is the case, the money that should have been spent on land is invested into the business and thus, operators may enjoy expanded value chain activities. This finding is in keeping with a priori expectations.

Credit use on the other hand negatively affected the likelihood event of expanding the business at a 5% significant level. This means that the more money the operators borrowed, the less likely they were to add value to their value chain activities. This may be a result of the high interest rate stated by banks that make firms aversive to borrowing and even those who insist on borrowing find it difficult to cover costs. With this in mind, value addition in terms of expansion or introduction of a new becomes extremely difficult. Cost of production was negatively related to poultry operators' decision to add value at a 1% level of significance indicating that as cost of production increased with a lower commensurate increase in profit, poultry operators would not seek any kind of expansion.

CONCLUSION AND RECOMMENDATIONS

Years of experience, income level, amount of credit, and land availability are the most significant factors influencing the decision to add value. More experience and income increase the likelihood of value addition, while more credit and higher production costs have a negative impact. Land availability also has a marginally positive influence.

Table 1; Socio-economic characteristics of poultry operators

Age (Years)	Percentage
20 - 39	29
40 - 59	63
60 - above	8
Total	100
Sex	
Female	37
Male	63
Total	100
Marital status	
Single	17
Married	72
Divorced	11
Total	100
Household size	
1 - 5	71
6 - 10	26
11 - above	3
Total	100
Education	
No formal	13
Primary	29
Secondary	46
Tertiary	13
Total	100
Cooperative membership	
Yes	63
No	37
Total	100
Years of experience	
1 - 5	15
6 - 10	37
11 - 15	29
21 - 25	6
Total	100

Source: Field survey, 2016

Table 2; Probit Regression Result of Factors Affecting Poultry Operators' Decision to Add Value

Parameter	Estimate	Std. Error	Z	Sig
Output size	.094	.054	2.219*	0.27
Years of experience	1.841	.587	3.135**	.002
Income level	.000	.000	2.544**	.011
Years of education	.168	.609	.277	.782
Amount of credit	-.449	.138	-3.268**	.001
Cost of production	-365	.001	-6.722***	.267
Land availability	.0831	.022	3.012**	.0721
1ntercept	.071	8.333	4.925***	.620

Source: Field Survey, 2016.*** = Significant at 1%, ** = Significant at 5%, *= Significant at 10%

REFERENCES

Abubakar. H. (2000) "Economic Analysis of Egg production in Birnin- Gwari, jama'a and Igabi Local Government Area of Kaduna state". Unpublished M.S.C Dissertation Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria. Nigeria.

Evbuomwan, G.O. (2006). Empirical Analysis of Cost and Return to Commercial Table Egg J Central Bank of Nigeria, Lagos. Farm Management Association of Nigerian (FAMAN). 2(1): 29-37

FOS (1996). Nigerian Federal Office of Statistics (FOS). Population Figure. FOS Publication.Int. J. Poultry Sci. 5:81-83

James, A. Iheanacho. O. and Karl, M.R. (2010) .Analyses of the poultry value chain and its linkages and interactions with HPA1 risk factors in Nigeria. Africa/IndonesiaTeam Working Paper 34

National Bureau of Statistics (NBS) (2005).Social Statistics in Nigeria. Federal Republic of Nigeria.

Constraints Affecting Adoption of Cocoyam Processing Technologies by Women Farmers' in Akwa Ibom State, Nigeria

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Abstract

A veritable search for solution to the soaring problem of food insecurity in Nigeria would need to encompass a renewed focus on cocoyam (Colocasia spp and Xanthosoma spp) as an important source of human nutrition, cash income and animal feed. This study examined constraints affecting adoption of cocoyam processing technologies by women farmers in Akwa Ibom State, Nigeria. Specifically, the study ascertained the level of adoption of cocoyam production technologies and also identified constraints faced by women cocoyam farmers in adopting recommended innovations. Relevant data were collected with the aid of a structured questionnaire from 90 women cocoyam farmers, purposively selected from a sample frame of women groups affiliated to the Women-in-Agriculture (WIA) programme of the Akwa Ibom State Agricultural Development Programme (AKADEP). Data analyses utilized both descriptive and inferential statistical tools and findings revealed that cocoyam fufu and cocoyam flour (x = 2.96; rank 1 respectively) and cocoyam pudding (x =2.83; rank=3) were the major adopted technologies. The least adopted were cocoyam balls (x=1.88; rank=13 cocoyam bread (x= 2.27; rank=12) and cocoyam fritters (x= 2. 41; rank =11). Factor analysis, using principal component approach revealed seven major dimensions of factors that contribute to the general level of constraints; the major factors were: Poor technological base (21.28%) and human factors (15.9%). Recommendations have been proffered to enhance adoption of cocoyam processing technologies, based on its inherent positive attributes.

Keywords: Cocoyam, constraints, technologies, adoption, women farmers, Akwa Ibom State

INTRODUCTION

The depressing status of food availability, accessibility and affordability in Nigeria is becoming a grave concern. The country is currently regarded as one of the countries with the hungriest population in the world, ranking 109 out of 125 surveyed countries, according to the Global Hunger Index (GHI-2024). It is revealed (NBS, 2024) that Nigeria battles with a record high inflation rate of 34.2 percent rate and a food inflation rate of 40.9 percent (in June, 2024) driven by increases in prices of staple food items; including beverages, cereals and tuber crops (yam, potatoes and cassava derivatives, like gari). It is projected by the World Food Programme (WFP, 2024) that about 26.5 million Nigerians would face acute hunger in the June-August 2024 lean season. Against this background, the United Nations has called on the Nigerian government to tackle insurgency, currency devaluation, soaring inflation, climate change, pest infestations, and other threats to agricultural productivity; based on its predictions to the effect that 82 million Nigerians may go hungry by 2030 (Akasike and Adaji ,2024; WFP, 2024).

One of the means of ensuring food security and concomitant reduction in prevailing high levels of hunger and protein-energy malnutrition may be through a focus on increased production and consumption of currently neglected indigenous staples of high energy content. One of such crops is cocoyam (*Colocasia esculenta* (taro) and *Xanthosoma sagittifolium* (tannia). The crop is cultivated mainly for its corms and cormels. It ranks third in importance after cassava and yam among the root and tuber crops cultivated and consumed in Nigeria. Cocoyam used to be recognized as a cheaper yam substitute, notably during period of food scarcity (hunger season) among many households, especially in southern parts of Nigeria and its production remains part of many smallholder, resource poor farming households in many parts of the southern and middle belt parts of the country.

Cocoyam is the only fully edible root and tuber crop in Nigeria because the corms and cormels are eaten in various forms while the vegetative parts are used as adjunct or spice to garnish and flavor food. It is regarded as nutritionally superior to major competitors like cassava and yam and hence, adjudged to possess superior health attributes as it can be used to manage complications arising from diseases like diabetes, prostate and breast cancer. It also has high economic and trade potentials as raw material for the pharmaceutical, confectionery and livestock industries (NRCRI 2020; CGIAR 2020).

Nigeria is the largest producer of cocoyam in the world and according to the National Root Crops Research Institute (NRCRI-2020) with an annual production of 5.49 million metric tonnes, equivalent to 45.9 % of world production and 72.2 % total output of cocoyam in West Africa. However, despite the global recognition of cocoyam production in Nigeria, the crop has suffered serious neglect, receiving little or no attention from agricultural researchers and government policy makers. This has resulted in a gross household-level underutilization of the enormous potentials of cocoyam for food security, income generation and nutritional enhancement. Cocoyam is mainly grown on a subsistent level and has been variously labeled as a neglected, poor man's food crop; which is often traded only in local markets. In essence, despite cocoyam's immense attributes and potentials, and the fact that it's low and affordable trading price can guarantee food security, especially for poor rural households; It has received minimal interest and attention by producers, consumers and even researchers. Many reasons have been proffered for the low recognition status of cocoyam, including; poor research and policy interventions, poor yield due to taro leaf blight (TLB), limited value chain propensity and reduced commercialization (Otekunrin et al; 2021).

Increased cocoyam production is a valuable venture that will surely boost the revenue base of the producing countries and enhance the livelihoods of the smallholder farmers and other actors along the value chain. A first step in this endeavour is to stabilize cocoyam tuber production and greatly enhance its utilization by adding value to its derivatives. Through its Women in Agriculture (WIA) unit the Akwa Ibom Development Programme (AKADEP) is involved in the dissemination of processed cocoyam technologies to women farmer groups. This study seeks to ascertain the level of adoption and major constraints affecting the adoption of cocoyam processing technologies introduced to women clientele of AKADEP in Akwa Ibom State.

METHODOLOGY

Data was collected from 90 respondents who were chosen through a multi-stage sampling procedure from 12 of the 23 active WIA women groups, broadly spread around the six zones of AKADEP in the State. Data analyses were with the aid of frequency counts, percentages, mean counts and factor analysis. To ascertain the level of adoption of improved cocoyam processing technologies**,** respondents were requested to respond to a 13 point list of technologies with the aid of a three (3) point Likert continuum of not adopted (1 point), adopted but discontinued (2 points) and fully adopted (3 points). On the other hand, factor analytic procedure was utilized to ascertain the major dimensions of the constraints to adoption of WIA- promoted cocoyam processing technologies. A factor loading of 0.50 and above was adopted in analyzing the data. A varimax rotated factor matrix was then employed to identify the most important constraining factors to utilization of cocoyam processing technologies. In essence, variables with coefficient greater than 0.50 were considered to have a high loading factor and were considered strong constraining factors while those with less than 0.50 were considered as minor constraint factors to the adoption of cocoyam processing technologies.

RESULTS AND DISCUSSION

Level of adoption of WIA promoted cocoyam processing technologies

Table 1 reveals a very high adoption level (92.3 %) of disseminated cocoyam production technologies. In essence, 12 out of 13 disseminated technologies were fully adopted by respondents. Cocoyam fufu and cocoyam flour ($\bar{x}$ = 2.96; rank =1 each) and cocoyam pudding (($\bar{x}$ =2.83; rank = 3) were the major adopted technologies while the least adopted were cocoyam fritters ($\bar{x}$ = 2.41; rank=11) cocoyam bread ($\bar{x}$ = 2.27; rank=12) and cocoyam balls ($\bar{x}$ = 1.88; rank=13). It is important to note that reported majorly adopted technologies are merely improved forms of familiar (hitherto locally utilized) food types. The semblance to local food types increased the ease of acceptance of these introduced technologies. Generally, respondents gave reasons for high utilization of the major technologies to include; cultural acceptance, ease of preparation and market demand. Table 1 also shows that although 'cocoyam balls' technology was ranked as least adopted, about 76.7 percent of respondents fully adopted the technology, while 33.3 percent either never adopted or had to discontinue its utilization. Respondents predicated the reason for this trend on lack of acceptability and concomitant poor economic value, arising out of poor market sales. Another important item of potential economic value like cocoyam bread surprisingly recorded a 'fully adopted' value of only 40 percent and a never adopted/ used but discontinued value of 60 percent. Reasons adduced for this trend were revealed to include: lack of funds to procure necessary machinery and support materials (like drying, grinding, storage and packaging materials) lack of incentive for adoption (because people are used to bread made from wheat;) and limited access to required inputs, especially raw cocoyam corms, which has a limited production potential.

A review of related literature reveals varying levels of adoption of value-added cocoyam technologies. Nwafor (2023) and Apata et al (2021) reported high levels of adoption of recommended technologies; while Onuekwusi, Odoemelam and Kanu (2017) reported average levels of utilization. On the other hand, Osahon and Odoemelam (2019); Ijoma et al (2014) and Osahon and Ifenkwe (2019) reported very low levels of utilization of disseminated cocoyam value added technologies. It may be noted that the majorly adopted technologies were not consistent with respect to all the perused scientific reports.

Table 1: Level of Adoption of WIA Promoted Cocoyam Processing Technologies*

Items	Statements	Never	Used but Discontinued	Fully Adopted	Mean	Rank	Decision
1	Cocoyam Achicha	6(6.7)	12(13.3)	72(80.0)	2.73	5	A
2	Cocoyam Chinchin	10(11.1)	5(5.6)	75(83.3)	2.72	6	A
3	Cocoyam Strips	12(13.3)	6(6.7)	72(80.0)	2.66	7	A
4	Cocoyam Cakes	2(2.2)	18(20.0)	70(77.8)	2.75	4	A
5	Cocoyam Doughnuts	16(17.8)	7(7.8)	67(74.4)	2.56	8	A
6	Cocoyam Muffins	15(16.7)	15(16.7)	60(66.7)	2.50	9	A
7	Cocoyam Bread	11(12.2)	43(47.8)	36(40.0)	2.37	12	A
8	Cocoyam Fritters	21(23.3)	11(12.2)	58(64.4)	2.41	11	A
9	Cocoyam Balls	10(11.1)	11(12.2)	69(76.7)	1.88	13	NA
10	Ikpan Ikpo	10(11.1)	31(34.4)	49(54.4)	2.43	10	A
11	Pudding	3(3.3)	9(10.0)	78(86.7)	2.83	3	A
12	Cocoyam Fufu	0(00.0)	3(3.3)	87(96.7)	2.96	1	A
13	Cocoyam Flour	0(00.0)	3(3.3)	87(96.7)	2.96	1	A

Source: Field Survey (2022). *Mean ($\bar{x}$) Cut off Point = 2.0

Major Dimensions of the Constraints to Adoption of WIA Promoted Cocoyam Processing Technologies

Nineteen items were initially generated and validated during the instrument construction phase to reflect this objective. Factor analytic procedure primarily analyzed the interrelationship among variables (scale items) in terms of their underlying dimensions (factors).

The results of the rotated component matrix showing the extracted factors, based on the responses of the respondents to major constraints deterring adoption of value-added cocoyam technologies are shown in Table 2. Based on the item loadings of the conducted factor analysis, seven critical factors were isolated and named. Factor 1 accounted for 21.28 percent of the variances in data and was named “Low financial/ Technological base’. These were made up of constraint items like lack of drying machine (0.906) lack of funds (0.878), lack of storage facilities (0.644) and lack of grinding machine (0.581). Factor 2 accounted for 15.9 percent variance and was named ‘human/institutional related’ factors. This factor was composed of items like ‘lack of enough land for farming’ (0.806), ‘lack of access to credit facilities’ (0.848), ‘lack of interest’ (0.667) and ‘cultural belief’ (0.518). The third major group of factors deterring utilization of cocoyam processing technologies accrued 12.33 percent of the variances and was termed ‘low incentive to adopt technologies. These were made up of two items which included ‘lack of incentive for adoption of innovations’ (0.802) and limited access to inputs (0.796). Other major factors included: Inadequate supply of cocoyam tubers (Factor 4- 9.43 % variance); poor accessibility (factor 5- 7.96% variance); high cost of Technology (factor 6- 5.80% variance) and lack of adoption supporting facilities/ accessories (factor 7- 5.27 % variance).

Table 2: Rotated Component Matrix on Farmers' Responses on Constraints to Adoption of cocoyam processing Technologies

Pre-disposing Factors	Components						
	1	2	3	4	5	6	7
Lack of funds to implement technology	**.878**	-.125	.107	-126	.083	-060	-045
Lack of drying machine	**.906**	-032	.021	-039	-031	007	258
Lack of grinding machine	**.581**	.340	.397	.313	-006	.267	.181
Lack of storage facilities	**.644**	.297	.267	.377	-045	.203	-015
Lack of package materials	.305	-072	.242	.087	.205	-094	**.804**
Lack of interest	-226	**.667**	.127	-048	.342	-150	.063
Lack of extra land for farming	.117	**.806**	.251	-199	-064	.038	-239
Disease attack	.181	.337	.318	.181	.532	.051	-535
No transport to access demonstration sites	.152	.454	.014	-208	-688	.191	060
High cost of recommended inputs (technology)	-051	.244	-266	.052	-147	-837	.087
Failure of extension workers to reach farmers	.147	.226	-203	-760	.000	.319	.233
Lack of access to training programme by non-members of WIA groups	.096	.081	.142	-081	**.862**	-034	.168
Unstable market price	.360	-325	.471	-549	-007	.035	-003
Inadequate supply of cocoyam tubers	.174	-050	-082	**.829**	.067	.091	.152
High cost of innovation	.021	.009	.008	-036	-386	**.714**	-020
Lack of incentive for adoption of innovations	.003	.205	**.802**	-.047	-.108	.116	.198
Limited access to credit	.089	**.848**	.124	.022	-.138	-.098	-.042
Limited access to inputs	.238	.170	**.796**	.032	.010	.091	-.072
Cultural belief	-394	**.518**	-.074	.342	-.022	-.096	.071

Source: Adapted from field survey (2022)

Related literature reveals major constraints to utilization of cocoyam processing technologies to include: lack of funds and inadequate improved varieties (Apata et al (2021); paucity of funds and lack of credit access (Ogada *et al.* (2014); rejection of technologies by farmers on the basis of incompatibility of technologies to farmers' local practices (Olatunji, Nwakor and Asumugha, 2015); no extension agents to answer their questions, lack of commitment and marketing of products (Onuekwusi, Odoemelam and Kanu, 2017). In their contribution, Apata et al (2021) proffered that Value addition to cocoyam is profitable and returns on investment is more plausible for medicinal purposes and needs to be encouraged.

CONCLUSIONS AND RECOMMENDATIONS

Indications are that there is a very high level of adoption of cocoyam processing (value-added) technologies disseminated by the women-in-agriculture (WIA) component of the Akwa Ibom Agric Development Programme (AKADEP) to women groups in Akwa Ibom State. Cocoyam fufu, cocoyam flour and cocoyam pudding were the major adopted technologies; mainly due to reasons of cultural acceptance and ease of preparation. It was also revealed that presumably important technologies like cocoyam bread (especially) and cocoyam balls recorded high levels of either non-adoption or discontinuance; mainly for reasons of high financial implications, lack of acceptability and concomitant poor market demand, resulting to poor economic value. It is important to note, in passing; that most of the adopted technologies are mainly for household utilization, with very limited income earning potentials. In essence, only the very limited culinary (human consumption) aspect of cocoyam (of the wide attributes and versatility of the crop) has been realized in the study area. People are yet to come to terms with its nutraceutical, industrial and trade potentials-which would have positive implications on economic livelihood and export. This situation may portend grave negative implications against sustained adoption. This is because a key motivating factor for sustainable adoption of disseminated technologies is the development of an entrepreneurial spirit and subsequent wealth creation. This should be the focus of policy makers and all other stakeholders' involved in the creation of awareness on the importance of the cocoyam crop. The following recommendations would help in this regard: i) Enhanced creation of public awareness on the attributes and potential benefits of cocoyam; ii) Release of funds by relevant stakeholders to enhance quality research on how to improve production levels, genetic diversity, biotech application and evaluation for adaptation Finally, a value-chain approach should be embarked upon as to drive productivity, competitiveness, entrepreneurship and growth of small and medium scale enterprises.

REFERENCES

Ademola, C. (2024) Nigeria ranked 109 of 125 countries in 2023 Global Hunger Index – Report https://nairametrics.com/2024/02/03/nigeria-ranked-109-of-125-countries-in-2023-global-hunger-index-report/ Accessed: 20/07/2024

Akasike, C. and D. Adaji (2024) 'Food crisis: 82 million Nigerians may go hungry soon, UN warns' The Punch On-line https://punchng.com/food-crisis-82-million-nigerians-may-go-hungry-soon unwarns/#:~:text=This%20year's%20results%20are%20alarming,severe%20food %20insecurity%20by%20 2030. 6th July. Accessed: 20/07/2024

Apata, T.G; E. A. Henry; C. Jaiyeoba; O. Igbalajobi, K. Oni, O. Bamigboye; and S. Bamisaye (2021) Value chain analysis of cocoyam enterprise in Southwest Region, Nigeria. *Journal of the Austrian Society of Agricultural Economics* 17 (3): 1-19 March.

CGIAR 2020). https://www.rtb.cgiar.org/news/cocoyam-has-huge-market-but-few-farmers-cultivate-it/ CGIAR Sept. 15, 2020

Nwafor, E. (2023) Adoption of recommended cocoyam production technologies among farmers in Enugu State, Nigeria. A Phd thesis submitted to Dept of Agric. Ext. and Rur. Devt, School of Agric. and Agric. Tech, Fed. University of Technology, Minna, Niger State, Nigeria August, 2023

Ogada, M.J, G. Mwabu and D. Muchai (2014). Farm technology adoption in Kenya: a simultaneous estimation of inorganic fertilizer and improved maize variety adoption decisions *Agricultural and Food Economics* 2:12

Olatunji, S. O; F. N. Nwakor and G. N. Asumugha (2015). Assessment of transfer of cocoyam technologies in Anambra State, Nigeria *The Journal of Agricultural Sciences* 10 (3) 168-176, September

Onuekwusi G. C., Odoemelam L. E., Kanu R. I. (2017). Improving rural women income through cocoyam value addition technologies in Abia state. *Nigeria Journal of Agricultural Extension* 21 (3) 116-125 October

Osahon, E.E. and Odoemelam L.E. (2019). Extent of utilization of cocoyam value added technologies among rural households in South-East Nigeria. *Nigerian Agricultural Journal* 50 (2) 233-240 December.

GHI (2024) 2023 global hunger index: The power of youth in shaping food system welthungerhilfe (whh); concern worldwide Bonn/ Dublin 2023. October

NBS (2024) CPI and Inflation Report June 2024 https://nigerianstat.gov.ng/elibrary/read/1241533

NRCRI (2020); https://nrcri.gov.ng/cocoyam-research/ Taro and cocoyam Programme

Osahon, E.E. and G.E.Ifenkwe (2019). Awareness and Utilization of Cocoyam Value Addition Technologies by Farmers in South-East, Nigeria JCCR 4(2) 127-133 December.

Otekunrin, O.A.; Sawicka, B.; Adeyonu, A.G.; Otekunrin, O.A.; Racho N, L (2021). Cocoyam [*Colocasia esculenta* (l.) schott]: exploring the production, health and trade

potentials in sub-Saharan Africa.*Sustainability* (*13)*, 4483. https://doi.org/10.3390/su13084483
WFP (2024) World Food Programme (WFP) 'Nigeria Country Brief' https://www.wfp.org/countries/nigeria Accessed: 20/07/2024

Fadama Vegetable Farmers Attitude and Utilization of Organic Farming Practices in Akwa-Ibom State, Nigeria

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Abstract
The study sought to examine Fadama farmers' attitude towards organic farming practices and subsequent level of utilization of such practices in Akwa Ibom State, Nigeria. Relevant data were obtained from 120 vegetable farmers, selected through a multi-stage sampling procedure from a sample frame of participants in the Fadama-Additional Funding (AF) programme in the State. A set of pre-tested and validated questionnaires was used to elicit relevant information. Respondents were requested to respond to a set of 19 attitudinal statements and 17 organic practices with the aid of relevant Likert type criteria. Collated data were analysed with the aid of descriptive statistics and results indicated that an average proportion of respondents (55%) were found to possess a high, positive and favourable attitude towards organic farming practices. The general belief is that organic agriculture contributes to safe and healthy diets and improves soil structure. It was also revealed that an average proportion of respondents regularly utilized; animal manure ($\overline{x}$ = 3.74), crop residues ($\overline{x}$ = 3.66) and reduced/minimum tillage ($\overline{x}$ = 3.52); on their farmlands. It is concluded that farmers possess a high propensity to go green and they should be encouraged in this endeavour by Fadama facilitators and extension agents.
Keywords: Attitude, utilization, organic farming, Fadama III-AF, vegetable farmers, Akwa Ibom State.

INTRODUCTION

One of the United Nations' Sustainable Development Goals (SDGs) is to create a world free of hunger by 2030. Recent trends however indicate that the world is moving farther away from meeting SDG 2 to achieve zero hunger. Food insecurity worsened in 2023 with about 282 million people worldwide, suffering from acute hunger. This number grew by 24 million when compared to 2022 figures, according to the (GRFC/FSIN (2024). One important and often overlooked component of helping increase food security around the world in a sustainable way is supporting smallholder farmers, who produce about one-third of the world's food supply. Among this group are the world's poorest, most food insecure and most vulnerable, who are furthest from the goals of SDG 1 and SDG 2 (Woodhill, Hasnain and Griffith (2020). Small-scale producers grow and process diverse and nutritionally rich dietary foods for local markets and fellow ruralites, thereby shortening supply chains and reducing wastage. Investing in them to engage in sustainable agricultural production can help ensure adequate food for all in a manner that will reduce environmental degradation.

This calls for an enhanced focus on sustainable agricultural practices, a major plank of which is organic farming (OF). Sustainable farming not only rejects artificial methods but also emphasizes farming practices that are economically viable and supportive (Chomsky, 2023). In a similar mode OF strictly compliments sustainable agriculture because it focuses on utilizing methods that benefit the environment, without the use of synthetic pesticides, chemical fertilizers and GMOs. OF plays a key role in realizing the different sustainable agricultural goals, especially as it relates to quality human life, preservation of environmental integrity and promotion of green economy measures, especially in developing countries where smallholder agriculture forms the backbone of the economy.

A key agricultural enterprise that could benefit from OF practice and ensure enhanced benefits to the smallholder farmers is vegetable production which is one of the global activities practiced in every economy, as it forms a major component of human diet. Studies discovered that not only is the global vegetable production increased by 100% in recent time, but also its trade value has exceeded that of cereals (Okonta et al (2023). Vegetables' provide essential nutrients to humans affordably with its vantage cheap and reliable sources of protein, vitamins and minerals for body development and repair. They render relished support to main cereals, root and tuber crops in the country (Oluwasusi, 2014). Smallholder farmers produce vegetables by integrating indigenous, adopted and scientific agricultural practices.

In view of the enormous benefits of OF, government intervention programmes geared toward improving the lives of the pro poor have consistently given priority to the inclusion of OF practices in its various programmes. The Third National Fadama Development Project (NFDP III) and its successor, the Fadama III-Additional Financing (Fadama-AF) project followed in this trend and exposed its beneficiary vegetable farmers to OF activities. This has been done consistently through capacity building and provision of relevant inputs and other associated activities; including espousing of benefits derivable from utilisation of organic vegetable practices; as well enumerated by Mbah et al (2020) and Fanu et al (2024); among very many other researchers.

Dissemination and subsequent adoption of agricultural technologies are tried and tested means of increasing farm productivity and concomitant poverty reduction among small scale farmers. Many studies, as listed by Zulqarnain et al (2020) however assert that the process of technology adoption and dissemination may be complex, challenging and consequently may affect the farmers' attitude towards agricultural technology adoption. It is however important to understand that farmers' response in terms of acceptance or rejection of technologies is an important determinant of the technology development process (Joshua, Massawe and Mwakalapuka, 2020). In essence, the attitude and knowledge of smallholder farmers towards their agricultural production and practices influence how they think and perceive their decisions (Kidane and Zwane (2022).

The tendency is to assume that people behave according to their attitudes. Pantakar (2020) opines that the concept that behaviour follows attitude is used extensively by advertising and marketing companies. In essence, when shaped in the right way, attitude can influence behaviour to achieve a favourable outcome. However, social psychologists have found that attitudes and actual behavior are not always perfectly aligned (Chaiklin, 2011). In essence, a large difference may exist between intention and actual behavior (Zhou and Ding, 2022). It is against this background that this study was conceived, to examine Fadama vegetable farmers' attitude towards OF practices and subsequent level of utilization of such practices in Akwa Ibom State, Nigeria.

METHODOLOGY

A multi-stage sampling procedure was used to select 120 respondents from a sample frame of Fadama vegetable farmers affiliated to 65 Fadama User Groups (FUGs) affiliated to 42 Fadama Community Associations (FCAs) in 16 of the 20 Local Government Areas (LGAs) participating in the programme in Akwa Ibom State. Data analyses were with the aid of frequency counts, percentages and mean counts. Farmers' attitude towards organic agriculture was evaluated using a 4-point rating scale of; Strongly Agreed (4), Agreed (3), Disagreed (2) and Strongly Disagreed (1) and consisted of nineteen (19) attitude statements; while utilization of organic practices consisted of 12 organic farming practices which were measured with the aid of a four-point Likert continuum of: Not practiced (1), Practiced but discontinued (2) Practiced- Selected Season (3) and Practiced every season (4).

RESULTS AND DISCUSSION

Attitude of Respondents towards Organic Farming

Major attitudinal dispositions of respondents, as indicated in Table 1 were "Organic agriculture contributes to safe and healthy diets" ($\overline{x}$ = 3.89; rank= 1); (ii) "Organic agriculture improves soil formation and composition" and ($\overline{x}$ = 3.62; rank= 2); and (iii) "Organic agriculture protects farmers' health" ($\overline{x}$ = 3.61; rank= 3).

These items revealed the potentials of organic farming practices to enhance farmers' health, promote food safety and quality and promote soil formation and structure; among others. As noted by the respondents, organic farming contributes to safe and healthy diets because as a farming system that excludes the use of chemicals, chemical residues which cause cancer and other related diseases are absent from harvested produce. Also, the farmer's health is protected since the farmer is not exposed to these chemicals (herbicides and pesticides) through application. Soil fauna and flora thrive in soils that are not replete with chemicals thereby improving their formation and composition. A few attitudinal statements however recorded mean values below the cut-off point of 2.5. These were: i) "there is a high demand for organic products" ($\overline{x}$ = 2.41; rank = 17), ii) "OA ensures food security" ($\overline{x}$ = 2.11; rank = 18) and; iii) "OA creates market niche" ($\overline{x}$ = 1.93; rank = 19).

These findings are an indication of the limitations of organic farming. The demand for organic products may not be high in the study area because some respondents noted that these products are generally sold at significantly higher prices than conventionally-produced food products. This secludes the product out of reach of the generality of the population, sequel to the current down-turn and generally low purchasing power in the study area. Also, to the ordinary citizens who frequent the open markets; there is no significant difference in the physical structure of both organically produced and conventionally produced vegetables. The only difference may be in price differentials on food shelves of supermarkets, many of which do not display vegetables on their shelves. Oluwasusi (2014) however reported a high demand for organic products in selected States of south west Nigeria.

Findings revealed a general moderate (average) disposition of respondents towards utilization of OF practices in their vegetable production activities. Table 2 indicates that about half (50%) of the respondents had high, positive and favourable disposition towards organic farming practices; unlike 42.5% (51) who indicated low, unfavourable attitude. These findings are consistent with those of Fanu et al (2024) Okonta et al (2023) Zhou and Ding (2022) and Oluwasusi (2014). Oyedele (2018) however reported that majority of respondents were undecided with reference to their disposition on OFP.

Predominant Organic Farming Practices (OFP)
Table 3 indicates organic farming activities practiced by the respondents. The most prevalent OFP activities were: i) "Use of animal manure" ($\bar{x}$ = 3.74); ii) "Use of crop residues" ($\bar{x}$ = 3.66) and; iii) "Reduced/minimum tillage ($\bar{x}$ = 3.52). On a general level, it was revealed that seven (7) of the 12 OFPs scored more than the mean cut-off point of 3.0 - indicating a moderate level utilization of introduced technologies. Findings revealed that many of the respondents are quite skeptical about the 'much touted potentials', of OFP based on its cumbersome nature and indifference of consumers and customers who refuse to pay higher prices for OF vegetables. Related literature reveals differing results on utilization of introduced OFPs. Mbah et al (2020) reported a high level of utilization of OFP in Imo State, with the major OFPs revealed as mixed cropping, shifting cultivation and crop rotation ; while Obazi et al 2022, in Enugu State; reported a mid-level (51.6%) utilization, with animal manure, farmyard manure and composting as major applications. Owolabi, Ajayi and Akintola, (2018) with reference to Ondo State; reported a similar average utilization level with mixed cropping, minimum tillage, mulching as mainly used OFPs. On the other hand, Fanu et al (2024) revealed a low level of OFP utilization with crop rotation, mulching, application of organic fertilizer in Ekiti State. A similar low utilization trend was reported for Owerri LGA by Egwuonwu and Onyeaka (2020) with animal manure and natural weed control as most predominant. In deference to reported relative differences in the utilization of OFPs in vegetable production, Ibeawuchi et al (2015) asserted that current practices of organic agriculture are a modification and continuation of indigenous practices that are more prominent in different respective areas in Nigeria.

The least utilized OFPs were: i) "use of off-farm organic wastes" ($\bar{x}$ = 2.08; rank= 10); ii) "intercropping" ($\bar{x}$ = 2.04; rank = 11) and; iii) "crop rotation" ($\bar{x}$ = 1.71; rank = 12). The practice of using off-farm organic wastes on the farm, such as kitchen sweepings, was low because most of the respondents lived far away from their farms. Intercropping was low too because, as asserted by some of the respondents, the design of Fadama III-AF Project allowed for each Fadama User Group (FUG) to be identified by a specific enterprise all through the lifespan of the Project, although some of the respondents (16.7%) planted a few other crops along with vegetable. This also explains why the practice of crop rotation was low.

Conclusion and recommendations
The findings of this study are indicative of the generally moderate attitude of the vegetable farmers towards OFPs. This study also tends to affirm behavior follows attitude (Pantakar, 2020) because the farmers' also recorded a moderate level of utilization of introduced OFPs. Many farmers possess a positive attitude towards OFPs because of its semblance to local, traditional farm practices. It therefore becomes imperative to leverage on the important traditional practices that share similar modes of operation with organic farming; as this will enhance its acceptability and easier diffusion through the farming system. It may also be important to understand reasons behind

selective adoption of some OFPs, as to help expose related inadequacies which may need to be addressed, to enhance higher utilization levels. In essence, extension agents must be capacitated to enable them keenly perform awareness and advocacy functions that will espouse the health, economic and environmental benefits of OFPs. It is also important that the positive attitudinal traits of farmers become more enhanced and better transformed into actual behavior of adoption. This should be done by exposing them to means of generating higher income from their farms through OFPs. It is well known that organic production can create employment, transfer knowledge and improve access to high value markets. In this wise, Organic agriculture should be given priority attention in Nigeria because it is demand-driven as the products are needed in advanced countries. Nigeria needs to get its share of the lucrative global organic products market, through embarking on a process of certification of her products by the relevant authorities in the world market. A first step in this direction is through the formulation or stricter implementation of suitable policies to enhance the practice of organic agriculture. After which, a targeted focus on training and capacity building in both primary production and building a veritable value chain for organic products; will be embarked upon for enhanced sustainability.

REFERENCES

Chaiklin H. (2011) Attitudes, behavior, and social practice. *The Journal of Sociology & Social Welfare*: 2011:38(1). doi:10.15453/0191-5096.3583)

Egwuonwu, Helen A. & Onyeaka, Blessing A. (2020) Utilization of organic farming practices among vegetable farmers in Owerri West LGA ofIimo state**.** *IJARD* 23(1): 4871-4876

Fanu, A. T., Banigbe, O.I., Owoseni, K. P.., Atoun, A. O. and Adebimpe, A. T. (2024) Assessment of Organic Farming Practices among arable crop farmers In Ikole-Ekiti LGA, Ekiti State, Nigeria *Nigerian Journal of Rural Sociology,* 24(1) 46-50

Global Report on Food Crises (2024) Nigeria https://www.fsinplatform.org/sites/default/files/resources/files/GRFC2024-country-NG.pdf
Food security information network (FSIN). Accessed:02/08/2024

Ibeawuchi I. I., Obiefuna J. C., Tom C. T., Ihejirika G. O., Omobvude S. O (2015) Indigenous and current practices in organic agriculture in Nigeria: A review. *Agriculture, Forestry and Fisheries.* 4(6) 257-262.

J.M.Joshua, F.A. Massawe and A. A.Mwakalapuka (2020) The relationship between farmers' attitude towards the improved cassava processing technology and adoption *IJAE &RDS* 7 (1) 12-26, February.

Kidane, T.T and E. F. Zwane (2022) Smallholder farmers' attitude towards organic farming and factors influencing their attitude: the case of kwazulu-Natal province, South Africa *Int. J. Agr. Ext.* 10 (01) 55-60

Mbah G.O, Ikenyirimba C., Bassey J.I. & G.E. Ifenkwe (2020) Utilization of organic farming practices among rural farming households in Imo State, Nigeria J Sust Agric Envir 18 (2): 266-281

Obazi, S.A., M. O. Iheanyichukwu ., D.J. Okoronkwo , K, Obasi , S. E. Esheya (2022) Adoption level on Organic Farming Practices by Fluted Pumpkin Vegetable Farmers in Enugu State, Nigeria. *IJASRT in EESs* 12(4):179-188

Oluwasusi, J.O. (2024) Vegetable farmers' attitude towards organic agriculture practices in selected states of South West Nigeria 6(7), 223-230, July. DOI: 10.5897/JAERD2013.0572

Okonta, O.W., Ajala, A.O., Kolawole, E.A., Ogunjimi, S.I., Adejumo, A.A. (2023). Willingness to Adopt Organic Farming Practices among Arable Crop Farmers in Oyo State, Nigeria. *J of Agric. Extension* 27 (3) 41- 52

Owolabi, K.O; Ajayi, F.O. and Akintola, A.K. (2018) Utilization of organic farming techniques among selected arable crop farmers in Ondo state, Nigeria *Applied Tropical Agriculture* 23(2) 98-111

Oyedele G. T., Wole-Alo F. I., Owolabi K. E., Okunlola J. O. (2018) Small–scale farmers perceptions on organic farming status in Ondo State, Nigeria. *American Jour of Agric. and Forestry*. 6 (6) 2018, pp. 186-190.

Patankar, U (2020) (How do attitudes influence our behaviour? https://timesofindia.indiatimes.com/readersblog/udayanspeaks/how-do-attitudes-influence-our-behaviour-25236/ August 28. Accessed: 22/07/2024

Ume CO, Onah OG, Okpukpara BC, Chukwuma-Ume N, Charles UI, Omeje EE, Chiemela CJ, Chituru IJ and Orazulike O (2023) Factors influencing smallholder adoption of organic agriculture in Southeast geopolitical region of Nigeria. *Front. Sustain. Food Syst.* 7:1173043. doi: 10.3389/fsufs.2023.1173043

Woodhill, J; S. Hasnain and A. Griffith (2020) *Farmers and food systems: What future for small scale agriculture?* Environmental Change Institute, University of Oxford. England)

Zhou, X. and Ding, D. (2022) Factors influencing farmers' willingness and behaviors in organic agriculture development: An empirical analysis based on survey data of farmers in anhui province. *Sustainability* 2022, *14*, 14945. https://doi.org/10.3390/su142214945. Accessed: 22/07/2024

Zulqarnain, N.M., J. Sharifuddin, M.Roslan and S. Hassan (2020) Factors Influencing Attitude towards Tech. Adoption among Perm.Food Prodn Park (PFPP) Prog. Participants in West Malaysia Jour of Agric Sc. & Tech, 10 (89-97)

Table 1: Attitude of respondents towards organic farming practices (N=120)

Attitude Statements	Strongly Agreed (SA)		Agreed (A)		Strongly Disagreed (SD)		(D Disagreed)		Mean*	Rank
	F	%	F	%	F	%	F	%		
Farmers earn more money from organic farming since they use less inputs.	20	16.7	64	53.3	6	5	30	25	2.62	14th
The environment is not polluted and degraded with chemicals.	18	15	70	58.3	5	4.2	27	22.5	2.65	13th
Food produced organically is safe and of high quality with the absence of chemical residues.	60	50	48	40	4	3.3	8	6.7	3.33	4th
Oxides of carbon and other harmful substances are not released into the atmosphere.	22	18.3	58	48.3	8	6.7	32	26.7	2.58	15th
OF builds soil quality and organic matter content.	42	35	50	41.7	16	13.3	12	10	3.02	11th
OF enhances the health of the natural environment	44	36.7	57	47.5	13	10.8	6	5	3.15	6th
OF increases agricultural efficiency, yield and output.	25	16.7	55	45.8	5	4.2	35	29.2	2.58	16th
With OF, there is food for all, at the right time, quantity and price (food security).	6	5	37	30.8	4	3.3	73	60.8	2.11	18th
OF encourages retention of Carbon in the soil.	14	11.7	84	70	8	6.7	14	11.7	2.82	12th
OF promotes agricultural sustainability.	38	31.7	60	50	9	7.5	13	10.8	3.03	9th
There is a high demand for organic products.	2	1.7	49	40.8	16	13.3	53	44.2	2.41	17th
OF protects farmers' health.	90	75	20	16.7	3	2.5	7	5.8	3.61	3rd
OF is a source of productive labour and employment.	30	25	80	66.7	6	5	4	3.3	3.13	7th
OF contributes to safe and healthy diets.	85	70.8	25	20.8	6	5	4	3.3	3.89	1st
OF improves soil formation and composition.	82	68.3	33	27.5	2	1.7	3	2.5	3.62	2nd
Ground water is safe for drinking since chemicals are not leached into it.	40	33.3	60	50	10	8.3	10	8.3	3.08	8th
OF encourages the existence of different beneficial organisms in the soil.	20	16.7	90	75	2	1.7	8	6.7	3.02	10th
OF minimizes air pollution.	33	27.5	81	67.5	5	4.2	1	0.8	3.22	5th
There is ready market for organic products only. (Market niche).	1	0.8	50	41.7	9	7.5	60	50	1.93	19th

Mean attitude = 3.0

Table 2: A summary table of respondents' attitude towards organic farming (N = 120)

Attitude of Respondents	Attitude score*	Frequency	Percent
Positive (Favourable)	> 54	60	50
Neutral	54	9	7.5
Negative (Unfavourable)	< 54	51	42.5

*Mean attitude score = 54

Table 3: Distribution of respondents based on organic farming practices (N = 120)

Organic farming practices	Practiced every season		Practiced selected seasons		Practiced but discontinued		Not practiced		Mean*	Rank
	F	%	F	%	F	%	F	%		
Use of animal manure	92	76.7	16	13.3	5	4.2	7	5.8	3.74	1st
Crop rotation	10	8.3	5	4.2	45	37.5	60	50.0	1.71	12th
Mulching	60	50.0	40	33.3	10	8.3	10	8.3	3.25	6th
Composting	22	18.3	70	58.3	7	5.8	21	17.5	2.78	9th
Intercropping	20	16.7	20	16.7	25	20.8	55	45.8	2.04	11th
Use of off-farm organic wastes	18	15.0	32	26.7	12	10.0	58	48.3	2.08	10th
Farm sanitation	60	50	40	33.3	9	7.5	11	9.2	3.24	7th
Reduced/minimum tillage	84	70.0	18	15.0	14	11.7	4	3.3	3.52	3rd
Cover cropping	22	18.3	78	65	12	10	8	6.7	2.92	8th
Use of crop residues	98	81.7	9	7.5	7	5.8	6	5.0	3.66	2nd
Adequate drainage system	70	58.3	35	29.2	10	8.3	5	4.2	3.42	5th
Use of local seed varieties	73	60.8	36	30	8	6.7	3	2.5	3.49	4th

*Mean value of organic farming practices = 2.5.

Utilization of Agro-Meteorological Information among Smallholder Crop Farmers: The Case of Cross River State, Nigeria

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Abstract
Despite efforts by the Nigeria Meteorological Agency (NIMET) to communicate weather forecasts and early warning signals to help farmers make farm-level decisions due to the erratic weather conditions, it appears agro-meteorological information services are rarely being used by smallholder crop farmers. This study investigated the extent of utilization of agro-meteorological information among smallholder farmers in Cross River State, Nigeria. A multistage sampling was used to select a sampling size of 104. Data were analyzed using descriptive and inferential statistics. The results revealed that utilization of agro-meteorological information was low as the farmers only utilized a few of the available forecast information such as seasonal amount of rainfall predictions ($\bar{x}$ = 2.3), flood predictions ($\bar{x}$ = 2.07), and daily weather forecast ($\bar{x}$ = 2.03) for making farm decisions. The multiple regression analysis revealed that only education and access to agro-meteorological information had a positive and significant influence on farmers' utilization of agro-meteorological information at $P< 0.05$. The study concluded that farmers utilization of agro-meteorological information was low due to a myriad of constraints. It was therefore recommended that NIMET should collaborate with extension service providers to disseminate location specific agro-meteorological information, supported by Rural Advisory Services (RAS) networks and community-based organizations in the country through advocacy for increased forecast information accessibility and utilization by farmers in making beneficial farm decisions.
Keywords: Agro-meteorological information, Communication, smallholder farmers, Utilization

INTRODUCTION
Rain-fed agriculture is the predominant source of food production and livelihood base of most rural dwellers in sub-Saharan Africa, including Nigeria (Hope, 2009; Olayide et al., 2016; Bjornlund *et al*. 2020). In spite of oil, agriculture remains the foundation of the Nigerian economy, providing the main source of livelihood to many households (Osabohien *et al*. 2020). Unfortunately, agriculture which is primarily dominated by smallholder farmers is one of the sectors highly susceptible to climate variability and change. In Nigeria, crop production is predominant and occupies approximately 94% of the agricultural sector (Okon *et al*. 2021). However, climate change has had a deleterious effect on crop production activities resulting in crop loss, low crop output and a decline in the cycle of growing days (Ebele and Emodi, 2016; Ezihe *et al*. 2017; Okon

et al., 2021). In Cross River State, severe flooding and other extreme climatic events have resulted in the destruction of livelihoods, reduced crop production and invariably food insecurity (Udoimuk et al. 2014; Ogogo et al., 2018; Kori et al. 2021). In order to reduce the risk and likely negative impacts of climate extremities on crop production, anticipatory adaptation has been advocated. One of the ways of providing anticipatory adaptation is through the provision and utilization of agro-meteorological information. several reports have revealed that responding to climate variability and change in agricultural communities will be incomplete without access to and utilization of weather and climate forecasting information (Mudombi & Nhamo, 2014; Singh et al. 2017; Tarchiani et al., 2021). Nevertheless, despite efforts by the NIMET to communicate weather forecasts and early warning signals for farmers to cushion the effects of these climate variability and change, food insecurity and cases of crop failures are still being reported in Nigeria. Accordingly, FAO, (2016) reported that due to low rainfall which hinders the production of certain crops, about 7.0 million people face acute food shortages in Nigeria, including Cross River State. It is based on the foregoing that the study attempts to investigate the extent of utilization of agro-meteorological information and the influence of selected socio-economic characteristics of smallholder crop farmers on the utilization of agrometeorological information. The results of the study will serve as a guide to stakeholders for planning and formulation of new policies on agro-meteorological information communication to farmers.

METHODOLOGY

The study was conducted in Cross River State, Nigeria. The population of the study consisted of all smallholder crop farmers in Cross River State. A multistage random sampling was used to select a sample size of 104 from 8 cells in 4 blocks. Primary data were sourced with the use of the structured questionnaire. A 3-point Likert-type scale with response categories of: Always Use = 3; Sometimes Use = 2; and Not use = 1 was used to ascertain the extent of utilization of agro-meteorological information. The cut –off mean value was 2.0. Therefore, items with cut-off mean values more than or equal to 2.0 were considered as agro-meteorological information used by farmers, while items with a cut-off mean values less than 2.0 were considered otherwise. The hypothesis of the study which sought to analyze the influence of selected socio-economic characteristics of the farmers on the utilization of agro-meteorological information was analyzed using a multiple regression model.

The regression model is postulated as:

$$Y = b0 + b^1x^1 + b^2x^2 + b^3x^3 + b^4x^4 + b^5x^5 + b^6x6 + b^7x^7 + b^8x^8 + e$$

Where,
Y = dependent variable (extent of utilization of agrometeorological information),
x^1 - x^8 = independent variables (socio-economic characteristics of the farmers),
e = Error term.

RESULTS AND DISCUSSION

Based on the magnitude of the mean scores, Table 1 reveals that the agro-meteorological information utilized by the smallholder crop farmers in making decisions were seasonal amount of rainfall predictions ($\bar{x}$ = 2.31); flood predictions ($\bar{x}$ = 2.07); daily weather forecast ($\bar{x}$ = 2.03); daily temperature information (= 2.00); and early warning messages and preparedness ($\bar{x}$ = 2.00). However, information on onset of the growing season $\bar{x}$ (= 1.42), length of growing season for crop production ($\bar{x}$ = 1.15), and soil moisture information ($\bar{x}$ = 1.21) among many other agrometeorological information were not utilized. The results of the multiple regression analysis in Table 8 reveals that educational (t- value = 5.245; P< 0.05) and access to agro-meteorological information (t- value = 7.941; P< 0.05) of smallholder farmers had a positive and significant influence on the utilization of agrometeorological information with an F- value of 28.32 and an adjusted R^2 of 0.680.

Table 1: Extent of utilization of agro-meteorological information in making farm decisions (n =104)

Agro-meteorological information/services	Mean	SD.
Seasonal amount of rainfall predictions	2.31*	0.48
Onset of the growing season and cessation dates of season	1.42	0.52
Length of growing season for crop production	1.15	0.49
Little dry season and dry spells predictions	1.69	0.71
Daily temperature information	2.00*	0.84
Monthly temperature information	1.06	0.23
Annual temperature information	1.01	0.09
Soil moisture information	1.21	0.41
Daily weather forecast	2.03*	0.54
Flood predictions	2.07*	0.74
Wind direction	1.09	0.32
Early warning messages and preparedness	2.00*	0.86
Crop stages performance information	1.22	0.48
Advisory services on farm operations	1.03	0.17
Crop/weather recommendations	1.09	0.28
Livestock production recommendation	1.00	0.00
Fish production recommendation	1.00	0.00
Advisory services on climate change	1.00	0.00
Monthly malaria severity forecast	1.27	0.49
Monthly human thermal (heat) stress predictions	1.38	0.47

Source: Field survey, 2022; Key * = utilized agro-meteorological information

Table 2: Multiple regression analysis of the influence of socio-economic variables on the utilization of agro-meteorological information among smallholder farmers (n =104)

Variables	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	T	Sig.
(Constant)	.445	.111		4.018	.000
Sex	.012	.023	.030	.495	.622
Age	.002	.002	.131	1.248	.215
Farming experience	-.003	.002	-.136	-1.358	.178
Educational Level	.013	.003	.379	5.245	.000**
Farm size	.011	.025	.050	.426	.671
Estimated Monthly income	-1.685E-006	.000	-.092	-.793	.430
Extension visit	-.007	.024	-.019	-.288	.774
Access to agro-met information	.544	.069	.574	7.941	.000**

Source: Field survey, 2022: **P< 0.05, F = 28.318, Adjusted R^2 = 0.680.

The extent of use of agro-meteorological information was very low as only few agro-meteorological information was utilized by crop farmers such as seasonal amount of rainfall predictions, daily Temperation information, among others. The high usage of seasonal rainfall predictions and daily weather forecast information could largely be due to the importance of time scale for farming decisions. This agrees with the report of Roncoli et al., (2009), that seasonal forecasts have considerable potential for improving agricultural production, food security and livelihoods particularly in areas where changes in precipitation and intensification of extreme weather events are expected with long-term climate change. The low use of this information in decision making by farmers in Cross River State could also be related to respondents' complaint of low availability and accessibility of most agro-meteorological information and services. The low use of agro-meteorological information could hinder the adoption of climate change adaptation strategies inherent in weather information, thereby limiting the farmers' capabilities in making climate smart farm decisions that are helpful in cushioning the effects of climate change on agricultural production. The finding corroborates with that of Zendera, (2011); Oyugi, (2016); and Thomas & Sanyaolu, (2017) who reported that majority of farmers utilized weather forecast information on seasonal rainfall predictions, daily weather forecast information, flood predictions and early warning messages and preparedness in different locations in Africa. The result of the multiple regression analysis indicates that education and access to agro-information have a positive and significant influence on farmers' utilization of agro-meteorological information in farm decision-making. This implies that access to formal education and agrometeorological information will lead to the utilization of agro-meteorological information, thereby upscaling farmers uptake of climate change adaptation strategies for improved crop yields and food security. The result conforms to the findings of Zendera, (2011) who reported that access to agro-meteorological information had a significant influence on kenyan farmers' utilization of agro-meteorological information. Also, Onwuemele (2019) found that educational attainment had a significant influence on farmers' use of climate services.

CONCLUSION AND RECOMMENDATIONS

Conclusively, small holder farmers' utilization of agro-meteorological information was low due to a myriad of constraints and the socio-economic characteristics of the farmers such as education and access to agro-met information had a positive and signification effect on the utilization of the information. Therefore, it can be recommended that NIMET should collaborate with extension service providers to disseminate location specific agro-meteorological information, supported by Rural Advisory Services (RAS) networks and community-based organizations in the country through advocacy for increased forecast information accessibility and utilization by farmers in making beneficial farm decisions.

REFERENCES

Bjornlund, V., Bjornlund, H. & Rooyen, A.F.V. (2020). Why agricultural production in sub-Saharan Africa remains low compared to the rest of the world – a historical perspective. *International Journal of Water Resources Development*, 36 (1), S20 – S53.

Ebele, N.E. & Emodi, N.V. (2016). Climate change and its impact in Nigerian economy. *Journal of Scientific Research Reports,* (2016), 1 – 13.

Ezihe, J.A., Agbugba, I.K. & Idang, C. (2017). Effect of climatic change and variability on groundnut (Arachis hypogea, I.) production in Nigeria. *Bulgaria Journal of Agricultural Sciences*, 23 (6), 906 – 914.

Hope, K. R. (2009). Climate change and poverty in Africa. *International Journal of Sustainable Development and World Ecology*, 16(6): 451-461.

Kori, E.C., Bullem, A.G., Owan, E.J. & Asu, O.A. (2021). Climate change and food security in Boki local government area of Cross River State, Nigeria. *PalArch's Journal of Archeology of Egypt*, 18 (8), 685 – 692.

Mudombi, S., & Nhamo, G. (2014). Access to Weather Forecasting and Early Warning Information by Communal Farmers in Seke and Murewa Districts, Zimbabwe. *Journal of Human Ecology ,* 48 (3): 357 -366.

Ogogo, A.U., Ekong, M.U. & Ifebueme, N.M. (2018). Climate change awareness and adaptation measures among farmers in Cross River and Akwa Ibom States of Nigeria. Leal Filho, W. (eds), *Handbook of Climate Change Resilience*. Springer, Cham, 1 21.

Olayide, O.E., Tetteh, I.K. & Popoola, L. (2016). Differential impacts of rainfall and irrigation on agricultural production in Nigeria: Any lessons for climate smart agriculture? *Agricultural Water Management*, 178, 30 – 36.

Onwuemela, A. (2019). Determinants of access and utilization of climate services among vulnerable communities: A case study of Isoko communities in Delta State, Nigeria. Christiansen, B. et al. (eds): *Emerging Economic Models for Global Sustainability and Social Development,* IGI Global Publishers203 – 219.

Osabohien, R., Adeleye, N. & De Alwis, T. (2020). Agro-financing and food production in Nigeria. *Heliyon*, 6 (5), 04001.

Oyugi, H. O. (2016). An evaluation of the effects of agro-meteorological information on maize enterprise management among smallholder farmers in Migori, Kenya.

Roncoli, C., Jost, P., Kirshen, M., & al, e. (2009). . From accessing to assessing forecasts: an end-to-end study of participatory climate forecast dissemination in Burkina Faso (West Africa). *Journal of Climatic Change,* 92: 433-460.

Singh, C., Daron, J., Bazaz, A. & …Kituyi, E. (2017). The utility of weather and climate information for adaptation decision-making: current uses and future prospects in Africa and India. *Climate and Development*, 10 (5), 389 – 405.

Tarchiani, V., Coulibaly, H., Baki, G. & Camacho, J. (2021). Access, uptake, use and impacts of agrometeorological services in Sahelian rural areas: The case of Burkina Faso. *Agronomy*, 11 (12), 2431.

Thomas, K., & Sanyaolu, A. (2017). Utilization of Agro-meteorological Services among Arable Crop Farmers in Oyo State, Nigeria. *Journal of Agricultural Extension ,* 21 (1): 47 - 66.

Udoimuk, A.B., Osang, J.E., Ettah, E.B., Uchie, P.O., Egor, A.O. & Alozie, S.I. (2014). An empirical study of seasonal rainfall effect in Calabar, Cross River State, Nigeria. IOSR *Journal of Applied Physics*, 5 (5), 7 – 15.

World Bank (2012). *Mainstreaming Adaptation to Climate Change in Agriculture and Natural Resources Management Projects Guidance Notes (6): Identifying Appropriate Adaptation Measures to Climate Change.* Washington DC: The World Bank.

Zendera, W. (2011). Access and utilization of Agro-meteorological information by Smallholder Farmers in Perrkerra and Lari-wendani Irrigation Schemes, Kenya. A Published Master's Thesis summitted to the Department of Agricultural Informaion and Communication Management, University of Egerton,Kenya.Https:/www.WZendera-2011-ir-library.egeton.ac.ke. Retrieved 9th, June, 2021.

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21-25 OCT. 2024
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Effect of Climate Change on Agricultural Production in Nigeria: A Review

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Abstract
Global agricultural productivity is seriously threatened by climate change, especially in developing nations like Nigeria where agriculture is a vital economic sector. Temperature variability, irregular rainfall patterns, droughts, floods, and other extreme weather events are changing farming practices, lowering yields, and endangering food security. This paper reviews existing studies on the effects of climate change on agricultural production in Nigeria, drawing on empirical evidence from different regions of the country. The review highlights how climate change affects crop yields, livestock, and fisheries, and the socio-economic implications for farmers. Moreover, it explores adaptation strategies that have been implemented by farmers to mitigate the adverse effects of climate change. The paper concludes with policy responses that promote climate-resilient agricultural practices and the need for urgent governmental and private sector intervention to support sustainable farming in the face of climate change.
Keywords: Climate, change, agriculture, livestock, fishery, Adaptation, strategies.

INTRODUCTION

Agriculture plays an integral role in the Nigerian economy, contributing over 25% of the country's GDP and employing approximately 70% of the population. Due to its reliance on rainwater, this sector is particularly vulnerable to fluctuations in the weather (Adejuwon, 2004). Climate change has emerged as a significant threat to Nigerian agriculture throughout the past few decades. Crop production, livestock farming, and fisheries have all been significantly impacted by the rise in the frequency and severity of extreme weather events, temperature increases, erratic rainfall patterns, and protracted dry spells (FAO, 2018). Due to their geographic location and poor adaptive capabilities, African nations, especially Nigeria, will be more severely affected by climate change, according to the Intergovernmental Panel on Climate Change (IPCC) (Legg, 2021). Nigeria's varied agro-ecological zones—from the savannah in the north to the rainforest in the south—are all specifically impacted by climatic fluctuations, thus it's critical to assess the regional effects in each area (Odekunle, 2004). Although considerable research has been done on the local effects of climate change, a thorough analysis of the body of knowledge regarding the overall impact of climate change on Nigeria's agricultural industry is still required.

This paper review aims to consolidate findings from various studies on the impacts of climate change on agricultural production in Nigeria. It seeks to offer insights into the magnitude of the problem; the coping mechanisms employed by Nigerian farmers, and suggest actionable policy recommendations for enhancing the resilience of the agricultural sector in the face of ongoing climate change.

LITERATURE REVIEW

The Impacts of Climate Change on Agricultural Production in Nigeria

One of the world's most important issues of the twenty-first century is climate change. Numerous factors contribute to its effects, but in developing nations like Nigeria, where agriculture plays a major role in the economy, it especially affects agricultural productivity. Approximately 25% of Nigeria's GDP comes from agriculture, which employs more than 60% of the working force and is crucial to the country's economy and means of subsistence (World Bank, 2021). However, the nation's agricultural production is coming under greater danger from shifting weather patterns, rising temperatures, erratic rainfall, and catastrophic occurrences like floods and droughts. Studies have indicated that Nigeria's agricultural production is impacted by climate change in a number of ways, such as elevated temperatures, altered precipitation patterns, and a rise in the frequency of extreme weather events (Ajetomobi, Abiodun, & Hassan, 2011). For instance, research has revealed that droughts and rising temperatures have decreased the productivity of staple crops including rice, cassava, and maize. This is especially true in northern Nigeria, where desertification is more severe (Farauta, et al., 2012).

Changes in Temperature and its Effects on Crop Yield

The most obvious effect of climate change in Nigeria has been the decrease in crop production brought about by altered rainfall patterns and rising temperatures. Ajetomobi et al. (2011) found that if current climate trends continue, crop productivity in the nation could decline by as much as 25% by 2050. The growth cycles of cereal crops, including as millet, sorghum, and maize, are greatly impacted by prolonged dry periods and erratic rainfall (Akpodiogaga-a, et al., 2010). Prolonged droughts have reduced harvests and created food insecurity in areas where these crops are mostly grown, such as the Guinea Savannah and Sudan Savannah (Adejuwon, 2004).

The increase in average temperatures is one of the most obvious effects of climate change on Nigerian agriculture. The nation has seen rising temperatures in recent decades, which is bad for crops, especially those that are heat-sensitive. Temperature variations have a big impact on staple crops including rice, sorghum, millet, and maize. Elevated temperatures cause a reduction in soil moisture availability and evapotranspiration, which in turn results in decreased yields (Sowunmi, F.A., 2020). For example, research indicates that a 2°C increase in temperature can cause a 10–25% decrease in Nigeria's wheat crop production (Adejuwon, 2004). A cascade effect of this agricultural yield decline leads to food shortages, price rises, and lower farmer income.

Impacts on Livestock Production

Livestock farming is another essential component of Nigerian agriculture, in addition to crop production. Droughts have become increasingly common due to climate change, which has decreased the amount of water and grazing ground available for cattle, especially in the northern regions where pastoralism is most prevalent. Conflicts over access to diminishing resources between crop farmers and pastoralists have increased as a result of this (FAO, 2018). Climate change also has a significant influence on livestock production, as rising temperatures and altered pasture supply have a detrimental effect on animal productivity and health (Obaniyi et al., 2022). The Sahara's invasion and desertification have notably affected the northern regions, which mostly depend on pastoralism. Due to the forced migration of cattle herders southward in pursuit of better grazing land, farmers and pastoralists often clash over the usage of land (Bello, 2013).

Impact on Fisheries

The effects of climate change have not been immune to Nigeria's fishing sector. Fish populations have decreased as a result of disturbances to aquatic ecosystems caused by variations in salinity, temperature, and acidity of rivers and lakes (FAO, 2018). These developments have had a significant impact on the way of life for fishing communities, especially in the Niger Delta and along the coast. Additionally, flooding is a risk in these areas, which can destroy fishing infrastructure and force communities to relocate (Enimu, et al., 2018).

Socio-economic Implications

Climate change has significant socioeconomic effects on Nigerian agriculture. Food insecurity results from decreased agricultural productivity, putting millions of people at danger of starvation and malnourishment. As a result, poverty rates rise, particularly in rural areas where agriculture is the primary livelihood (Ologeh, 2022). The Nigerian government yearly spends billions of naira on food imports, which may make the nation's economic problems worse. The rural inhabitants and smallholder farmers are the ones that suffer the most from all of these. Due to decreased production, many farmers experience diminishing incomes, which exacerbates poverty and food insecurity (Ozor, et al., 2015). Furthermore, migration has evolved into a coping strategy for many impacted populations, especially in the north where desertification has destroyed a significant portion of the agricultural land (Bello, 2013).

Adaptation Strategies

One of the biggest threats to agricultural production in the world today is climate change, and Nigeria is not exempt from its effects. Because agriculture is the backbone of the national economy, the effects of climate change such as erratic rainfall patterns, protracted droughts, flooding, and rising temperatures threaten to seriously undermine food security, the livelihoods of farmers, and the stability of the national economy. To mitigate these challenges, several adaptation strategies have been employed to improve resilience and sustainability within Nigeria's agricultural sector. Some of these adaptation strategies include; i. Improved Crop Varieties, ii. Water Management and Irrigation Systems, iii. Agroforestry and Sustainable Land Management, iv. Diversification of Livelihoods, v. Climate-Smart Agriculture (CSA) Practices, vi. Access to Climate Information Services.

Policy Responses and Institutional Frameworks

Agriculture's ability to adapt to climate change is greatly influenced by government policies. Many policies and programs have been put in place in Nigeria to aid in the adaptation efforts of farmers. One such law that assists vulnerable communities in their adaptation to climate change is the National Agricultural Resilience Framework (NARF), which encourages climate-smart activities. The Federal Ministry of Environment (2011) formed the National Adaptation Strategy and Plan of Action on Climate Change for Nigeria (NASPA-CCN) with the aim of promoting agricultural techniques that are adaptable to climate change. Nevertheless, low budget, a lack of cooperation amongst government agencies, and a lack of awareness among farmers have made it difficult to put these plans into action. Additionally, the government collaborates with international organizations such as the Food and Agriculture Organization (FAO) to promote research, capacity building, and access to financing for climate-resilient agricultural practices (FMARD, 2016).

CONCLUSION AND RECOMMENDATIONS

Nigeria's agricultural productivity is seriously threatened by climate change, which has a broad impact on fisheries, livestock rearing, and crop harvests. Smallholder farmers, who are frequently the most exposed to climatic fluctuation, are particularly severely affected socioeconomically. Even though certain adaption measures have been put into practice, there is still a big lack of resources, expertise, and policy support. In order to promote sustainable agriculture and increase the resilience of farming systems, there is an urgent need for action at the community and governmental levels in response to the challenges posed by climate change. In the face of a changing climate, policymakers, research institutions, and farmers must keep collaborating to maintain food security and sustainable agricultural development.

REFERENCES

Adejuwon, S. A. (2004). Impact of climate variability and change on crop yield in Nigeria. A paper presented at the stakeholders' workshop on assessment of impacts and adaptation to climate change, (AIACC) conference, Ile-Ife, 15pp.

Ajetomobi, J., Abiodun, A., & Hassan, R. (2011). Impacts of climate change on rice agriculture in Nigeria. *Tropical and subtropical agroecosystems*, *14*(2), 613-622.

Akpodiogaga-a, P., & Odjugo, O. (2010). General overview of climate change impacts in Nigeria. *Journal of human ecology*, *29*(1), 47-55.

Bello, A. U. (2013). Herdsmen and farmers conflicts in North-Eastern Nigeria: Causes, repercussions and resolutions. *Academic journal of interdisciplinary studies*, *2*(5), 129-139.

Building Nigeria's Response to Climate Change (BNRCC) and Federal Ministry of Environment. National Adaptation Strategy and Plan of Action on Climate Change for Nigeria (NASPA-CCN); Federal Ministry of Environment: Abuja, Nigeria, 2011.

Enimu, S., & Onome, G. E. (2018). Determinants of Climate Change Adaptation Strategies Among Farm Households in Delta State, Nigeria. Curr Inves Agri Curr Res 5 (3)-2018. CIACR. MS. ID. 000213. DOI: 10.32474/CIACR. 2018.05. 000213. 615. *Environment*, *8*(3), 61-68.

FAO, F. A. O. S. T. A. T. (2018). Food and agriculture organization of the United Nations. *Rome, URL: http://faostat. fao. org*, 403-403.

Farauta, B. K., Egbule, C. L., Agwu, A. E., Idrisa, Y. L., & Onyekuru, N. A. (2012). Farmers' adaptation initiatives to the impact of climate change on agriculture in northern Nigeria. *Journal of Agricultural Extension*, *16*(1), 132-144.

Federal Ministry of Agriculture and Rural Development, (2016). The Agriculture Promotion Policy (2016 – 2020): Building on the Successes of the ATA, Closing Key Gaps, Policy and Strategy Document. Abuja: Nigeria

Legg, S. (2021). IPCC, 2021: Climate change 2021-the physical science basis. *Interaction*, *49*(4), 44-45.

Obaniyi, K. S., Aremu, C. O., Obembe, E. O., & Aniyi, T. (2022). Climate Change Issues in Nigeria: A Call For A Sustainable Policy in Agricultural Sector.

Odekunle, T. O. (2004). Rainfall and the length of the growing season in Nigeria. *International Journal of Climatology: A Journal of the Royal Meteorological Society*, *24*(4), 467-479.

Ologeh, I., & Adesina, F. (2022, September). Evaluation of climate change as a major determinant of crop yield improvement in Nigeria. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1077, No. 1, p. 012002). IOP Publishing.

Ozor, N., Umunakwe, P. C., Ani, A. O., & Nnadi, F. N. (2015). Perceived impacts of climate change among rural farmers in Imo State, Nigeria. *African Journal of Agricultural Research*, *10*(14), 1756-1764.

Sowunmi, F. A. (2020). Effects of climatic variability on cassava production in Nigeria. *Journal of Agribusiness and Rural Development*, *57*(3), 327-335

The World Bank Annual Report 2021 (Rapport Annuel 2021), World Bank Publications – Books, The World Bank Group, number 36067.

Factors Influencing Cucumber Production in Ayamelum Local Government Area of Anambra State, Nigeria

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Abstract

Cucumber's place in food value has not been ranked because of its limited use. Hence, the study analysed the profitability of cucumber production in Ayamelum Local Government Area of Anambra State, Nigeria. The objectives of the study are to identify the factors influencing cucumber production in the study area and estimate the constraints associated with cucumber production. A total of 120 cucumber producers were used for the study. The researcher adopted a multi-stage sampling procedure that was used to select a total of 120 respondents for the study. The data was analysed using multiple regression analysis and likert-type rating scale. The results of the analysis showed that the key factors influencing cucmber production are net income, cost of planting materials, age, household size, and farm size. The major constraints to cucumber production are inadequate capital, high incidence of pests, low output of harvested crops and inadequate storage facilities. The study therefore recommended that agrochemicals for pest control should be subsidized for farmers to afford them and modern day storage facilities should be made available and readily affordable to cucumber farmers.

Keywords: Cucumber production, determinants, constraints, Ayamelum.

INTRODUCTION

Although cucumber production has been an ongoing practice as a source of livelihood for many people in Nigeria, it is a relatively recent addition to the diet of Nigerians. However, producers are faced with challenges that could be grouped into agronomic and socio-economic factors (Okonmah, 2011). For instance, many farmers are smallholders who are unable to adopt mechanized farming and therefore experience low farm productivity. Researchers have argued that the production of cucumber is low in Southeast Nigeria. Cucumber (Cucumissativus L.) is a member of the cucurbitaceae and is an important vegetable crop. Cucumbers have a mild, refreshing taste and a highwater content. People eat cucumber as a savory food (Agbanje *et al*., 2023). It also features in some beauty products (Megan, 2019). Cucumber is one of the freshest and most nutritious foods on the planet, being frequently used for the preparation of salads, soups and even refreshing juices (Opara *et al*, 2013). The crop is the fourth most important vegetable after tomato, cabbage, and onions in Nigeria. Cucumber is also being subjected to damage by some insect pests such as aphids, whitefly, thrips, and cucumber beetles (Okafor & Yaduma, 2021). This study became imperative because vegetables are important sources of food and income. Due to the continued realization

of the importance of fruits in our diets and the over whelming importance of cucumber health benefits along with skin care, there is an increase demand for the product in Nigeria. Yet, supply of cucumber has not been able to satisfy the growing demand. Hence, researchers have argued that the shortage in supply could be linked to the production which is also linked to farmers down the line of production. Small scale farmers are still responsible for the production of agricultural crops at subsistent level with crude tools, small plot of land and engaged in multiple copping practices. In Nigeria, adequate research has not been conducted to find out the definite types of staking to support the best yield of cucumber in large farms and near the cities (Okonmah, 2011). The study aimed at analyzing the factors influencing cucumber production in Ayamelum Local Government Area of Anambra State, Nigeria. The objectives of the study were to:
i. identify the factors influencing cucumber production in the study area; and
ii. estimate the constraints associated with cucumber production.

METHODOLOGY

The researcher adopted a multi-stage sampling procedure that was used to select the respondents for the study. In stage I, Ayamelum local government area was purposefully selected because of the dominance of cucumber farmers. In stage II, four (4) communities (Ifite-Ogwari, Igbakwu, Anaku and Umeje) were randomly selected from the Local government Areas. In stage III, from each of the selected four (4) communities, 30 cucumber farmers were randomly selected. This gave a total of 120 cucumber farmers selected for the study. Multiple regression analysis and principal factor analysis were the statistical tools used for the study. Objective 1 was analysed using multiple regression analysis, while objective 2 was achieved using likert-scale rating scale. For the multiple regression analysis, four functional forms namely Linear, Exponential, Semilog, and Double-log were tried and the lead equation was selected based on the functional form with the highest R2, the highest number of significant variable (t-ratio), highest F-stat, and in conformity with the a priori expectation.

RESULTS AND DISCUSSION

Table 1 shows the output of four functional forms of the regression model for predictors of actors in cucumber production among smallholder farmers in Ayamelum LGA. The result indicated that output of the linear form gave the best result in terms of number of significant predictors, signs and sizes of the predictors as well as the value of F-statistics, R^2 and R^2 adjusted and was chosen as the lead equation. The coefficient of multiple determination (R^2) 74.5% meant that 75% of the variation in the income of the actors in cucumber production among smallholder farmers was explained by the variations in the independent variables while the remaining 25% was due to error. These confirms to overall significance of the regression analysis.

Out of nine independent variables included in the model cost of planting materials, age, household size and farm size were statistically and significantly influenced the net income earned by the farmers. The remaining five (cost of fertilizer, cost of pesticides and herbicides, renting and leasing of land, educational status and farming experience) were not significant. The coefficient of age was significant at 10% level of probability but negatively related to net production income. The negative association with age indicates the preference of the younger generation for white collar jobs over agricultural wage labour. The coefficient of farm size had positive and statistically significant at 1% probability level. This implies that the farmers who had their farm land increases tends to make more returns in off farm than those with less. They become more serious in their off farm income generation to fund their farm for greater revenue. This is in agreement with Okonmah (2011). The coefficient of household size had positive and statistically significant at 1% probability level. This implies that as the household size increases, income from cucumber production among smallholder farmers in Ayamelum LGA income increases. The children of these farmers do assist their parents in production activities that generate more income to the family. The coefficient of cost of planting materials had positive and statistically significant at 1% probability level. This implies that as increase in unit of planting materials results in increase in the revenue accrue to the farmers.

Table 1: Factors Influencing Cucumber Production in the Study Area

Variable	Double Log	Exponential	Semi-log	Linear
Constant	1133	1280000	12254	4.1123
	(0.86)	0.00**	(2.12)	(3.03)
Cost of planting material	4311.96	0.000013	0.000163	0.000123***
	0.00***	0.00***	(0.04)	(3.50)
Cost of fertilizer	-0.0000001	346.6	00.0000001	0.0868
	0.68	(1.20)	0.57	(1.18)
Cost of pesticides and	-54.21016	199.3	217.8***	0.09022
herbicides	0.96	(1.80)	(0.16)	(4.3481)
Renting & leasing land	12.165	1210000	0.01345	-13437
	(4.450)	0.00***	(3.23)	(-1.34)
Household size	1.2497**	0.01005	37221.12	0.03234*
	(0.465)	(0.10)	0.00***	(1.44)
Educational status	0.004	37221.12	0.0252*	-0.02111
	(0.0097)	0.00**	(0.30)	(1.30)
Farm size	0.333	-1129.866	-830000	12050***
	(0.002)	0.20	0.58	(15.00)
Age	4081733	0.001488	1880000	0.002827**
	0.14	0.29	0.58	0.87
Farming experience	0.0000001	216000	-7735472	-0.004928
	0.66	0.93	0.42	0.31
R^2	0.691	0.760	0.804	0.913
R^2 Adj	59.8%	68.2%	63.2%	74.5%
F-Stat	52.2%	60.1%	58.5%	69.2%
D-W Stat				

Field Survey, (2023). Key Note: * = significant at p<0.10, **= significant at p<0.05, *** = significant at p<0.01.

Constraints to Cucumber Production in Ayamelum LGA

The constraints associated with cucumber production among smallholder farmers in the study area were shown in Table 2. The findings showed that inadequacy of capital (M= 3.05) was perceived as the most serious constrained to cucumber production. Lack of sufficient capital impedes production and consequently reduces income and revenue. The high incidence of pests (M=3.01) reduces the value which equally reduces the market price of the produce thereby affecting the net returns of the farmer. Another constraints of importance is low output of harvested crops (M=2.89) in the study area. The absence of modern storage facilities is becoming a menace among producers in agricultural circle as most product are either sold below the expected price or wasted when it stays beyond the period of its freshness. Cucumber production depends solely on availability of natural rain for its production but due to variation in climate sometimes rain may not come at the time expected or may be irregular at the time of production thereby hindering growth and equally production thus variability in weather condition

(M= 2.58) is among the serious constraints. Other constraints to cucumber production but were not of great impediment were Low and poor extension services, inadequate required skills, poor skill in management, inadequacy of land and Urban migration.

Table 2: Constraints to Cucumber Production

	Constraints	Mean score	Rank
1	High incidence of pests	3.01	2nd
2	Inadequate storage facilities	2.52	5th
3	Inadequacy of land.	2.01	9th
4	Poor skill in management	2.20	8th
5	Urban migration	1.98	10th
6	Inadequate required skills.	2.30	7th
7	Variability in weather condition	2.58	4th
8	Low and poor extension services	2.50	6th
9	Inadequacy of capital	3.05	1st
10	Low output of harvested crops.	2.89	3rd

Source: Field Survey, 2023

CONCLUSION AND RECOMMENDATIONS

Costs and return of cucumber production among smallholder farmers in Ayamelum LGA, Anambra State given a positive values of gross margin, net farm income and net return on investment is profitable. The level of profitability will be improved if necessary measures are taken to mitigate the above address challenges.

Based on the findings of this study, it is recommended that agrochemicals for pest control should be subsidized for farmers to afford them. Modern day storage facilities should be made available and readily affordable to cucumber farmers.

REFERENCES

Agbanje, C.E., Isibor, C.A., Nkamigbo, D.C. & Adejoh, S.O. (2023). Profit analysis of rain fed cucumber production in Anambra State. *International Journal of Agriculture and Earth Science, 9*(7), 157-167.

Okonmah, L.U. (2011). Effects of different types of staking and their cost effectiveness on the growth, yield and yield components of Cucumber (*Cucumis sativa* L.). *International Journal of Agricultural Science, 1*(5), 90-95.

Opara, E.C., Zuofa, K., Isirima, N.O. & Douglas, D.C. (2013). Effects of poultry manure supplemented by N.P.K. fertilizer on cucumber (*cumis sativus L.*) production in Port Harcourt (Nigeria). *International Journal of Agricultural Policies and Practices, 1*(2), 28-33.

Okafor, B.N. & Yaduma, J.J. (2021). Soil and agronomic management for cucumber production in Nigeria. In H. Wang. (Eds). Cucumber economic values and its cultivation and breeding. 1-10.

Optimizing Profit Efficiency in Micro-scale Grain Milling Agribusiness: Insights from Bwari Area Council Abuja, Nigeria

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Abstract
The study aimed to assess the profit efficiency of micro-scale grain milling agribusinesses in Bwari Area Council, Abuja. A random sample of fifty micro-scale millers was selected for analysis. The data collected were evaluated using descriptive statistics, a profit model, and a transcendental logarithmic stochastic profit frontier function. Results indicated that 72% of respondents were male, with an average age of 38 years, and 80% had primary education as their highest educational attainment. The average household size was three persons, and the average milling experience was four years. The enterprise's revenue primarily came from fees charged for milling customers' grains. Variable costs constituted 85% of the total operational costs, of which labour and energy accounted for about 70%. While the average monthly revenue and profit were ₦156,451 and ₦130,461, respectively. Key determinants of profit efficiency included labor costs, machinery costs, and fuel costs. Moreover, milling experience and the source of capital were significant contributors to inefficiencies in the enterprises. The mean profit efficiency was found to be 69.8%. The study concludes that while micro-scale grain milling agribusinesses in the area are profitable, they are not fully profit-efficient. It is recommended that relevant agencies provide training on improved management practices to enhance profit efficiency.
Keywords: Agribusiness, Profit Efficiency, Micro-Scale Grain Milling, Transcendental Logarithmic, Stochastic Profit Frontier, Bwari-Abuja

INTRODUCTION

Grain milling is a critical processing activity in Nigeria, where most grains consumed undergo some form of milling, particularly dry milling (Asiegbu, 2016). Small-scale grain milling enterprises, where households pay a fee to mill their grains, play a significant role in the economy, especially in agricultural sectors. These enterprises typically use equipment such as hammer mills and roller mills to produce flours from maize, sorghum, and guinea corn (Asiegbu, 2016). Despite their importance, there is limited research on the profit efficiency of these businesses, particularly in Bwari Area Council, Abuja.

Profit efficiency refers to a firm's ability to maximize profit while minimizing costs. The study employs the Stochastic Frontier Approach (SFA), a parametric method that allows for the separation of random errors from inefficiency, to assess the profit efficiency of these enterprises (Aigner et al., 1977). The research addresses a gap in existing literature by focusing on the profit efficiency of micro-scale grain milling enterprises in the study area.

This study seeks to answer three key questions: What are the characteristics of these enterprises? What are their profit levels? And what is their profit efficiency? The findings will contribute to understanding the profitability and efficiency of micro-scale agribusinesses in Nigeria.

MATERIALS AND METHODS

Study Area

Bwari Area Council is located in the north-eastern part of Federal Capital Territory, Abuja. It is approximately 15km north of Abuja city and 25km northeast of Suleja, Niger state. Geographically, it is located $9^0$28" N and $7^0$39" E (Baba *et al.,* 2017). The northern expressway of Abuja is the boundary between Abuja Municipal Area council and Bwari Area Council. Its headquarters is in the town of Bwari. It has an area of 914km^2 and a population of 227, 216 according to the 2006 census (Baba, *et al.,* 2017).

Sampling Procedure and Sample Size

Five out of the ten wards in the Area Council were purposively selected (Kubwa, Bwari central, Kuduru, Dutse Alhaji and Ushafa) due to the high concentration of micro-scale grain milling enterprises in these wards. A sample frame of 57 was established while a sample size of 50 was arrived at using the Yamane formula. Thereafter, 10 respondents were randomly selected from each ward, thus having a total of 50 microbusiness grain millers as the sample size.

Data Collection and Analysis

This study uses primary data which was collected using an Interview schedule Objectives one was analysed using descriptive statistics, objective two using the profit model, and objective three using Stochastic profit frontier model

RESULTS AND DISCUSSION

Socio-Economic Characteristics of the Respondents

The study's findings indicate that the grain milling business in Bwari Area Council is predominantly male-dominated, with 72% of respondents being men. This is likely due to the physically demanding nature of grain milling, which is more suited to males, who tend to be more labor-efficient compared to females (Reddy et al., 2008). The average age of the respondents is 38 years, suggesting that they are in their most productive years, which could positively impact their productivity. The majority of respondents (80%) have only a primary education, reflecting the nature of micro-scale grain milling, which does not require highly sophisticated machinery. However, this low educational level may disadvantage them in adopting modern and more efficient milling technologies (Ndanitsa, 2008). The average household size is small, likely due to the relatively young age of the respondents, and all respondents rely exclusively on family labor for their milling activities. With an average of just four years of experience in grain milling, the respondents are relatively new to the business. This limited experience could impact their efficiency, as increased experience typically correlates with higher efficiency (Abu and Kirsten, 2009).

Profit Level of Micro-Scale Grain Milling Enterprises

Table 1 gives a breakdown of the monthly averages of cost and returns for the respondents during the study period

Table 1: Monthly Cost and Returns for micro scale grain milling enterprises

		Descriptions	Amount (N)	%
A	**COSTS ITEMS**			
	1	**Fixed Cost Items**		
		Depreciation on Milling Machines	3,020	3.31
		Depreciation on Milling Accessories	1,000	0.00
		Total Fixed Cost (TFC)	**4,020**	**15.47**
	II	**Variable Cost Items**		
		Electricity / Fuel	8,764	39.89
		Labour	6,388	29.08
		Rent	3,000	13.65
		Repairs	3,818	17.38
		Total Variable Cost (TVC)	**21,970**	**84.56**
	III	**Total Cost (TFC + TVC)**	**25,990**	**100.00**
B	**REVENUE**			
		Milling Fee	156,451	
		Total Revenue	**156,451**	
C	**NET PROFIT (B – A)**		**130,461**	

Source: Field Survey, 2018

About 85% of the total cost was accounted for by the Variable cost. Of the total variable cost, labour and energy accounted for about 70%. The Fixed cost which is mainly depreciation on milling machine and its accessories accounted for about 15%. Meanwhile, the revenue for the enterprise is mainly fee from the fees charged whenever customers bring their grains for milling. Subtracting the total cost from the revenue gives the net profit which stands at about ₦130,000 monthly. This implied that during the study period, micro-scale grain milling enterprises in the study area were profitable.

Estimated Profit Efficiency

The estimates of the stochastic frontier profit model for the micro-scale grain milling enterprises are presented in Table 4.

Table 2: Estimates from the stochastic profit model of micro scale mill processors

	Parameter	Coefficient	SE	t-ratio
Constant	$_0$	69.65	0.99	70.35***
Ln(Cost of labour)	$_1$	12.18	2.92	4.17***
Ln(Cost of machinery)	$_2$	-54.77	0.87	-62.95***
Ln(Cost of fuel)	$_3$	21.73	2.20	9.88***
Ln(Cost of labour) Ln(Cost of labour)	$_4$	-1.37	2.24	-0.61
Ln(Cost of machinery) Ln(Cost of machinery)	$_5$	-3.04	1.06	-2.87***
Ln(Cost of fuel) Ln(Cost of fuel)	$_6$	0.05	0.21	0.24
Ln(Cost of labour) Ln(Cost of machinery)	$_7$	5.01	0.16	3.13***
Ln(Cost of labour) Ln(Cost of fuel)	$_8$	-3.65	0.95	-3.84***
Ln(Cost of machinery) Ln(Cost of fuel)	$_9$	2.14	0.34	6.29***
sigma-squared	^{2}	0.06	0.01	6.00***
Gamma		0.003	0.23	0.01
Log likelihood function	LLF			-2.87

Note: *** = significant at 1% level; ** = significant at 5% level; * = significant at 10% level;
Source: Output from FRONTIER version 4.1/Field Survey, 2018

The estimation of the stochastic frontier profit model for micro-scale grain milling enterprises shows that certain cost factors significantly impact profit efficiency. The sigma-squared coefficient is 0.06, significant at a 1% probability level, indicating a good model fit and validating the distribution assumptions for the error term (Aigner et al., 1977). The small and non-significant gamma value (0.003) suggests that only 0.3% of profit deviations are due to inefficiency, implying that these enterprises operate close to their profit efficiency frontier.

Key findings from the model include the negative and statistically significant relationship between the cost of machinery and profit (coefficient of -54.77). This indicates that reducing machinery costs could lead to higher profits. On the other hand, the costs of labor (coefficient of 12.18) and fuel (coefficient of 21.73) are positively and significantly related to profit, suggesting that increased spending in these areas can boost output and, consequently, profit.

Interactions between different cost factors also reveal significant effects. The interaction between machinery costs and labor costs (coefficient of 5.01) is positive and significant, indicating that combined increases in these costs could enhance profitability. Conversely, the interaction between labor and fuel costs (coefficient of -3.65) and between machinery throughput and machinery costs (coefficient of -3.04) are negative, meaning that rising joint costs in these areas could reduce profits.

These results underscore the importance of managing costs, particularly machinery, to improve profit efficiency in micro-scale grain milling enterprises. Efficient cost management, especially in machinery and energy, is crucial for maintaining and enhancing profitability.

Distribution of profit efficiency of micro scale grain mills

The results revealed that micro-scale grain mills in the study area operate at profit efficiency levels ranging from a low of 44.8% to a high of 99.8% with a mean profit efficiency of 69.8%. In other words, this implies that the respondents can increase their profit on average by 30.2% by improving their efficiency levels using the existing resources and technology (Abu and Kirsten, 2009).

Determinants of profit inefficiency

Owing to the differences in the levels of profit efficiency between mills, it was necessary to investigate further why some mills achieved higher efficiency scores than others. The inefficiency results are presented in Table 3.

Table 3: The determinants of profit inefficiency in micro scale grain milling enterprises

	Parameter	Coefficient	SE	t-ratio
Constant	0	0.38	0.67	0.57
Gender	1	0.07	0.13	0.54
Age	2	0.01	0.01	1.00
Marital Status	3	-0.12	0.08	-1.50*
Highest Educational Level	4	0.004	0.12	0.03
Household size	5	0.008	0.04	0.20
Milling Experience	6	-0.15	0.05	3.00***
Access to Credit	7	-0.16	0.10	-0.16
Source of Capital	8	-0.13	0.05	2.60***
Source of Labour	9	0.38	0.67	0.57

Note: *** = significant at 1% level; ** = significant at 5% level; * = significant at 10% level; Source: Output from FRONTIER version 4.1/Field Survey, 2018

The study identified marital status, milling experience, and the source of capital as significant determinants of profit inefficiency among micro-scale grain milling enterprises. Marital status, with a negative coefficient of -0.12, suggests that being married positively influences profit efficiency, likely due to increased responsibility and motivation, consistent with findings by Crentsil and Essilfie (2014). Milling experience also had a negative coefficient of -0.15, indicating that more experienced millers tend to be more efficient, which aligns with the general expectation that experience enhances operational effectiveness, Additionally, the source of capital had a negative coefficient of -0.13, showing that better access to capital improves efficiency. Overall, the study highlights that these factors play crucial roles in enhancing the profit efficiency of grain milling enterprises.

Test of hypothesis

The results of the transcendental logarithmic stochastic frontier output indicated that the mean efficiency of micro-scale grain mills in the study area was 69.8% and ranged from 44.8% to 99.8%, Based on these results, we reject the null hypothesis that micro scale grain milling enterprises in the study area were not profit efficient.

CONCLUSION AND RECOMMENDATIONS

The result of the analysis confirmed that small-scale grain milling enterprises are profitable with a mean profit efficiency of 69.8%.. It is hereby recommended that training on better management practices be conducted by relevant agencies to improve profit efficiency.

REFERENCES

Abu, O. and Kirsten, J. F. (2009). Profit Efficiency of Small and Medium Scale Maize Milling Enterprises in South Africa. *Journal of Agricultural Sciences*, 4(2): 203-243

Aigner, D., Lovell, C. A. K. and Schmidt, P. (1977). Formulation and Estimation of Stochastic Frontier Production Function Models. *Journal of Econometrics* 6: 21 – 37

Baba, E. B., Olateju, A. M. and Lebana, M.D. (2017). Assessment of the Implementation of Bwari Master Plan. *International Journal of Advanced Studies in Business Strategies and Management,* 5(2): 2354-424.

Crenstsil, C. and Essilfie, F.L. (2014). Measurement of Technical Efficiency of Smallholder Fish Production in Ghana: A Stochastic Frontier Apprach. *Academic Journals*, 6(5):203-211.

Ndanitsa, M.A.(2008). Impact of Small Scale Irrigation Technologies on Crop Production by Fadama Users in Niger State. A Paper Presented at the 10th National Annual Conference of National Association of Agricultural Economist (NAAE), held at the Main Campus of University of Abuja, Abuja, Nigeria.

Reddy, S.S, Ram, P.R, Neelakanta-sastry, T.V., and Deri, I.B. (2008). *Agricultural Economics.* Oxford and IBH Publishing Co. PVT Ltd: New Delhi. P.646

Empowering Women through Bean Cake Processing: Analyzing Profitability and Challenges in Suleja, Niger State

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Abstract
This study examines the socio-economic characteristics, profitability, and challenges of bean cake (akara) processing as a microbusiness among women in the Suleja area of Niger State, Nigeria. Bean cake processing is a significant source of income and livelihood for many women in this region, contributing to household welfare and local economic development. The study employs a two-stage sampling technique to select 100 respondents from five wards in Suleja, analyzing data through descriptive statistics, gross margin analysis, and regression analysis. The findings reveal that most bean cake processors are married women with an average age of 41 years, limited formal education, and substantial experience in the business. Despite the modest scale of operations, the business is profitable, with a gross margin of ₦13,038.58 and a return on investment (ROI) of 32.13%. However, the profitability is influenced significantly by marital status, years of experience, and location, with an R-squared value of 0.8778. The study also identifies key constraints, including high risk and stress, inadequate equipment, rising input costs, and weather-related disruptions. These findings underscore the need for targeted interventions to enhance the sustainability and profitability of bean cake processing, including improved access to finance, equipment, and training. The study contributes to understanding the dynamics of microbusinesses in informal economies and the critical role of women entrepreneurs in local economic development.
Keywords: Bean Cake Processing, Microbusiness, Female Entrepreneurs, Profitability, Suleja, Niger State.

INTRODUCTION

Bean cake processing, particularly the production of akara, is a significant microbusiness in Nigeria, deeply embedded in the cultural and economic fabric of the country. In Suleja, Niger State, this small-scale enterprise plays a vital role in the local economy, primarily driven by female entrepreneurs who depend on akara production for their livelihoods. This microbusiness is characterized by low entry barriers, requiring minimal capital investment, making it an attractive option for women who may lack access to formal employment. Operating from informal settings like roadside stalls, these women cater to both local residents and travelers, providing an affordable and nutritious meal option that contributes to food security and stimulates local commerce (Nwankwo et al. 2019).

Despite its importance, bean cake processing faces several challenges that threaten its profitability and sustainability. Key issues include limited access to modern processing equipment, reliance on traditional methods that are labor-intensive and result in inconsistent product quality, and fluctuations in the prices of raw materials like beans and cooking oil. These factors significantly impact profit margins. Additionally, the informal nature of these businesses often leaves women without access to formal support systems, such as credit, training, or business development services, hindering their ability to scale operations or enhance product quality. Competition from larger food processing businesses further exacerbates these challenges, posing a significant threat to the sustainability of small-scale akara producers.

Given the critical role of bean cake processing in providing employment and income for women in Suleja, it is essential to explore strategies that can improve the efficiency and sustainability of this microbusiness. This study aims to assess the current state of bean cake processing in Suleja, identify the challenges faced by female processors, and propose interventions that could enhance their economic outcomes, thereby contributing to local economic development.

To address these issues, the following research questions will guide the study:
What are the socioeconomic characteristics of bean cake processors in the study area?
How profitable is bean cake processing in the study area?
What factors influence the profitability of bean cake processors in the study area?
What specific challenges do bean cake processors encounter in the study area?
What recommendations can be made to enhance the sustainability and profitability of bean cake processing in the study area?

METHODOLOGY

Study Area

This study was carried out in Suleja, Niger state. Suleja LGA is a city and an emirate in Niger State which is located in the North-central part of Nigeria. The local government area is located in the eastern part of Niger state. The city lies between the latitude of 9˚10"60.00N and longitude of 7˚10'60.00E. It has a total population of 215,075 (NPC, 2006). Suleja city is sometimes confused as Abuja due to its proximity and the fact that it was originally called Abuja. Some districts under Suleja include; Gauraka, kwamba, Madalla, Maje, Rafin kaffi, Rafin sanyin.

Sampling Technique

Two-stage sampling techniques were used to sample the population. The first stage involved purposive selection of five (5) wards from Suleja Local Government Area. The wards selected were Gauraka, Kwamba, Madalla, Maje and Rafin Sanyi. The wards where selected due to the high concentration of bean cake processors. Random sampling was used for the second stage in which twenty (20) respondents were randomly selected from each of the wards above to make a total of one hundred (100) respondents.

Data Collection and Analysis

Data was collected through interview schedule administration anf was analyzed using descriptive statistics, Gross Margin Analysis and Regression Analysis

RESULTS AND DISCUSSION

Socio-economic Characteristics of Respondents

The socio-economic characteristics of bean cake processors in Suleja reveal a demographic primarily composed of women, with an average age of 41 years, indicating their crucial role in supporting households during economically active years. Most respondents are married (80%), and they manage an average household size of six, underscoring significant family responsibilities that drive their engagement in this microbusiness. Educationally, 38.7% have secondary education, and 34.4% possess primary education, reflecting limited access to higher education, which may hinder opportunities for more lucrative employment. With an average processing experience of 4.6 years, most women learned the trade informally as apprentices, indicating a gap in access to formal skills development. Additionally, 97% consider bean cake processing their primary occupation, relying heavily on informal capital from family (73%) and personal savings (23%), demonstrating the challenges faced in accessing formal financial services. Overall, these factors highlight the vital economic contributions of women in this sector while pointing to the need for targeted interventions to improve their education, training, and access to financial resources. Similar findings were reported by Nwankwo et al (2019).

Cost and Returns of the Respondents

Table 2 shows that collectively beans, vegetable oil and labour accounted for 81.79% of the total variable cost of beans cake processors in the study area.

Table 2: Average Weekly Cost and Returns of the Bean- cake Processors in the Study area

S/N	Descriptions	Qty.	Price	Amount (₦)	%
A	Variable Inputs				
	Beans	19.06	809.50	15,429.07	38.02
	Vegetable oil	19	622.97	11,836.43	29.16
	Labour (inputted)	5	680	5,930	14.61
	Energy	-	-	3,208	7.90
	Processing	19.06	115	2,191.9	5.40
	Vegetables	-	-	1,139	2.81
	Spices and Seasonings	-	-	851	2.10
	Total Variable Cost			**40,585.40**	**100.00**
B	**Total Revenue**	**19.06**	**2813.43**	53,623.98	
C	**Gross Margin (B–A)**			13,038.58	
	ROI			32.13%	

Computed from field survey data, 2022.

With a total variable cost of ₦40,585.40 and revenue of ₦53,623.98, the processors achieve a gross margin of ₦13,038.58, reflecting a 32.13% ROI. This indicates that despite their modest scale, these businesses can be profitable. However, the high costs of beans and vegetable oil make them vulnerable to price fluctuations, and the undervaluation of labour reflects the informal nature of these enterprises. Additionally, energy costs remain significant, but could be mitigated with more reliable and affordable energy sources. These findings underscore the potential of microbusinesses to support household incomes, especially in informal sectors dominated by women, while also highlighting the need for better cost management and access to resources to enhance sustainability and profitability. Similar findings were also reported by Babayo et al (2020).

Regression Analysis
Results in table 3, revealed that marital status, years of experience and location where the significant factors that positively influences the profit of the bean cake processors in the study area.

Table 3: Results of Regression Analysis for Beans cake processors

Variables	Coefficient	Standard Error	t –value	P- value
Age	-69.2354	202.9648	-0.34	0.734
Marital Status	6289.802	2754.446	2.28	0.025**
Educational Level	2448.305	1341.97	1.82	0.071
Household Size	1145.365	951.423	1.20	0.232
Years of Experience	909.6803	707.0509	1.29	0.014**
Source of Capital	1934.52	1192.192	1.62	0.108
Location	1889.365	1035.005	1.83	0.031**
Intercept	19653	9474.248	2.07	0.041
R-squared	0.8778			

Computed from Field Survey data, 2022.

The regression analysis of bean cake processors in Suleja reveals that marital status, years of experience, and location are significant factors influencing profitability, with an R-squared value of 0.8778, indicating that 87.78% of the variation in profitability is explained by the model. Specifically, being married increases profitability by ₦6,289.80 (p = 0.025), suggesting stronger support systems for married women. Each additional year of experience boosts profitability by ₦909.68 (p = 0.014), reflecting the value of improved skills and market understanding. Location also significantly impacts profitability, with certain areas providing an advantage, increasing income by ₦1,889.37 (p = 0.031). These findings underscore the critical roles of socio-economic support, practical experience, and strategic location in enhancing the success of this microbusiness. This conforms to the findings of Jacob and Addae, (2018) which reported that "time spent in the production cycle is an important factor in determining profitability of every business".

Constraints
Bean-cake processors in the Suleja area face several constraints that hinder their business operations and profitability, with 29% reporting high levels of risk and stress associated with running a microbusiness in the informal sector. A lack of adequate working equipment affects 24% of processors, limiting their production capacity and efficiency, while 22% cite rising input costs for essential items, such as beans and vegetable oil, as a critical challenge due to price volatility. Additionally, 13% are impacted by bad weather, which disrupts processing and sales, and 7% experience low sales attributed to market saturation and economic factors. Finally, 5% struggle with debtors who delay payments, straining cash flow. Addressing these multifaceted challenges requires focused interventions, including improved access to finance and equipment, training for better business management, and infrastructure development to mitigate weather-related effects, aligning with broader research highlighting the struggles of small-scale food processors in resource-limited environments.

CONCLUSION AND RECOMMENDATIONS

Bean cake processing is a vital microbusiness in Suleja, Niger State, primarily managed by women who rely on it for their livelihood. The study finds that despite the profitability of this sector, the business faces several significant challenges. To enhance the sustainability and profitability of bean cake processing in Suleja, it is essential to improve access to modern processing equipment and provide targeted training in both technical and business management skills

REFERENCES

Akinbola A.E and Aturamu O.A, (2021), Determinants of Profitability of Small-Scale Plantain Processing Entrepreneurs in Osun State, Nigeria. Scientific papers series management, Economic Engineering in Agriculture and Rural Development.

Babayo, G., Mudi, Y.A., Makinta, U, & Kurawa, M.K. (2020). Evaluation of Employment and Income Generation from Soybean Processing in Gombe State, Nigeria. *Journal of Agricultural Economics, Environment and Social Sciences*, *6*(1), 1-12. Retrieved from https://www.jaeess.com.ng/index.php/jaeess/article/view/29

NPC, (2006): National Population Commission, Federal Office of Statistics. Census 2006

Nwankwo T. N. Okoli T. O Ugwumba C. O. A. (2019). Value Addition to Beans: The Case of Bean Balls “Akara” Production in Idemili South Local Government of Anambra State, Nigeria. *Asian Journal of Agricultural Extension, Economics & Sociology* 33(2): 1-7; Article no.AJAEES.48854ISSN: 2320-

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Limitations to Adoption of Garri Processing Technology by Women in Enugu State of Nigeria

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Abstract

The study was on limitations to Adoption of garri processing technology by women processors in Enugu State of Nigeria. Data were obtained from 120 respondents using questionnaire. Principal Component Analysis (PCA) was used to analyzed the data. The results shows that the main limitations to the adoption of the innovation were poor access to credit, high cost of cassava roots and high labour cost. Enhancing women processors' access to credit facility and labour saving devices were recommended.

Keywords: Adoption, Limitations, Garri, Processing, Technology, Women

INTRODUCTION

Garri is one of the cassava derivatives and one of the commonest staple food in Nigeria. It consumed by over 130 million Nigerians- home and abroad (Faostat, 2018). Current demand for garri is insatiable. The whole Nation produces just 7.7million tons per year, while she needed 12million tons per year to meet up with demand. Out of the 7.7million tons, 25% are exported (Ifediora, 2017). The wide acceptability of the derivatives could be ascribed to its relatively long shelf life, ease of preparation for consumption and cheaper than other carbohydrate sources, especially rice and maize. Nevertheless, gari can be consumed with a variety of additives such as sugar, groundnut, fish, meat and stew (Ibekwe, Chikezie, Obasi, Eze and Henri- Ukoha, 2012):.Gari production from fresh cassava involves the unit operations of peeling, washing, grating, pressing and fermentation, sieving and roasting. Gari, has features, included creamy-white or yellow (if fortified with red palm oil) granular flour with a slightly fermented flavour and a slightly sour taste made from fermented gelatinized fresh cassava tubers (Samuel, 2017.The processing technologies were disseminated onward adoption by the processors by the government relevant agencies. Literatures on the rate of adoption of the technologies were not encouraging (Ume, *et al;* 2020). in Nigeria are greeted with mixed feelings. For instance, in Anambra State (Ume; *et al;*-2020) The factors often cited that hinder the adoption of the technology were poor access to credit, high labour cost, poor access to extension services, high cost of cassava roots and high cost of transportation (Faostat, 2018). In the study area, information on the factors limiting the rate adoption of the technologies to the best of the knowledge of the researchers is dearth and the need to bridge the gap is very fundamental. Specifically, the objectives of the study are to describe the socioeconomics characteristics of the respondents and identify the constraints to the adoption of the technology becomes imperative

MATERIAL AND METHODS

Abia State lies between latitudes 04^{0}45'and 04^{o}41' North and longitudes 7^{0}5' and 08^{0}04' East. It occupies a total land area of 6,420square kilometer with a population of approximately 284.104 million people (NPC, 2006).A total of 120 women were interviewed and used for the study. Structured questionnaire and oral interview were used to collect the data. Descriptive statistics such as percentage responses was used to capture the socioecnomic characteristics of the respondents. Principal Component Analysis (PCA) was used to address the constraints to adoption of odourless fufu processing technology.

Model Specification

Principal Component Analysis (PCA)

The Model of Principal Component (PCA) is stated thus:

x= $x1,2,x3,\ldots,xp$ (1)

$$\propto_k = \propto_{1k1}, \propto_2 K, \propto_3 k, \ldots, \propto pk \quad (2)$$

$$\propto_K^T x = \sum_{j=1}^{p} \propto_{KjXj} \quad (3)$$

$Var = [\propto_K^T X]$ is maximum (4)

Maximise subject to

$$\propto_K^T \propto_K = 1 \quad (5)$$

$$\text{Cov} = [\propto_1^t \propto - \propto_2^t \propto] = 0 \quad (6)$$

The Variance of each of the Principal Component:

$$Var[\propto_k X] = \lambda_k \quad (7)$$

$$S = \frac{1}{n-1}(X - \bar{X})(X - \bar{X})^T \quad (8)$$

$$S_i = \frac{1}{n-1}\sum_{i=1}^{n}(X_i - \bar{X}_i)(X_I - \bar{X}_i) \quad (9)$$

Where: X = vector of 'P' Random Variables; $\propto k$ = Vector of 'P' Constraints; λk= Eigen Value; T = Transpose; S = Sample Covariance Matrix.

RESULTS AND DISCUSSION.

The mean socioeconomic statistics of garri processors in Enugu State, Nigeria is shown in table 1.On the average, a typical gari processor was 46 years. Implying that the processors were aged and could overcome the intricacies involved garri processing through years of experimenting of observations of varied technologies (Samuel, 2017). Also, Also, an average processor attained educational level of 6.7 years. Educated people are receptive to technology adoption as well prudent in resource use compare to those without formal education (Faostat 2018). More so, the mean of household size by the sampled farmers was 6 persons. Household size serves as source of family labour to reduce cost of processing (Ume, *et al*; 2020). Additionally, an average processor had processing experience of 14.6 years. Long years of processing experience enhances efficient use of scarce resources by the farmers (Faostat 2018).

The result in Table 2 revealed that the number of principal components retained using the Kaiser Meyer criterion were four in line with Eigen-values greater than 1. The retained components explained 8619% of the disparities of the components incorporated in the model. The Kaiser-Meyer-Olkin which measures sampling adequacy (KMO) contributed a value of 0.813 and the Bartlett test of sphericity of 2776.012 was perceived to be significant at 1% alpha level. This suggests the significant of employing the set of information for factor analysis. The problem of poor access to credit had an Eigen-value of 3.6832 and was ranked 1st in the order of importance as affirmed by the processors. The poor access to credit could be related to the fact that most poor resource farmers do not have collateral as demanded by the lending agencies before granting their loans to them(Ume, *et al;* 2020). This is followed by poor access to extension services with Eigen value –value of 3.44742. Poor motivation of the extension agents by the government agencies concerned, leading to negative attitude by the change agent to their duties and consequently technologies adoption by farmers and impoverished welfare ensure (Samuel, 2017).. The least of the variables considered in order of importance was price of garri, with Eigen-values of 0.0887 and ranked 8th.

CONCLUSION AND RECOMMENDATIONS

The constraints to the adoption of the innovation were poor access to credit, high labour cost, poor access to extension services, high cost of cassava roots and high cost of transportation. The need to enhance processors' access to credit facility at reduced interest rate, ensure their access to extension services and need to refurbish rural and other feeder roads were recommended.

Table 1: Mean Socioeconomic Statistics of odourless fufu processors in Abia State, Nigeria

Variable	Mean	Std Deviation
Age (Year)	46	2.213
Educational Level(Years)	6.7	0.017
Household Size(No)	6	0.024
Processing Experience	14.6	0.042

Source: Field Survey, 2021

Table 2: Results of the Principal Component Analysis

Constraints	Eigen-Value	Difference	Proportion	Cumulative
Poor access to Credit	3.6832	0.52412	0.2654	0.2789
Poor access to extension Services	3.44742	1.39874	0.2343	0.4513
High cost of cassava roots	2.1835	0.38650	0.2819	0.4291
High cost of transportation	1.0168	0.2357	0.1005	0.4074
Price of garri	0.0887	0.20134	0.0750	0.7219
KMO	0.813			
Chi-Square	2776.012***			
Rho	1.00000			

Source; Field Survey, 2024. *Bartlett Test of Sphericity*

REFERENCES

Ewebiyi, I.O., Ikotun,T.O. and Olayemi, O.O. (2020) Constraint to utilization of improved processing technologies among cassava processors in Oyo State, Nigeria. *Journal of Science & Sustainable Development* ISSN: 2070-1748 · Volume 7 · Number 1 · August · 2020 · pp. 41 – 49

Faostat (2018) statistical database. Cassava production in 2016 [online], Rome: Food and agriculture organization <www.fao.org/faostat/en/#home> [accessed 31 May 2018]

Ibekwe U. C, Chikezie C, Obasi P. C, Eze C. C and Henri- Ukoha, A. (2012): Profitability of garri processing in Owerri north local government area of imo state*. Journal of Science and Technology*. 2 (4), 340-343.

National Population Commission (NPC) (2006). Statistical Bulletin of Nigeria Population census

Samuel, A. A. (2017). Investment Analysis of gari processing machineries in Ondo State, Nigeria. World, 1(2), 32 – 38.

Ume, S I, Adeoye-Agomoh, Q C, Onuh, N C and Achebe, U. (2020). Evaluation of Effects of Environmental Pollution by Small Scale Gari Processors in Anambra State of Nigeria. *International Journal of Research and Scientific Innovation* (IJRSI) | Volume VII, Issue IX, September 2020 Page 211

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Profitability of Sweet potato Production in Enugu State, Nigeria

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Abstract

One hundred and twenty (120)farmers were selected using multistage random sampling techniques. A well-structured questionnaire and oral interview were used to collect information on primary data. Percentage responses and Net Farm income model were used to address the objectives of the study. The sweet potato is profitable with total revenue (TR), Gross margin (GM) and Net farm income (NFI) per hectare were N1,820, 000, ₦1620000 and ₦1,590, 000 respectively. The return on investment was 0.87. Policies aimed at enhancing farmers' access to improved production inputs, and labour saving devices were recommended.

Keywords: Farmer, Sweet Potato, Profitability..Net Farm Income and Nigeria

INTRODUCTION

Sweet potato is source of food and raw material for industry. It is an early maturing crop and can be planted mixed with other crops like yam or mono cropped depending on the intension of the farmer (FAOSTAT (2020). Nigeria is the largest producer of sweet potato in West Africa and third in the World with 4 million hectares on farm size of about 1.7m Hectares (ha) and yield of 2.3t/ha (Ettah, Udumo, Abanyam, & Bullem, 2021; Maharazu I and Oladele, 2023). Sweet potato is cheap, inexpensive and easily cultivated, yet low productivity is common among farmers in Nigeria despite government incentives to boost its mass production. For instance, Ume, Onunka, Nwaneri & Okoro (2016) reported yield less than 3.0 tons/hectare, compared to the potential of 18-24 tons per hectare. High cost of labour, high transaction cost, poor transportation, irregular and seasonal supply of sweet potato roots and poor resource use has been variously attributed by literatures to be responsible for the low production and productivity Ettah, Udumo, Abanyam & Bullem, 2021, Maharazu and Oladele, 2023).). Therefore, it becomes paramount to determine the factors that affect sweet potato' performance and their productivity in terms of profit accruing from the sweet potato production in the study area.The specific objectives of the study are to describe the socioeconomic characteristics of the producers, estimate the profitability of sweet potato production and identify constraints to gari processing in the study area.

MATERIALS AND METHODS

Enugu StatE lies between latitudes 6°30'N and 7°10'N of Equator and longitudes 6°35' E and 7°30' E of Greenwich Meridian. The state has an estimated population of about 4, 1671 million people (NPC, 2006) and land area of 16,727 square km^2.The inhabitants were mainly agrarians and still engage in non-agricultural activities. A well-structured questionnaire was used to collect data for the study. Multi-stage random sampling technique was used to select one hundred twenty farmers for the study. Percentage response and Net farm income were used to analyze the objectives of the study.

Gross margin (G.M.) = TR – TVC (1)

TR = Total revenue,.
TVC= Total variable cost
The Net farm income (NFI) can be calculated by gross margin less Total fixed cost;

NFI= GM –TFC (2)

RESULTS AND DISCUSSION

The results in Table 1 showed that majority (48%) of who were 30 – 40 years of age. This age group has the physical strength needed in farming in order to boost output and profit in such enterprise (Odebode, Ogheneakpobor & Nwanebo, 2021). On the basis of educational level, majority of the respondents (67.5%) were educated, while 32.5% had no formal education. Education aids individual I being receptive to innovation leading to high profitability through enhanced productivity (Ettah; *et al*; 2021). More so, 61% of the respondents had had farm experience of 21 - 40 years. Farmers with many years of experiences are capable of being good managers of scanty resources for high farm output to accrue (Nomeh, 2022). Furthermore, 63% of the sampled farmers had access to credit, while only, 37%had no access. Credit facilitates farmers in procuring farm inputs at appropriate time and payment of hired labour (Nyor, Mbanasor & Agwu, 2021).

The gross margin was used to assess the profitability of sweet potato production among farmers and is presented in Table 2. The average variable cost/hectare was ₦211,000/ha with labour cost accounting for about 67.% of the total costs of production. The high cost of labour according to Ume, *et al*; (2016) could be ascribed to high inflation rate in the country, hence leaving farm labourers with option of charging high cost for any farm activity done in order to make a living. The total revenue (TR), Gross margin (GM) and Net farm income (NFI) per hectare were N1,820, 000,₦1620000 and ₦1,590, 000 respectively. The return on investment was 0.87, indicating that out of every naira (N) spent by the sweetpotato farmer about 87 kobo accrues to the farmer as net income. This finding is in consonance with Nomeh, 2022), who got return on investment of 0.84

CONCLUSION AND RECOMMENDATIONS

Sweet potato production was a profitable venture with Net Farm Income and return per investment of ₦1,590, 000 and 0.87 respectively. The need to enhance farmers' access to improved farm inputs at moderate prices and the need to development and disseminate to farmers labour saving device such as hand driven plough at subsidized cost were recommended.

Table 1: Socio–economic characteristics of the farmers

Factors	Frequency	Percentages
Age		
30 – 40	58	48
41 – 50	35	29
51 -61	18	15
62 -72	9	8
Level of Education		
No formal	39	32.5
Primary	51	42.5
Secondary	30	25
Tertiary	–	–
Access to credit		
Yes	75	63
No	45	37
Farming Experience		
1 – 20	39	22
21 -40	73	61
41-60	8	7

Source: Field Survey; (2024)

Table 2: Average Costs and Return in Sweet potato per hectare

Cost item	Value	Percentage
Physical input		
Planting Material	10,000	4.4
Transportation	5,000	2.2
Fertilizer	42,000	18
Labour cost	154,000	67
Total variable cost (TVC)	₦211, 000)	
Gross margin (G.M) (TR-TVC)	₦1620000	
Total fixed cost	₦20000	
Total cost =	₦230000	
Net farm Income(TR-TC)	₦1,590, 000	
Return on investment	₦0.87	
Revenue	N1,820, 000	

Field Survey, 2024

REFERENCES

Ettah, O I., Udumo, B ,O., Abanyam, V A. & Bullem, F A.(2021) Resource use in sweet potato production in Delta State, Nigeria: A Technical efficiency Approach.*Global Journal of Agricultural Science* Vol. 21: 1 - 6.

FAOSTAT (2020); Sweet potato production; World Region/ production quantity from pick list*. Statistics Division (FAOSTAT). Food and Agriculture Organization of the United Nations. 2020. Retrieved 24 March 2021*

Maharazu I and Oladele, O A (2023). Poduction Function and Profitablityof Sweet Potato Production in Sabon – Gari Local Government Area (LGA) of Kaduna State, Nigeria. Agricultural Society of Nigeria (ASN) Proceeding of the 57th Annual Conference / 23 – 27 Oct. 2023 / Fulafia Nasarawa State, Nigeria. Pp 67

NPC (National Population Commission), (2006): Population census of Federal Republic of Nigeria: Analytical report at the national level. National Population Commission, Abuja.

Nomeh, P M (2022) Economics of Sweet Potato(*Ipomoea batatas*) Production in Ikwo Local Government Area, Ebonyi State, Nigeria. Un published Msc research Thesis of Department of Agricultural Economics. University of Nigeria, Nsukka, Enugu State, Nigeria

Nyor, JT, Mbanasor, J A & Agwu, M N (2021) Technical Efficiency of Orange-Fleshed Sweet Potato Root Production in North Central, Nigeria. *Journal of Sustainable Agriculture and the Environment* 15(4); 23 – 36

Odebode, S.O., Ogheneakpobor, O. & Nwanebo, C.C. (2021). Determinants Of Sweet Potato Production Level Among Farming Households in Imo State, Nigeria. *International Journal of Agric and Rural Dev,* 4(1): 5559-5568

Ume, S.I., Onunka B.N., Nwaneri T.C. & Okoro G.O (2016) Socio-economic Determinants of Sweet Potato Production among Small Holder Women Farmers in Ezza South Local Government Area of Ebonyi State, Nigeria. Global Journal of Advance Research 3 (9); 972-883 www.gjar.org

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Analysis of risk management strategies by cassava farmers in South East, Nigeria

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Abstract.
Analysis of risk management strategies among cassava farmers in Enugu State, Nigeria was studied. 120 respondents were randomly selected using multi stage random sampling technique. Primary data for the study was collected using a well-structured questionnaire and interview scheduled. Percentage responses and multinomial Logit model were used to captured the objectives of the study. The result of multinomial logit showed that the coefficient of rearing experience, educational level extension services affected farmers choice of risk coping strategies in the study area. The need to enhance farmers' access to extension services and educational programmes were advocated.

Keyword Analysis, Risk Management, Strategies Cassava, Farmer, Multinomial Logit Model

INTRODUCTION

Cassava production enhances households' food security through improve energy intake, source of income through marketing of the product, provides employment opportunities, Nation's Gross Domestic Product (GDP) and as poverty alleviation strategy (Reuters, (2022). Nigeria is ranked highest in cassava production in the world with an estimated production of 60mmetric tons (Ume, Okoye, Onwujiariri and Achebe, 2020). One of the factors that hinders farmers tapping the full potentials of the business is risks and uncertainties (Nto, Mbanasor and Nwaru, (2011). Nevertheless, the risks arising from cassava productions could be linked to diseases, climate change, inadequate management, input price variability, technology change, theft, insecurity and among others (Reuters, 2022). It is crucial to emphasize that the smallholder cassava farmers is most vulnerable to aforementioned risks and uncertainty factors , since they are less equipped and do not have the perfect knowledge to mitigate the risks associated with the business (Hardecker, Huirne and Anderson, 2017). Studies revealed that the risks and uncertainties are capable of causing colossal losses in monetary value, psychological displacement and even total failure in business (.Halek and Eisenhauer 2001). Therefore, the need for risk management becomes imperative. .In Nigeria and other developing countries, Globally, in most developed and some developing, the farmers have diverse ways of risk mitigation, included forward pricing, production practices, insurance, diversification, and among others (Hardecker; *et al*; 2017). However, in many farming societies in most developing countries, the farmers rely on mostly in different—traditionalǁ coping strategies and risk-mitigation techniques, but most of these are ineffective (Nto, et el, 2011). It is against this backdrop that this study was carried out. The specific objectives study were to describe the socio-economic characteristics of the farmers and determinants to choice of adaptation to risk coping strategies by the respondents

MATERIALS AND METHODS

The study was conducted in South East of Nigeria. The zone lies between 5 9'and 7 75'N of equator and longitude 6 85' and 8 46' East of Greenwich mean time. .It has a total land area of 10952400 hectare. It comprises of five states; Anambra, Imo and Ebonyi, Abia. Four states (Enugu, Ebonyi, Imo) were purposively chosen because of intensity of wet starch processing in these areas. Multi stage sampling technique was employed in selecting 120 processors for the study. Structured questionnaire and interview schedule were used to gather primary data from the respondents for the study. Percentage response and multinomial logit model were used to address the objectives of the study.
Model Specification

Multinomial Logit Model (MNLM)

The MNL Model according to Ume, et al; (2020) as:

$$P(y = j|x) = \frac{\exp(x\beta_j)}{\left[1 + \sum_{h=1}^{J} \exp(x\beta_h),\ \ j = 1, \ldots, J\right]} \qquad (1)$$

Let x be a 1 x k vector with first element unity.

Where βj is k x1, j=1,...,j

Implicit;

$$Y_i = \ln(P_i, P_1) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + ei \qquad (2)$$

Where; Y_i = adoption practices (Diversification, Improved variety and good cultural practices),
X_i, where I = 1,2,….i are explanatory variables,
X_1 = Age of the farmer (Years),
X_2 = Educational attainment (Years)'
X_3 = Rearing experience (Years),
X_4 = Membership of farmers organization (Yes=1 and 0; Otherwise).

RESULTS AND DISCUSSION

The mean statistics of analysis of risk management strategies by cassava farmers in South East, Nigeria is shown in table I. On the average, a typical cassava farmer was 46 years old. Aged people are often risk averse and conservative to new technology for fear of losing their hard earned wealth during youthful age. Also, an average cassava farmer attained educational level of 4.6 years. Farmers with formal education are adoptable and receptive individuals especially that could improve their risk coping strategies for high output to accrue (Nto, Mbanasor and Nwaru, 2011). In addition, an average cassava farmer had 12years farming experience. Long years of farming experiences according to Nzeakor and Ume, (2021) usually have practical knowledge on how to overwhelm certain risks and uncertainties associated with cassava farming for, high yield to ensue. Furthermore, the sampled farmers belonged to average organization of 3. Studies show that members have access to information on improved their risks averting methods in their farms (Nto, Mbanasor and Osuala, 2013).

Table 2 shows that the LR chi-square of 108.55 and was highly significant suggesting that the model has a strong explanatory power. The coefficients of age had negative and significant impact on the choice of risk coping strategies to cassava production in the study area. This infers that as the farmers are advancing in age, there are possibilities that they could adopt the following risk coping strategies such as diversification and good hygiene practices. Nto, *et al;* (2013) showed that old people gain risk managerial ability through experimentation and knowledge , thus could adopt best risk coping strategy options from among alternatives. The coefficients of educational level and membership of organization had were positive and significant relationship with all the choice of risk management in cassava production in the study area. Educated people are usually prudent in resources use and are exposed to information that could guide in rational decision making on choices of best risk coping strategies options (Nto, et al; 2011).Cooperative societies have been found to enhance according to Nzeako and Ume, (2021) interaction and cross-fertilization of ideas among members which may bother on better risk management strategies in given cassava production practices, thus facilitating in reduction of risks that may hamper significantly farmers' output.

CONCLUSION AND RECOMMENDATIONS

The result of multinomial logit showed that the coefficient of rearing experience and educational level affected farmers choice of risk coping strategies in the study. There is need to enhance farmers' level of education through workshops, seminars and adult education. Furthermore, farmers should be advised to form or join cooperative organization in order to have access to credit and training to improve their adoption intensity

REFERENCES

Halek M, and Eisenhauer JG. (2001)Demography of risk aversion.Journal of Risk and Insurance. 1:1-24.

Hardecker, J.B., Huirne, R.M.B and Anderson, J.R. **(**2017). Coping with Risk In Agriculture CAB International, Walling ford.Pp 32 – 36

Nto, P.O.O., Mbanasor, J A and A.E. Osuala, A. E. (2013). Evaluation of risk management practices in rice production in Abia State, Nigeria. American Journal of Experimental Agriculture, 4(3): 263-274.

Nto, P.O.O., J.A. Mbanasor and J.C. Nwaru, (2011). Analysis of risk among agribusiness enterprises investment in Abia State, Nigeria. Journal of Economics and International Finance, 3(3): 187-194.

Nzeakor, F. C.1 and Ume, S. I (2021) Analysis of Profitability and Adoption of Nr 8082 Cassava Technology Among Adopters and Non-Adopter in Abia State, Nigeria. AKSU *Journal of Agriculture and Food Sciences* 5(3): 98-116, 2021.

Reuters, (2022). Thai exports of cassava products surge as Ukraine war disrupts grain supplies.Availableathttps://www.reuters.com/article/thailand-cassavaidlNL4N2Y71LBAccessed on December 24, 2022

Ume, S I, Okoye, F U, Onwujiariri, U.J and Achebe, U. (2020) Analysis of Intensity of Adoption of Odourless Fufu Processing Technology by Pro vitamin A Cassava Variety Processors in Anambra State of Nigeria *International Journal of Science and Healthcare Research; 5; Issue: 3; July-Sept. 2020*

Table 1: Mean socioeconomic statistics of cassava farmers.

Variable	Mean	Std Deviation
Age (Year)	46	1.008
Educational Level(Years)	4.6	0.009
Farming Experience	12	0.034
Organization	3	0.002

Source: Field Survey, 2024

Table 2: Multinomial Logit (MNL) model

Variable	Diversification.	Improved variety	Culturalpractice
Age	0.731(1.006)*	0.438(0.98)	0.651(-1.001)*
Education.	0.241(-0.18)	0.091(-2.001)**) **	1.023(-3.18) ***
Experience	1.009(2.09)**	2.531(0.090)	0.412(1.7677)*
Organization	4.098(3.503)***	2.091(2.004)**	0.821(2.621)**
Cons	4.098(7.099)	0.694(9.0865)	12.056(6.009)

Source: Field survey, 2024. Base category = Insurance, Number of Observations = 120, LR Chi-square (120) = 108.55,Log Likelihood = -120.40104, Pseudo-R^2 = 0.3107. ***, ** and * shows the significant at 1%, 5% and 10% levels respectively. Values in bracket represent z-values.

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Early Application of Brassinolides Improved Performance and Yield of Bambara Groundnut (*Vigna subterranea* L. Verdc) in Southeastern Rainforest Agro-Ecology

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Abstract
Evaluation of the effectiveness of brassinolide, sprayed at different growth stages on the performance of bambara groundnut, was carried out in a Screen house, in the 2015 early cropping season, at the University of Calabar Teaching and Research Farm, Calabar, Southeastern rainforest agro-ecological zone of Nigeria. Four treatments described as; zero spray (control), spraying at the seedling (3WAP), vegetative (6WAP) and flowering (9WAP) stages respectively, were laid out in a randomized complete block design and replicated thrice. Data on crop growth and yield parameters were analyzed using GenStat 10.3 DE edition (2011), and post-hoc test on significant treatment means utilized Fisher's Least Significant Difference (F-LSD) ($P \leq 0.05$). From results, significant ($P \leq 0.05$) effects of treatments on plant height, number of leaves, canopy spread, leaf area index, petiole length, days to 50 % flowering, number of pods per plant, pod length, seed weight per plant, dry matter yield and seed yield per hectare in both screen house and field experiments were observed. Brassinolide sprays at the seedling stage resulted in significantly ($P \leq 0.05$) taller plants, with more branches and highest number of leaves, canopy spread and leaf area index. This was followed by spraying at the vegetative stage, flowering stages with the least values from the control. Plants sprayed at the seedling stage also produced the highest number of pods per plant, largest seed sizes and weight per plant, highest dry matter yield and highest seed yield per hectare in both screen house and field experiments. Screen house trial yield was of the order: seedling stage ((1.07 t/ha) > vegetative stage (0.73 t/ha) > flowering stage (0.25 t/ha), corresponding to 55.73, 46.20 and 22.13 %, respectively. Brassinolide spraying is more effective during early plant growth.
Keywords: Climate proofing, plant hormones, food security, yields

INTRODUCTION
Brassinolides (BRs) are steroidal and natural phytohormones, ubiquitous in the plant kingdom. Generally, they are referred to as plant growth regulators or hormones which can affect a wide range of developmental processes in plants, such as germination, rhizogenesis, growth, flowering, and fruit setting (Awais *et al*., 2023). Under normal conditions, EBL stimulates various plant metabolic processes including ATP synthesis, ROS metabolism, biosynthesis of nucleic acid, and CO_2 assimilation. Moreover, it regulates various key enzymes involved in photosynthesis, cell cycle, and homeostatic response in plants (Siddiqui *et al*., 2018). Even though EBL's mechanism of action in

plants is not fully understood yet, it is recommended as environmentally safe, eco-friendly and exogenously applicable on leafy plants by a number of international organizations (EFSA, 2020). Considering the commercial application of EBL in agriculture as a potential strategy to enhance growth and yield is still relatively new and unexplored. Furthermore, crop-specific response to exogenous application of EBL and optimum dose needs to be further evaluated. Bambara groundnut or Bambara nut (*Vigna subterranean* (L.) Verdc; *syn Voandzeia subterranean* Thousars) is an annual pulse, and a member of *Fabaceae* family. It is of immense potential in enhancing food security especially in drought prone agricultural systems as an intercrop with cereals (Linnemann, 1988). It is drought resistant in nature, growing successfully below 500 mm rainfall conditions per annum. However, under very low rainfall, it is susceptible to the risk of total crop failure (Sessay and Sungu, 2000). Bambara groundnut is an extremely adaptable to hot dry climate and marginal soils (Azam-Ali, *et al*., 2001), and highly tolerant to pests and diseases, and can be produced easily with minimal inputs (Ntundu *et al*., 2006). Bambara groundnut is the most neglected and under-researched of all the grain legumes widely cultivated in Nigeria. The crop has remained at peasant level, despite its long history of cultivation in Africa (Tanimu & Aliyu, 1997). Food shortages presently being experienced due to rising human population indicates that not only the production of popular staples be increased but that the hitherto neglected crops like bambara groundnut be accorded adequate attention for enhanced productivity. One of the present research efforts is geared towards yield improvement. This study therefore sought to evaluate the effects of brassinolide on the performance and yield of Bambara nut.

MATRIALS AND METHODS

Screen house and field experiments on Bambara groundnut were conducted at the Faculty of Agriculture Teaching and Research Farm, University of Calabar during the 2015 late cropping season from August-December (04^{o} – 57'N and longitude 08^{o} – 19'E, 37 m ASL). The BL (24-epibrassinolide) was obtained from Xenan Xinyu Chemical Technology Company Limited (Ltd), Henan Province, China. Cream coloured Bambara groundnut landrace (Black eye) seeds were obtained from the Department of Crop Science, University of Agriculture, Makurdi Benue State, Nigeria. Plastic buckets (96 cm wide and 32 cm deep), were used to plant Bambara groundnut seeds in the screen house. The buckets were base perforated for drainage, filled with 6.5 kg top soil collected from the site of the field experiment, leaving about 5 cm to the brim of the buckets. A solution of brassinolide was prepared and applied according to the manufacturer's specification. A spray solution was made by dissolving 12.5g of the nutrient in 10 litres of clean tap water. Two seeds were sown in each bucket and thinned to one per bucket one week after emergence. Before sowing, the buckets were watered adequately with twenty liters of water and left overnight before planting the following day. A group of six buckets arranged in three rows of two buckets each constituted a unit plot in the screen house experiment and the middle row was used for sampling. Regular watering with twenty-five liters of water once a week was carried out in the screen house to prevent moisture stress since the experiment was not exposed to natural rainfall. Spraying of plants was done between 8 am and 9 am each time using a knapsack sprayer. Spraying was done in such a way that sprayed plants were completely drenched and the time of spraying was according to the recommendation of the manufacturer to have good result. Data were collected for growth and yield variables, analyzed using GenStat 10.3 DE edition (2011), and post-hoc test on significant treatment means utilized Fisher's Least Significant Difference (F-LSD) ($P \leq 0.05$)

RESULTS AND DISCUSSSION

The physico-chemical properties of the soil at the experimental site before planting are shown in Table 1. The soil had high sand content, low total Nitrogen below critical value, with base saturation of 88.0%. Sandy soils are basically poor in nutrient sufficiency and water retention for cropping and are often marginal soils. Results (Table 2) indicate that plant height, leaf area index and petiole length at 15 weeks after planting (WAP) were significantly higher ($p<0.05$) for seedlings that received BR treatments than for other periods of treatment application. Flowering occurred earlier when BG was treated with BR at seedling stage, immediately followed by BG that received BR at 6 WAP, compared to all others. Control and spraying at 9 WAP were not different for days to flowering ($p>0.05$). The dry matter was significantly higher for BG that received BR at seedling stage and this translated into significantly higher seed yield (1.92 t/ha), with the control (Zero BR) being the least of all parameters recorded (Table 2). The significant increase in the height of bambara groundnut in plots treated with BR compared with the control where BR was not applied may be attributed to the promotion of cell expansion and cell elongation by the hormone. This agrees with the findings of Hola (2010) who reported that BR increased the height of "two field grown inbred lines of maize" (*Zea mays* L.) during the vegetative and early reproductive phases of their development, when BR was applied during the early growth stage. BR application at seedling stage was most effective on all parameters assessed, and the effectiveness decreased as the plants grew older. Enhanced crop growth obtained by early application of BR could be due to the boosting effect of the growth hormone at the time biological N fixation had not commenced effectively and the plants were still depending on native N content of the soil which was very low. The effectiveness of BR when applied at the seedling stage was reflected in increased plant height, leafiness, which had positive effects on soil moisture conservation, high weed smothering capacity and creation of microclimatic conditions that could enhance rapid growth of the crop. Plants that did not receive BR at early stages obviously suffered from nutrients stress and exhibited reduced growth which was absent in plants treated earlier. This agrees with Vadhini and Rao (1998) who reported the BRs induced growth promotion was found to be associated with increased levels of carbohydrates, soluble protein and nucleic acids that initiate early healthy growth and development. Early application of BR did not only stimulate vegetative growth, but also improved dry matter yield (both seed and shoot dry matter) of bambara groundnut as was also reported by Arteca and Arteca (2001) and Nakaya *et al.* (2002). BR-induced plant growth has been reported to be associated with increased metabolic activities like the photosynthetic process (Sairam, 1994), protein synthesis and nucleic acid production (Sengupta *et al*., 2011). The significant increase in number of pods per plant, pod length, seed weight per plant, dry matter yield (root and shoot inclusive) and seed yield obtained could be attributed to enhanced metabolic activities of the treated bambara groundnut plants.

CONCLUSION AND RECOMMENDATIONS

The stage of spraying significantly ($P \leq 0.05$) affected both the growth and yield components measured. Bambara groundnut plants sprayed BR at seedling stage had significantly ($P \leq 0.05$) higher growth and yield parameter values in the experiments. This suggests that spraying BR at the seedling stage is more beneficial for optimal performance of bambara groundnut and should be inculcated into Bambara groundnut production.

REFERENCES

Awais, A., El-Kamil, T., Thobayet, S., Alshahrani, S., & Seleiman, M. F. (. 2023). Enhancement of morphological and physiological performance of *Zea mays* L. under saline stress using ZnO nanoparticles and 24-epibrassinolide seed priming. *Agronomy*, 13:771. doi: 10.3390/agronomy13030771.

Siddiqui, H., Ahmed, K. B. M., & Hayat, S. (2018). Comparative effect of 28-homobrassinolide and 24-epibrassinolide on the performance of different components influencing the photosynthetic machinery in *Brassica juncea* L. *Plant Physiology & Biochemistry,*129:198–212. doi: 10.1016/j.plaphy.2018.05.027.

European Food Safety Authority (EFSA) (2020). Anastassiadou M., Arena M., Auteri D., Brancato A., Bura L., Carrasco Cabrera L., Chaideftou E., Chiusolo A., Marques D.C., *et al*. Peer review of the pesticide risk assessment of the active substance 24-epibrassinolide. *EFSA Journal*, 18:e06132. doi: 10.2903/j.efsa.2020.6132.

Linnamann, A. R. (1988). Cultivation of bambara groundnuts vogue Subterianea L. Verdc. In Northern Nigerian Tropical Communication, 15: 1-4.

Sessay, A. & Zungu, H. (2000). Estimating leaf area per plant in Bambara groundnut (*Vigna subterranean*) using leaf numbers and leaf weight. *UNISWA Research Journal of Agricultural Science and Technology*, 3(7): 63-65.

Arteca, J. M. & Arteca, R. N. (2001). Brassinosteroid induced exaggerated growth in hydroponically grown *Arabidospsis* plants. *Physiology of Plant*, 112:104-112.

Azam, Ali, S. N., Aguilar-Manjarrez, J. & Bannayan-Avval, M. (2001). A global mapping system for Bambara groundnut production. *FAO Agricultural Information Management Series*, 1.

Ntundu, W. H., Shillah, S. A., Marandu, W. Y. F. & Christiansen, J. L. (2004). Morphological diversity of Bambara groundnut (*Vigna subterranea* (L.) Verdc). Landraces in Tanzania. *Genetic Resources and Crop Evolution*, 53(2): 367-378.

Tanimu, B. & Aliyu, L. (1997). Country Reports – Northern Nigerian. In: J. Heller, F. Begeman and J. Mushonga (eds.) Bambara groundnut (*Vigna subterranea* (L.) Verdc). Proceedings of the workshop on conservation and improvement of Bamabara groundnut (*Vigna subterranea* (L.) Verdc) 14-16 November, 1995, Harare, Zimbabwe (pp. 45-49) 4, Biodiversity International.

Hola, D., Rohova, O., Kocova, M., Kohout, L. & Kvasnica, M. (2010). The effect of brassinolides on the morphology development and yield of field-grown maize. *Plant Growth Regulation*, 61: 29-43.

Vardhini, B. V. & Rao, S. S. R. (1998). Effect of brassinosteroids on growth, metabolite content and yield of *Arachis hypogaea*. *Phytochemistry*, 48: 927-930,

Nakaya, M., Tsukaya, H., Murakama, N. & Kato, M. (2002). Brassinosteroids control the proliferation of leaf cells of *Arabidopsis thaliana*. *Plant Cell Physiology*, 43: 239-244.

Sairam, R. K. (1994). Effect of homobrassinolide application on plant metabolism and grain yield under irrigated and moisture – stress conditions of two wheat varieties. *Plant Growth Regulation*, 14: 173-181.

Sengupta, K., Banik, N.C., Bhui, S. & Mitra, S. (2011). Effect of brassinolide on growth and yield of summer green crop. *Journal of Crop and Weed*, 7(2): 152-154.

Table 1: Physico-chemical characteristics of the soil before planting and post harvesting at the experimental site

Physical and chemical properties	Pre-planting
Physical Properties	
Sand (%)	73.0
Silt (%)	16.0
Clay (%)	11.0
Texture	Sandy soil
Chemical Properties	
pH	5.2
Total Nitrogen (%)	0.10
Available Phosphorus (mg/Kg)	33.25
Organic Matter (%)	2.12
Exchangeable Potassium (cmol/Kg)	0.11
Exchangeable Calcium (cmol/Kg)	4.1
Exchangeable Magnesium (cmol/Kg)	2.0
Exchangeable Sodium (cmol/Kg)	0.09
Aluminum ion (cmol/Kg)	0.68
Hydrogen ion (cmol/Kg)	0.16
Exchangeable Cation Exchange Capacity (ECEC)	7.14
% Base saturation (Bs)	88

Table 2: Effect of spraying stages of BR (plant hormone) on some growth and yield variables of bambara groundnut (*Vigna subterranean* (L.) Verdc)

Growth variables at 15 WAP						
Treatment	Plant ht. (cm)	Leaf area index	Petiole length (cm	50% flowering	Dry matter (g)	Seed yield kg/ha
Control (no spray)	33.68	0.508	2.74	50.60	17.70	0.85
Spraying @ 3 WAP	53.60	0.637	3.44	48.10	19.81	1.92
Spraying @ 6 WAP	40.88	0.621	3.01	49.20	18.62	1.58
Spraying @ 9 WAP	35.46	0.542	2.74	50.80	18.03	1.12
$LSD_{0.05}$	4.44	0.014	0.25	1.80	0.80	0.25

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Cost-Benefit Analysis of *Clarias gariepinus* (Burchell, 1822) Fry Fed the Co-Mixed of Betaine and β - glucan as Feed Additive

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Abstract

Research was conducted at Lay-Joy Fish Farm, Billiri, Gombe State to determine the cost-benefit analysis of *Clarias gariepinus* fry fed co-mixed of betaine and β-glucan as feed additive. Co-mixed of betaine and β-glucan was included into Coppens fish feed (0.2 – 0.5mm) with 49% crude protein at 0.0g/100g (BBG_0), 0.325g/100g (BBG_1), 0.75g/100g (BBG_2), 1.125g/100g (BBG_3) and 1.50g/100g (BBG_4) in triplicates. Diet without the co-mixed of betaine and β-glucan served as control (BBG_0). All the diets were fed to fry (n = 1,500; 0.25±0.0g) for 28 days in 15 plastic hatchery tanks (n = 100 per tank). Fry were fed at a fixed feeding rate of 10% body weight 6 times daily between the hours of 07:00 and 23:00 at regular interval. Cost-benefit analysis for each of the diets was calculated. Mean net profit (₦15.21), profit index (3.46), incidence of cost (₦1.99) and benefit cost ratio (2.20), were better in fry fed diet BBG_2, while the mean net profit (₦11.30) was least in fry fed diet BBG_0, profit index (2.70) was least in both the fry fed diets BBG_0 and BBG_3, incidence of cost (₦2.34) was poor in fry fed diet BBG_3 and benefit cost ratio (1.69) was least in fry fed diet BBG_0. Findings from this research shows that the inclusion of the co-mixed of betaine and β-glucan as feed additive at 0.75.g/100g into the diet of *C. gariepinus* fry would be profitable.

Keywords: Cost-Benefit Analysis, Clarias gariepinus, Fry, Co-mixed, Feed Additive.

INTRODUCTION

The advancement in intensive aquaculture is always encountered with the high cost of feed, which accounts for approximately 70 to 89% of the total costs of production thereby causing declined in profits (Ishaku et al*.,* 2023). An attempt to increase the profit is to reduce the feed cost as minimal as possible; one way to do this is to explore cost-benefit analysis of the different feeds and the additives that can be used as an alternative for lowering the cost of production (Ali et al*.,* 2024a). The cost-benefit analysis of African mud catfish farming is a topic that has garnered significant attention in recent years (Nababa et al*.,* 2024). While some argue that the economic benefits outweigh the potential environmental costs, it is essential to consider the long term consequences of this practice. According to Mafra et al. (2017), it is important to first understand potential costs and benefits as well as possible challenges in aquaculture. Increasing demand for fish in global markets and the complex networks that affect the supply and prices of fish are influencing aquaculture production both at national and local levels (Nababa et al*.,* 2024). Nations are now faced with the challenges of improving the efficiency and effectiveness of their production (Ishaku et al*.,* 2023). However, there are opportunities and challenges that need to be addressed (Nababa et al*.,* 2024). Therefore, this study is focused on the cost-benefit analysis of *Clarias gariepinus* **(**Burchell, 1822) fry fed the co-mixed of betaine and β-glucan as feed additive.

MATERIALS AND METHODS

Study Area

The study was carried out at the Lay-Joy Fish Farm, Gombe-Yola road, Billiri local government area (LGA), Gombe State Nigeria. Billiri LGA lies within Lat. 9°50’N; 11°09´E and Long.9.833°N, 11.150°E. It covers an area of 737km² (285 sq. m) and is 50 km away from Gombe, the state capital. The fry for the experiment were bred at the hatchery room of the farm. The fry were 4 days old at the commencement of the feeding trial.

Experimental Diets

Coppens fish feed (0.2 – 0.5mm) was used as the basal diet for this study and was obtained from feed suppliers at Gombe, while the betaine powder naturally derived from sugar beets (*Beta vulgaris*) and the β-glucan (β - 1,3/1,6 - D - glucan) powder naturally derived from the baker’s yeast (*Saccharomyces cerevisiae*) were obtained from Bon - Amour Pharmacy Limited Lagos, Nigeria, imported from Piping Rock Health Products, Ronkonkoma, New - York, USA. Experimental diets were prepared by incorporating the co-mixed of betaine/β-glucan additive as feed additives at 0.0g/100g, 0.325g/100g, 0.75g/100g 1.125g/100g and 1.50g/100g feed, into Coppens fish feeds (0.2 – 0.5mm), while diet without the co-mixed of betaine/β-glucan that is, 0.0g/100g feed served as the control diet and coded as BBG_0, BBG_1, BBG_2, BBG_3 and BBG_4 respectively. The co-mixed of betaine/β-glucan was included at the measured quantity for each diet and was diluted into 5ml of warm water (35^0C) to form a solution. The solution was sprayed onto the Coppens fish feed (0.2 – 0.5mm), fish oil was added to all the experimental diets with the co-mixed of betaine/β-glucan to reserve the co-mixed of betaine/β-glucan additive. The Coppens fish feed (0.2 – 0.5mm) with the co-mixed of betaine/β-glucan additive was prepared in 100g each time. The proximate composition of the Coppens fish fry feed (0.2 – 0.5mm) fed to the *C. gariepinus* fry is presented in Table 1. The diet contained 49% crude protein, 12% crude lipid, 6.0% crude fibre, 8.0% ash, 1.5% calcium, 8.0% moisture and 1.5% phosphorus.

Table 1: Proximate Composition of Coppens Fry Feed (0.2 – 0.5 mm) Used for the Study

Nutrients	Percentage (%)
Crude protein	49
Crude lipid	12
Crude fibre	6.0
Ash	8.0
Calcium	1.5
Moisture	8.0
Phosphorus	1.5

Experimental Design

Each of the treatment diets were fed to *C. gariepinus* fry (n = 1,500; 0.25±0.0g) in triplicate making a total of 15 plastic hatchery tanks (semi flow - through system) i.e. (n = 100 per tank). Water quality parameters such as; temperature, pH, dissolved oxygen (DO) and ammonia (NH_3) were monitored weekly. Fry were fed 6 times daily between the hours of 07:00 and 23:00 at regular interval for a period of 28 days at a fixed feeding rate of 10% body weight as recommended by Ukwe et al. (2018). The initial body weight of each set of fry was measured using a digital weighing balance before stocking and subsequently bulk weighing of fry in each tank was done after every 7 days, the growth performance parameters were examined. Data on cost - benefit analysis were collected.

Cost-Benefit Analysis of Clarias gariepinus Fry Fed the Co-mixed of Betaine and β-glucan as Feed Additive

The cost-benefit analysis of the *C. gariepinus* fry fed the co-mixed of betaine and β-glucan as feed additive was calculated based on the works of Ali et al. (2024b):

$$\text{Investment cost analysis (ICA)} = \text{cost of feed (₦)} + \text{cost of fish stocked (₦)}$$
$$\text{Profit index (PI)} = \text{net profit (₦)}/\text{cost of feed (₦)}$$
$$\text{Incidence of cost (IC)} = \text{cost of feed (₦)}/\text{weight of fish produce (g)}$$
$$\text{Benefit cost ratio (BCR)} = \text{net profit (₦)}/\text{investment cost analysis}$$

Cost benefit analysis was based on the following:

A major assumption was that all other operating costs for the *C. gariepinus* fry production remained the same for all the dietary treatments. Thus, cost of feed was the only economic criterion (expenditure) considered in this study.

Cost of feed was based on the prevailing market prices of the *C. gariepinus* fry feed as at the time of purchase (that is time of commencement of the experiment).

Value of *C. gariepinus* fry produced (cost of fish cropped) depends on the selling price of *C. gariepinus* fry per gram (12/g) in the markets around Gombe as at the end of the experiment.

Cost of producing the co-mixed of betaine and β-glucan additive diet depended on the cost of obtaining the co-mixed of betaine and β-glucan.

Total weights of *C. gariepinus* fry produced were obtained from the total weight of fish recovered at the end of the feeding trial.

Statistical Analysis

The data collected were analysed using the cost-benefit analysis models as described by Ali (2022).

RESULTS AND DISCUSSION

The results of cost-benefit analysis of the *C. gariepinus* fry fed the co-mixed of betaine and β-glucan as feed additive is shown in Table 2. Fry fed diet BBG_2 (Betaine/β - glucan at 0.75.g/100g) had the highest mean final body weight value (2.21g), while the fry fed the control diet BBG_0 (Betaine/β-glucan at 0.0g/100g) had the least mean final body weight value (1.80g). There was an increased in the mean cost of feed from the value of ₦4.20) from fry fed control diet (BBG_0) to the value of ₦4.49 in fry fed diet BBG_4 (Betaine/β-glucan at 1.5g/100g)) respectively. The least mean cost of feed value (₦4.20) was recorded from the fry fed control diet (BBG_0). The investment cost analysis value (₦6.99) was highest in fry fed diet BBG_4, followed by those from fry fed diet BBG_3 (₦6.94), BBG_2 (₦6.89) and BBG_1 (₦6.84) respectively, while the least value (₦6.70) was recorded from fry fed control diet (BBG_0). The highest mean net profit value (₦15.21) was recorded from the fry fed diet BBG_2, while the least value (₦11.30) was recorded from the fry fed control diet (BBG_0).

The highest profit index value (3.46) was recorded from the fry fed diet BBG_2, while the least value (2.70) were recorded from both the fry fed diet BBG_3 and the control diet (BBG_0) respectively. The least (better) incidence of cost value (₦1.99) was recorded from the fry fed diet $BBG_{2,}$ while the highest (poor) value (₦2.34) was recorded from the fry fed diet $BBG_{3.}$ Also, the results indicated that fry fed diet BBG_2 had the highest benefit cost ratio value (2.20), while the fry fed the control diet (BBG_0) has the least value (1.69).

Table 2: The Cost-Benefit Analysis of *Clarias gariepinus* Fingerlings Fed the Co-mixed of Betaine and β-glucan as Feed Additive

Parameters	BBG_0	BBG_1	BBG_2	BBG_3	BBG_4
Mean final weight (g/fish)	1.80	1.88	2.21	1.89	1.95
Mean cost of feed/g (₦)	4.20	4.34	4.39	4.44	4.49
Cost of fish (₦/fish)	2.50	2.50	2.50	2.50	2.50
Investment cost analysis (₦)	6.70	6.84	6.89	6.94	6.99
Cost of fish/kg (₦)	10.00	10.00	10.00	10.00	10.00
Mean yield cost/fish (₦)	18.00	18.80	22.10	18.90	19.50
Mean net profit (₦)	11.30	11.96	15.21	11.96	12.51
Profit index	2.70	2.76	3.46	2.70	2.78
Incidence of cost (₦)	2.33	2.31	1.99	2.34	2.30
Benefit cost ratio (BCR)	1.69	1.75	2.20	1.72	1.73

Keys: BBG_0 - Betaine/β-glucan (0.0g/100g), BBG_1 - Betaine/β-glucan (0.375g/100g), BBG_2 - Betaine/β-glucan (0.75.g/100g), BBG_3 - Betaine/β-glucan (1.125g/100g), BBG_4 - Betaine/β-glucan (1.5g/100g)

The mean final body weight values, 1.80g – 2.21g recorded from this study were comparable with the values 1.81g - 2.60g reported by Ali et al. (2023) for *C. gariepinus* fry fed dietary betaine hydrochloride and higher than the values, 1.18g - 1.52g reported by Nababa et al. (2024) for *C. gariepinus* hatchlings fed baker's yeast, egg yolk and milk powder as starter diets. This indicated that the experimental diets were well utilized by the *C. gariepinus* fry. Ali et al. (2024b) stated that the dietary treatment with the highest weight gain also produced fish with the highest value for *C. gariepinus* fed different levels of maca (*Lepidium meyenii* Walp.) root powder as feed additive. The mean net profit values of ₦11.30 - ₦15.21 recorded from this study were in corroboration with the values of ₦11.19 - ₦16.24 reported by Sogbesan and Bashir (2018) *for Oreochromis niloticus* fed fermented cassava (*Manihot esculentus*) leaf meal supplemented diets and lower than the values of ₦11.30 - ₦19.05 reported by Ali et al. (2024a) for *C. gariepinus* fry fed dietary betaine hydrochloride based diet, but higher than the values, ₦6.10 - ₦9.30 reported by Nababa et al. (2024) for *C. gariepinus* hatchlings fed baker's yeast, egg yolk and milk powder as starter diets. This indicated that the used of the co-mixed of betaine and β-glucan as feed additive resulted to higher mean net profits in this study. The profit index values of 2.70 - 3.46 recorded from this study were lower than the values of 3.44 - 3.64 reported by Ali et al. (2024b) for *C. gariepinus* hatchlings fed different levels of Maca root powder as feed additive. The profit index values recorded from this study shows that more profit was generated; this finding further buttresses the fact that the diets were better utilized. The incidence of cost values of ₦1.99 - ₦2.33 recorded from this study were comparable with the values of ₦1.67 - ₦2.37 reported Ali et al. (2024a). The least (best) incidence of cost value recorded form the Fry fed diet BBG_2 indicated that using the co-mixed of betaine and β-glucan as feed additive at 0.75.g/100g produced the most cost-effective diet. The benefit cost ratio values of 1.69 - 2.20 recorded from this study were higher than the values of 0.72 - 1.27 reported by Sogbesan and Bashir (2018). Wambua (2018) reported that when the benefit cost ratio value is greater than one or equal to one it indicated profitability, but less than one indicated lack of viability or unprofitability of the venture. However, since the ratio values in all the diets were greater than one, it indicated that feeding *C. gariepinus* fry with the co-mixed of betaine and β-glucan as feed additive is economically efficient and beneficial implying that during the study period, the stream of benefits exceeds the costs incurred.

CONCLUSION AND RECOMMENDATIONS

The inclusion of the co-mixed of betaine and β-glucan as feed additive at 0.75.g/100g into the diet of *C. gariepinus* fry indicated the higher potentials by lowering the cost of production; with the highest mean net profit (₦15.21), highest and better benefit cost ratio (2.20) along with the least and better incidence of cost (₦1.99) and highest profit index (3.46).

REFERENCES

Ali, M. E. (2022). Performance and cost benefit of African mud catfish *Clarias gariepinus* (Burchell, 1822) fed different levels of dietary betaine, β - glucan and co - mixed additives diets. Ph.D. Thesis, Department of Fisheries, Modibbo Adama University, Yola, Nigeria. Pp. 183.

Ali, M. E., Yusuf, Z. A., Ibeagi, M. C., Remkyes, M. S., Yakubu, M. and Useni, S. S. (2023). Effect of different levels of dietary betaine hydrochloride on the growth response of fry of *Clarias gariepinus* (Burchell, 1822). *Proceedings of the 57th Annual Conference of the Agricultural Society of Nigeria (ASN)*. Pp. 989 - 992.

Ali, M. E., Maisheru, J. A., Ekaette, E. E., Yusuf, Z. A., Nababa, A. S., Useni, S. S. and Ogunmefun, G. S. (2024a). Cost - benefit analysis of African mud catfish (*Clarias gariepinus*, Burchell, 1822) fry fed dietary betaine hydrochloride - based diet. *Proceedings of the 49th Conference of the Nigerian Society for Animal Production (NSAP)*. Pp. 216 - 219.

Ali, M. E., Watafua, H., Maisheru, J. A., Salisu, A. S., Remkyes, M. S. and Yakubu, M. (2024b). Cost - benefit of *Clarias gariepinus* (Burchell, 1822) hatchlings fed different levels of maca (*Lepidium meyenii* Walp.) root Powder as feed additive. *Journal of Agriculture, Environmental Resources and Management,* 6 (4):106 - 113.

Ishaku, A. H., Ahmed, Y., Ali, M. E., Kela, E. and Sogbesan, O. A. (2023). Growth performance and nutrient utilizations of *Heterobranchus bidorsalis* (Geoffory Saint

Hilaire, 1809) fed on fermented sorghum bran meal diets. *Asian Journal of Fisheries and Aquatic Research,* 25(6): 43 - 56.

Mafra, P. V., González, P. E., Ricardo, P. P. and Wahrlich, R. A. (2027). Cost -benefit analysis of three gillnet fisheries in Santa Catarina, Brazil: contributing to fisheries management decisions. *Latin American Journal of Aquatic Research,* 44(5):1096 - 1115. Available from: doi:10.3856/vol44-issue5.

Nababa, A. S., Idris, M., Yahaya, I., Ogunmefun, G. S., Ekaette, E. E., Yusuf, S. K., Yusuf, Z. A. and Ali, M. E. (2024). Analysis on the cost benefit of *Clarias gariepinus* (Burchell,1822) hatchlings fed baker's yeast, egg yolk and milk powder as starter diets. *Proceedings of the 49th Conference of the Nigerian Society for Animal Production (NSAP)*. Pp. 2003 - 2006.

Sogbesan, O. A. and Bashir, S. Y. (2018). Utilization and cost benefit analyses of *Oreochromis niloticus* fed fermented cassava, *Manihot esculentus* leaf meal supplemented diets. *Journal of Aquaculture and Marine Biology,* 7(4): 199 - 204. DOI: 10.15406/jamb.2018.07.00209

Wambua, M. M. (2018). *A cost - benefit analysis of the fish farming enterprise productivity program project in Kenya. The case of implementation of the aquaculture development component in Meru County.* United Nations University Fisheries Training Programme, Iceland [final project]. Pp. 38. http://www.unuftp.is/static/fellows/document/moses15prf.pdf

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PROCEEDINGS

Efficacy of the Co-Mixed of Betaine and β - glucan as Feed Additive on the Performance of *Clarias gariepinus* (Burchell, 1822) Fry

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Abstract

A study was carried out at Lay-Joy Fish Farm, Billiri, Gombe State to evaluate the efficacy of the co-mixed of betaine and β-glucan as feed additive on the performance of *Clarias gariepinus* fry. Co-mixed of betaine and β-glucan was included into Coppens fish feed (0.2 – 0.5mm) with 49% crude protein at 0.0g/100g (BBG$_0$), 0.325g/100g (BBG$_1$), 0.75g/100g (BBG$_2$), 1.125g/100g (BBG$_3$) and 1.50g/100g (BBG$_4$) in triplicates, diet without the co-mixed of betaine and β-glucan (BBG$_0$) served as the control. The diets were fed to fry (n = 1,500; 0.25±0.0g) for 28 days in 15 plastic hatchery tanks (n = 100 per tank). Fry were fed at a fixed feeding rate of 10% body weight 6 times daily between the hours of 07:00 and 23:00 at regular interval. Data obtained were analysed using One-way ANOVA at P = 0.05. Mean Weight Gain [MWG] (1.96±0.81 g/fish), Daily Weight Gain [DWG] (0.070±0.09 g/day) and Specific Growth Rate [SGR] (3.38±0.16 %/day) were higher significantly ($p < 0.05$) in fry fed diet BBG$_2$, while the control diet (BBG$_0$) had the least MWG (1.55±0.09 g/fish), DWG (0.055±0.04 g/day) and SGR (3.06±0.14 %/day). Also, Feed Conversion Ratio was best (least) in fry fed diet BBG$_2$ (0.357±0.01), while it was poor (highest) in BBG$_0$ (0.451±0.08). Survival rate was *significantly* ($p < 0.05$) higher in fry fed diet BBG$_2$ (92.8±1.22 %), while it was least in BBG$_0$ (88.0±1.13 %). Findings from this study indicated that the inclusion of the co-mixed of betaine and β-glucan specifically at 0.75g/100g into the diet of *C. gariepinus* fry positively improved its performance.

Keywords: Efficacy, Co-Mixed, Betaine, β-glucan, Clarias gariepinus

INTRODUCTION

Feed additives are substances which are added in a very little quantity to diets or feed ingredients to preserve their nutritional characteristics prior to feeding, facilitates ingredients dispersion or feed pelleting, facilitate feed ingestion and consumer acceptability of the product or to supply essential nutrients in purified form (Anene et al., 2019). There are many available feed additives which can be included in fish diets to facilitate the fish performances such as growth, survival, digestibly and other important parameters (Ali, 2022). In aquaculture practices both betaine and β-glucans are used as feed additives for enhancing growth, survival rate and protection against infections and pathogen (Abed Ali and Al-Faragi, 2017). Betaine is amino acid derivatives which is derive from amino acid glycine (is the trimethyl glycine), is a metabolite of plant and animal tissues, betaine is considered as a by-product of sugar beet processing, betaine has nutritional function commonly used as feed additive in animal, poultry and aquatic nutrition, betaine improve growth performance, health status, feed digestibility, palatability, flesh quality and immune status of fish species (Abed Ali and Al-Faragi, 2017; Leong-Seng et al., 2019). β-glucans are long chain complex carbohydrates which can be found in cereals, seaweeds, mushrooms yeast and some bacteria (Ali et al., 2022a). β-glucans as adjuvants, prebiotics or probiotics are the most popular immuno-nutrients used in aquaculture, which promising for stimulating of non - specific immune response in fish and promoting growth (Homechaudhuri et al., 2016; Ali, 2022). This study was designed to evaluate the efficacy of the co-mixed of betaine and β-glucan as feed additive on the performance of *Clarias gariepinus* fry.

MATERIALS AND METHODS

Study Area

The study was carried out at the Lay-Joy Fish Farm, Gombe-Yola road, Billiri local government area (LGA), Gombe State Nigeria. Billiri LGA lies within Lat. 9°50'N, 11°09´E and Long. 9.833°N, 11.150°E. It covers an area of 737km² (285 sq. m) and is 50 km away from Gombe, the state capital. The fry for the experiment were bred at the hatchery unit of the farm. The fry were 4 days old at the commencement of the feeding trial.

Experimental Diets

Coppens fish feed (0.2 – 0.5mm) was used as the basal diet for this study and was obtained from feed suppliers at Gombe, while the betaine powder naturally derived from sugar beets (*Beta vulgaris*) and the β-glucan (β - 1,3/1,6 - D-glucan) powder naturally derived from the baker's yeast (*Saccharomyces cerevisiae*) were obtained from Bon-Amour Pharmacy Limited Lagos, Nigeria, imported from Piping Rock Health Products, Ronkonkoma, New-York, USA. Experimental diets were prepared by incorporating the co-mixed of betaine/β-glucan additive as feed additives at 0.0g/100g, 0.325g/100g, 0.75g/100g 1.125g/100g and 1.50g/100g feed, into Coppens fish feeds (0.2 – 0.5mm), while diet without the co - mixed of betaine/β - glucan i.e. 0.0g/100g feed served as the control diet and coded as BBG_0, BBG_1, BBG_2, BBG_3 and BBG_4 respectively. The co-mixed of betaine/β-glucan was included at the measured quantity for each diet and was diluted into 5 ml of warm water (35^0C) to form a solution. The solution was sprayed onto the Coppens fish feed (0.2 – 0.5mm), fish oil was added to all the experimental diets with the co-mixed of betaine/β-glucan to reserve the co-mixed of betaine/β-glucan additive. The Coppens fish feed (0.2 – 0.5mm) with t the co - mixed of betaine/β-glucan additive was prepared in 100g each time. The proximate composition of the Coppens fish fry feed (0.2 – 0.5mm) fed to the *C. gariepinus* fry is presented in Table 1. The diet contained 49% crude protein, 12% crude lipid, 6.0% crude fibre, 8.0% ash, 1.5% calcium, 8.0% moisture and 1.5% phosphorus.

Table 1: Proximate Composition of Coppens Fry Feed (0.2 – 0.5 mm) Used for the Study

Nutrients	Percentage (%)
Crude protein	49
Crude lipid	12
Crude fibre	6.0
Ash	8.0
Calcium	1.5
Moisture	8.0
Phosphorus	1.5

Experimental Design

Each of the treatment diets were fed to *C. gariepinus* fry (n = 1,500; 0.25±0.0g) in triplicate making a total of 15 plastic hatchery tanks (semi flow - through system) that is, n = 100 per tank. Water quality parameters such as temperature, pH, dissolved oxygen (DO) and ammonia (NH_3) were monitored weekly. Fry were fed 6 times daily between the hours of 07:00 and 23:00 at regular interval for a period of 28 days at a fixed feeding rate of 10% body weight as recommended by Ukwe et al*.* (2018). The initial body weight of each set of fry was measured using a digital weighing balance before stocking and subsequently bulk weighing of fry in each tank was done after every 7 days, the growth performance parameters were computed and analyzed according to the following equations as described by Stickey et al*.* (2006) as follows:

$$Mean\ weight\ gain, MWG = final\ weight\ (g) - initial\ weight\ (g)$$
$$Daily\ weight\ gain, DWG = \{final\ weight\ (g) - initial\ weight\ (g)\}/experimental\ days$$
$$Specific\ Growth\ Rate, SGR = \{(log\ final\ weight\ (g) - log\ initial\ weight\ (g))/\ culture\ period\} \times 100$$
$$Feed\ Conversion\ Ratio, FCR\ (g/g) = feed\ intake\ (g)/weight\ gain\ (g)$$
$$Survival\ rate = \{(final\ no.\ of fish - initial\ no.\ of fish)/initial\ no.\ of\ fish\} \times 100$$

Statistical Analysis

The data obtained were subjected to one-way analysis of variance (ANOVA) using the GraphPad instant package for windows 2010 of statistical analysis system (SAS, 2010). Mean separation was done (at P = 0.05) using Fisher's least significance difference (LSD) to separate the means in cases of significant difference.

RESULTS AND DISCUSSION

Results of the performance of the *C. gariepinus* fry fed the co-mixed of betaine/β-glucan as feed additive is presented in Table 2. The statistically significant ($p<0.05$) highest growth performance parameters' values in terms of mean weight gain (MWG) 1.96±0.81g/fish, daily weight gain (DWG) 0.070±0.09 g/day and specific growth rate (SGR) 3.38±0.16 %/day were recorded from the fry fed the co-mixed of Betaine/β-glucan incorporated diet at 0.75g/100g feed (BBG_3). Similarly, the statistically significant ($p<0.05$) least (best) feed conversion ratio (FCR) value of 0.357±0.01 was recorded from the fry fed diet BBG3. The highest survival rate value (92.8±1.22 %) was recorded for the fry fed diet BBG_3. There was also a significant difference ($p<0.05$) in terms of the survival rate values recorded for the fry fed diets with the co - mixed of

Betaine/β-glucan as feed additive compared with the control diet. Throughout the study period, the water quality parameters monitored such as the water temperature, pH, dissolved oxygen (DO) and ammonia (NH_3) were within the recommended range for the culture of *C. gariepinus*.

Table 2: Performance of *Clarias gariepinus* Fry Fed the Co - Mixed of Betaine/β - glucan as Feed Additive

Parameters	BBG_0	BBG_1	BBG_2	BBG_3	BBG_4
Mean initial weight (g/fry)	$0.25±0.0^a$	$0.25±0.0^a$	$0.25±0.0^a$	$0.25±0.0^a$	$0.25±0.0^a$
Mean final weight (g/fr	$1.80±0.14^a$	$1.88±0.16^b$	$2.21±0.31^c$	$1.89±0.18^b$	$1.95±0.13^b$
Mean weight gain (g/fry	$1.55±0.09^a$	$1.63±0.05^b$	$1.96±0.81^c$	$1.64±0.80^b$	$1.70±0.15^b$
Daily weight gain (g/day)	$0.055±0.04^a$	$0.058±0.07^a$	$0.070±0.09^b$	$0.059±0.01^a$	$0.060±0.02^a$
Specific growth rate (%/day)	$3.06±0.14^a$	$3.12±0.19^a$	3.38±0.16b	$3.13±0.11^a$	$3.18±0.13^a$
Feed conversion ratio (g/fry)	$0.451±0.08^b$	$0.429±0.06^b$	$0.357±0.01^a$	$0.426±0.07^b$	$0.411±0.05^b$
Survival rate (%)	$88.0±1.13^a$	$90.6±1.18^b$	$92.8±1.22^c$	$90.8±1.06^b$	$91.1±1.03^b$

Mean values in each row with similar superscripts are not statistically significantly different ($p>0.05$).

Keys: BBGo - Betaine/β - glucan (0.0g/100g), BBG_1 - Betaine/β - glucan (0.375g/100g), BBG_2 - Betaine/β - glucan (0.75.g/100g), BBG_3 - Betaine/β - glucan (1.125g/100g), BBG_4 - Betaine/β - glucan (1.5g/100g)

The highest growth performance parameters in this study in terms of the MWG, DWG and SGR recorded for the fry fed the co-mixed of Betaine/β-glucan incorporated diet at 0.75g/100g feed corroborates the findings of Ali et al. (2023) which reported a similar result for *C. gariepinus* fry fed dietary betaine hydrochloride and Ali et al. (2022b) for *C. gariepinus* \fingerlings fed dietary β-glucan as natural additive. The least (best) value of FCR recorded for the fry fed the co-mixed of Betaine/β-glucan at 0.75g/100g feed was also in agreement with the findings of Ali (2022) which reported similar results for *C. gariepinus* fingerlings fed the co-mixed of Betaine/β-glucan additive diet.

The high survival rate values recorded in this study for the fry fed all the treatment diets with the co-mixed of Betaine/β-glucan and the control diets revealed that the diets were well tolerated by the fry. The better performance in terms of the MWG, DWG, SGR, FCR and survival rate values observed for the fry fed diet incorporated with the co-mixed of Betaine/β-glucan at 0.75g/100g feed ekucidated that the co-mixed of Betaine/β-glucan had a beneficial effect when incorporated into the diet of *C. gariepinus* fry and corroborates with the report of Abed Ali & Al-Faragi (2017) which stated that the addition of betaine and β-glucan into the feed of common carp (*Cyprinus carpio* L.) fingerlings resulted in better performances. The water quality parameters were not polluted by the incorporation of the co-mixed of Betaine/β-glucan into the diets.

CONCLUSION AND RECOMMENDATIONS

The co-mixed of Betaine/β-glucan at 0.75g/100g feed inclusion level exhibited better performance in terms of the MWG, DWG, SGR, FCR and the survival rate values compared to other levels of inclusion, hence it is recommended.

REFERENCES

Abed Ali, H. H. & Al-Faragi, J. K. A. (2017). Efficiency of betaine and β - glucan as feed additives on the growth performance and survival rate of common carp (*Cyprinus carpio* L.) fingerlings. *Journal of Entomology and Zoology Studies,* 5(4): 27 - 31.

Ali, M. E. (2022). Performance and cost benefit of African mud catfish *Clarias gariepinus* (Burchell, 1822) fed different levels of dietary betaine, β - glucan and co - mixed additives diets. Ph.D. Thesis, Department of Fisheries, Modibbo Adama University, Yola, Nigeria. Pp. 183.

Ali, M. E., Abubakar, K. A. & Sogbesan, O. A. (2022a). Efficacy of dietary β - glucan as natural additive on the growth performance and survival rate of *Clarias gariepinus* (Burchell, 1822) fingerlings. *Proceedings of the 37th Annual Conference of the Fisheries Society of Nigeria (FISON)*. Pp. 133 - 137.

Ali, M. E., Abubakar, K. A. & Sogbesan, O. A. (2022b). Growth performance and nutrient utilization of *Clarias gariepinus* (Burchell, 1822) fingerlings fed dietary betaine additive diets. *Proceedings of the 37th Annual Conference of the Fisheries Society of Nigeria (FISON)*. Pp. 129 - 133.

Ali, M. E., Yusuf, Z. A., Ibeagi, M. C., Remkyes, M. S., Yakubu, M. & Useni, S. S. (2023). Effect of different levels of dietary betaine hydrochloride on the growth response of fry of *Clarias gariepinus* (Burchell, 1822). *Proceedings of the 57th Annual Conference of the Agricultural Society of Nigeria (ASN)*. Pp. 989 - 992.

Anene, A., Okorie, E. O. and Johnson, G. C. (2019). Assessment of the growth performance and proximate quality of fingerlings of *Clarias gariepinus* (Burchell, 1822) fed diets containing varying levels of onions powder (*Allium cepa*) as phyto - additive. *Proceedings of the 34th Annual Conference of the Fisheries Society of Nigeria (FISON).* Pp. 136 - 138.

Homechaudhuri, S., Pal, S., Roy, D. O. & Ray, S. D. (2016). Effects of β - glucan as immunostimulant on *Labeo rohita* challenged with a bacterial pathogen *Aeromonas hydrophila. International Journal of Innovative Studies in Aquatic Biology and Fisheries,* 2 (5): 10 - 19. DOI: http://dx.doi.org/10.20431/2454-7670.0205003

Leong - Seng, L., Ahmad, R. J., Audrey - Daning, T., Rossita, S. & Gunzo, K. (2019). Acceptability to betaine as a feed enhancer in the brown - marbled grouper (*Epinephelus fuscoguttatus*) at grow - out stage. *Songklanakarin Journal of Science and Technology,* 41(3): 490 - 493.

Stickey, R. R., Hardy, R. W., Koch, K., Harold, R., Searight, D., Massee, K. C., Tacon, A. G. J. & Jackson, A. J. (2006). Utilization of conventional protein sources in practical fish feeds. *Journal of Food Science,* 2(4): 45 - 56.

Ukwe, O. I. K., Edun, O. M. & Akinrotimi, O. A. (2018). Comparative growth performance and survival of African catfish (*Clarias gariepinus*) fed with artemia and acartia live feeds. *Journal of Aquatic Science and Marine Biology,* 1(3):.24 - 28.

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AGRICULTURAL SOCIETY OF NIGERIA
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21-25 OCT. 2024
PROCEEDINGS

Comparative Analysis of Fish Consumption Pattern among Households in Lagos State

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Abstract
This study assesses Comparative analysis of fish consumption among households in Lagos State. A multistage random sampling technique was used to select 400 household fish consumers. A structured questionnaire was used to collect the data needed for the study. The data were analyzed using the descriptive statistics and inferential statistics (multinomial logit model). The result shows the average monthly expenditure on fish by household was ₦5.9. Result of the descriptive statistics further shows that the largest number of consumers (60.7%) had preference for fresh fish. Smoked fish was the second most preferred fish form consumed by the households (54.7%). While dried fish emerged was consumed by 52.7% of the households making it the third preferred fish form. The least preferred form of fish consumed in the area was frozen fish and 50.7% of the household consumed this fish form. The result of the multinomial result shows that Education, Age, mode of income, Gender and Household income were statistically significant at 5% Level of probability. The multiple regression result shows that only three regresors (Age, Household income, and marital status) out of seven regressors were statistically significant at 5% level of probability. The study recommends the improvement of the market for fish consumption by creating value through packaging processing and storage and better storage facilities. This can be achieved by government provision of steady power supply and agro processing industries which must be linked to production for household consumption.

Keywords: Analysis, Fish Consumption, Lagos-State. Pattern, Regression.

INTRODUCTION
The fishery subsector in Nigeria holds the potential to contribute to food security and reduce rural fishery sub sector hunger by providing employment to many Nigerians, it is also a major contributor to GDP. Its contribution to GDP as at 1990 Constant basic prices stood at ₦9,240.54, ₦9,810.63, ₦10,395.40 and ₦1,012.63 in 2008, 2009, 2010 and 2011, respectively (Central Bank of Nigeria, 2011). Apart from providing employment for over five hundred thousand people, it contributes over 40 percent of the animal protein intake of the resource poor people (Sani *et al.*, 2009).

Fish is an important component of a modern healthy diet and also a critical food source for developing countries Fish provides key macro and micro nutrients, protein and are low in saturated fat (Lynch & Macmillan, 2017). fish consumption has been linked to a wide array of health benefits for infants and adult including the developing foetus (Millen *et al.,* 2015) According to Nesheim and Taktine (2007), fish can supply up to 50 percent or more of high quality protein, mineral elements (B6, B12, niacin, thiamine, riboflavin, Vitamin E) and essential fatty acid such as oleic acid and omega3 fatty acid.

The United Nation Food and Agriculture organization noted that world population growth has outweighed fish production due to increased fish consumption. (FAO. 2018c) Fish consumption per capita across the world has increased from 9.0kg in 1961 to 20.5kg in 2017 FAO (2018d). Considering the upsurge in population growth, urbanization and demographic dynamics (Falaye & Jenyo-Oni, 2009). Fish consumption (demand) raises enormous challenges for Nigerian economy. 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 to 88 percent in 2016 (Vannuccini *et al.*, 2018).

Nigeria is adjudged to be highly deficient in animal protein security with the per capita consumption put at 9.3g/day by Food and Agricultural Organization (FAO) to be the minimum requirement for the growth and development of the body (Esobhawan et *al.,* (2008). Inspite of the large livestock population in Nigeria, the daily per capita animal protein intake by Nigerians was 6g/day. This however is far below the World Health Organization (WHO) stipulated 12g/day level (WHO, 1998).

Fish is a good source of sulphur and essential amino acids such as lysine, leucine, valine and arginine (Amiengheme, 2005). It is therefore suitable for supplementing diets of high carbohydrates contents. Apart from its high availability and relatively cheap cost, there is hardly any religious taboo, and any known limitations affecting the consumption of fish unlike pork and beef meat (Eyo, 2011).Fish is reputed to be nutritionally superior to other sources of animal protein. It contains most of the essential amino acid particularly Lysine. Leucine, methionine and tryptophan and hence fish is regarded as first-class protein producer (Ekelemu *et al.,* 2000). But CentralBank of Nigeria (CBN) 2003 reported that the anticipated growth rate of the fishery sub sector has not been achieved, suggesting that the current production practices may not be capable of achieving the desired production target in the face of increasing population. Central Bank of Nigeria (CBN 2006) put the current demand for fish in Nigeria at l.5million metric tons per annum and the current domestic output at 600,000 metric tons per annum thereby leaving a shortfall of 899,400 metric tons. This implies significant aspect of the demand for fish not been met, despite the low consumption. The situation in Nigeria has not changed since then.

Cereny and Harold, 2001 stated that protein for human consumption usually comes from plants and animals. Plant proteins are deficient in certain amino acids notably methionine, tryptophan and lysine which are necessary for proper healthy growth. They are also relatively inferior to animal protein because protein quantity and quality differ widely at different parts as those obtained from root plants are not the same as ones from leafy plants. Some plant proteins have undesirable substances such as anatoxin (as in groundnut seeds, corn and tree nuts) which is said to cause liver cancer in poultry and man, (Eratoti and Groopman (1994). Animal protein is however rich in amino acids and it is therefore, described as first class or good quality protein (Praise and Schweigert, 1971). This has informed a part of the reasons for the acceptability of animal protein.

The quality of the fish/seafood freshness is the prime determinant. In this regard frozen fish are treated as non-fresh, bad quality, tasteless, watery and boring (Olsen, 2001). Other attributes like price and convenience also have impact on fish consumption attitude formation. However, Olsen (2004) found price, value for money and household income not barriers to seafood consumption, while Verbeke (2005) reported that price negatively affect fish consumption attitude because of complex preparation and cooking procedure, fish is treated as an inconvenient food item (Verbeke *et al*, 2007). The objectives of the study are to: determine the Comparative factors influencing consumer's expenditure on fish and identify the constraints for fish consumption in the study area.

METHODOLOGY

The study was carried out in Lagos State Nigeria. Lagos State is located in the south-western part of the Nigeria. On the North and East Lagos is bounded by Ogun State. In the West the state shares boundaries with the Republic of Benin. Lagos state is bounded to the south by Atlantic Ocean. Twenty two percent of state land area (3,577 km^2) are lagoons and creeks. Lagos state lies within the latitude 6^0 and 24^1 and 6^0 31^1 N, longitude 3^016^1 and 3^037^1. There are twenty local Government Areas in Lagos State. The state has a population of 9,013,534. (National population commission, 2006). The highest maximum temperature ever recorded in Lagos was 37.3°C (99.1°F) and the minimum 13.9°C (57.0°F) (Lagos Meteorological Organization 2012).

Result Discussion on Multinomial Logit Regression Output for factors influencing forms of fish consumed by households

Multinomial Logit regression model was used to capture the factors that influence the households' consumption preference for different forms of fish as earlier described in the study. This model is appropriate since the dependent variable is nominal. The diagnostic result for the Logit model shows that the chi-square, which measures the goodness of fit of the model, is statistically significant ($\varkappa^2$ =110.603; $P<0.05$). Thus, the null hypothesis which says that the intercepts and coefficients are zero is rejected because the model is of good fit. The Pseudo-R^2 value (0.56) also indicated that the model is good.

Result in Table 1, Provides information of the comparison between consumption of various fish forms and the reference category which is 'consumption preference for fresh fish'. For the comparison between consumption preference for frozen fish and fresh fish, the coefficient of education is significant with a positive sign (at $p<0.05$). Increase in respondents' education increases the odds or probability of respondents' consumption of frozen fish by 1.19 (exp(0.18)).While the comparison between smoked and fresh fish is also significant with a positive sign (at $p<0.05$). An increase in respondent's education status will lead to more awareness about the nutritional benefit of fish consumption. The descriptive result shows that literacy level among the respondents is relatively high this will facilitate consumption of frozen fish. The comparison between consumption preference for Dried fish and fresh fish in Table 4.3 the coefficient of age is significant and with a negative sign (at $p<0.05$). This implies that older household heads tends to consume more fresh fish than the younger ones leading to -.076* (exp(0.18)). Descriptive result shows that most of the respondents are above 40 years thus increasing the preference for fresh fish as compared to dried fish.

The comparison between consumption preference for frozen fish and fresh fish in in Table 4.3 the coefficient of mode of income is significant with a negative sign (at $p<0.05$).This implies that a positive change in income status will reduce the fish consumption preference for frozen fish among the respondents by 0.345(exp(0.18)).Thus with increasing income respondents tend to prefer fresh fish to frozen fish. Also in the comparison between consumption preference for dried fish and fresh fish in in Table 1.0 the coefficient of mode of income is significant with a negative sign (at $p<0.05$).This implies that a percentage in income status will the consumption of the dried fish as compared to fresh fish by 0.683 (exp(0.18) among the respondents. This implies that preference for dried and frozen fish form is low among high income earners as compared to fresh fish. The comparison between consumption preference for smoked fish and fresh fish in in Table 4.5 the coefficient of gender is significant with a positive sign (at $p<0.05$).This implies that female headed household have higher probability to prefer consumption of smoked fish than fresh fish by 2.343 (exp(0.18)).This implies that smoked fish is more preferred than fresh fish by women. This maybe because women are more involved in the smoking process of fish preservation. However, descriptive result shows that male headed household are more than female headed household in the study area.

The comparison between consumption preference for frozen fish and fresh fish in in Table 4.3 the coefficient of marital status is significant with a positive sign (at $p<0.05$). This implies that increase in married respondents increases the odds or probability of respondents' consumption of frozen fish by 0.6.806(exp(0.18)) as compared to fresh fish. Descriptive result shows that many of the household heads in the study area are married.

The comparison between consumption preference for smoked fish and fresh fish in in Table 4.3 the coefficient of household income is significant with a positive sign (at $p<0.05$). This implies that increase in the income increases the probability of consumption of smoked fish than fresh fish by 2.16 (exp(0.77)). However, the descriptive result shows that most of the household have low income. The study found positive relationship between education and demand for frozen fish. This outcome is in line with various literature (Can *et.al* 2015 & Buger *et.al* 1999). Which found a significant association between education and consumption of fish. There are, however other studies which similarly found no association between education and fish consumption (Hicks D &Mcdermot 2008). The income of consumers and its related variable of total budget for fish showed strong positive relationship to demand for fish, contrary to the sign on the income variable for fish consumption by Burger et.al 1999 in their USA study. Other known studies which corroborated the positive relationship for the income and household size variable against demand for fish include Amao et al 2006; Can et al 2015; Dalhatu & Ala 2010.

Table 1: Multinomial Logit Regression Output for factors influencing forms of fish consumed by households

Variables	Frozen			Smoked			Dried	
	Beta Coeff.	**Std. Error**	**Exp (B)**	**Beta Coeff.**	**Std. Error**	**Exp (B)**	**Beta Coeff.**	**Std. Error**
Intercept	-4.107	1.378		-28.592	2.350		1.419	1.120
Education (yrs)	.175*	.060	1.192	.043	.086	1.044	.009	.068
Age (yrs)	.032	.022	1.033	.081	.043	1.084	-.076*	.027
Household Size	-.101	.093	.904	-.033	.129	.968	-.043	.103
Mode of income (salaried =0; Non salaried = 1)	-1.06*	.510	.345	-.381	.828	.683	-1.65*	.537
Gender (male = 0: female =1)	-.118	.497	.889	2.343*	.857	10.415	1,048	.551
Marital status (Married =1; Single =0)	1.918*	.585	6.806	21.399	.000	196561 5973.525	-.147	.555
Household Income {₦}	.310	.179	1.364	.773*	.274	2.166	.329	.181

Source: Field Survey, 2023. Adjusted R^2 = 0.56; -2 Log Likelihood = 274.218; Chi-square = 110.603*; Reference category = Fresh Fish form; *P<0.05

Table 1.1: Result on Household Consumption Pattern by Constraint

Constraint	Frequency	Percentage
Distance from the Market	101	67.3
Low Traded Volume of Fish	18	12.0
Rapid Fish Spoilage	104	69.3
High price of fish	96	64.0
Low Level of Consumer Income	62	41.3
Religious Belief	38	25.3
Health Reasons	41	27.3

Source: Computed from Field Survey (2023).

The result in Table 1.1 reveals that majority of households sampled fish consuming household accounting for about 67.3% of total sampled respondents gave rapid fish spoilage as constraint because they consume fresh fish and preserved by refrigerating or sun drying. Rapid spoilage of fish could be as a result of poor power supply to power the refrigerator use for preservation of the product. While 67.3% sampled fish consuming household accounting for distance from the market as their challenge, other constraint include high price of fish (64%). High prices of the product could be as a result of high transportation, high cost of production and high cost of preservation. Low level of consumer income (41.3%), health reasons (27.3), religious belief (25.3%) and low traded volume (12%).

CONCLUSION

Fresh fish is the highest form of fish in the consumer market, whereas smoked fish is the lowest priced. As the income of the consumers increases, they buy only a little more smoked and frozen fish because most smoked fish consumed in the metropolis are perceived to be of low quality. Wealthier consumers tend to buy more of fresh fish and dried fish (such as stock fish) which consumer perceived to be of better quality in terms of nutrition and safety. The dried and fresh forms of fish are substitute mainly because the most common type of fresh fish in the area (the cat fish) is also the dried fish in the market.

RECOMMENDATIONS

With increasing awareness of health and nutritional importance of fish, especially among older folks, supply of fish should be encouraged and facilitated locally through improvement of local production so that low income household can affordably consume Facilitation of supply of fresh and frozen fish is recommended because it attracts higher preference especially in the open market.

Based on the findings, the study recommends that fish prices should be stabilized, adequate cold storage facilities should be purchased by the fish mongers. Fishery sector should expand their ponds and be encouraged to produce more fresh fish at affordable prices for the masses. There is a need therefore to increase domestic fish supply in the country and ensure fish supplies to consumers at affordable prices in all market in the metropolis.

REFERENCES

Amao, J.O. and Ayantoye, K. (2014). Consumer Preference and Consumer Pattern for selected forms of fish in Oyo State, Nigeria. *841-860 in International Journal of Science, Environment, and Technology.*

Aminu, F.O., Adebanjo, O.A., Mohammed, H.A. (2016). Determinants of Food Expenditure Patterns Among Households in Oshodi Isolo Local Government Area of Lagos State, Nigeria. *12(2):98-102 in Nigerian Journal of Agriculture, Food, and Environment.*

Aromolaran, A. B., and O.A. Akintunde (1998). Economics analysis of consumption patterns and consumer preferences for selected animal products in Delta State, Nigeria, Proceedings of the 3rd Annual Conference of the Animal Science Association of Nigeria, Sept 22-24, in Ologhobo A.D. and Iyayi E.A. (eds).

Babalola, D.A. & Isitor, S.U. (2014). Analysis of the Determinants of Food Expenditure Patterns among Urban Households in Nigeria: Evidence from Lagos State. *7(5): 71-75 in the IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS).*

Chianu, J.N., and Tsujii, H. (2007). Gender differences in labor allocation in West Africa: A case study of the Savannas of Northern Nigeria. Human and Social Sciences Journal, vol. 2, no. 2, pp. 93-103.

Fabiyi Y.L. (1985). Demand for fish in Calabar, Cross River State, Nigeria, Proceedings of the 4th Annual Conference of the Fisheries Society of Nigeria (FISON), Port Harcourt, 1985:62-70.

Falaye AE and A Jenyo-Oni (2009) Aquatic biodiversity and the implications for artisanal fishing production, African Journal of Livestock Extension. (2009); 7:39-43

FAO (1990): Nutrition in Agriculture: Conducting Small-Scale Nutrition Surveys. A Field Manual Nutrition, Planning, Assessment, and Evaluation Service. Food Policy and Nutrition Division.

FAO (2008c), The State of World Fisheries and Aquaculture (SOFIA), 2008 PAERT1: World Review of Fisheries and Aquaculture, Fish consumption, P. 58-65

FAO (2018d) The State of World Fisheries and Aquaculture: Meeting the Sustainable Development Goals.FAO, Rome, 2018.

Ibrahim, M. (1999).Factors Affecting Soyabean Consumption in Municipal Local Govt. Areas in Kano State An Unpublished Project, UDUS, 1999:47.

National Population Commission (2006) Population Census of Nigeria, Government Press, Abuja, Nigeria.

Nesheim MC and AL Yaktine, Seafood Choices: Balancing Benefits and Risks. The National Academic Press, Washington, DC (2007).

Sani, R.M., David A.E., Kushwade Sand Sustainable fish production: an economic analysis of fish farming in Bauchi state. *1(1): 75-83 in the Tropical Journal of Animal Science.*

S.O. Anyanwu (2012).Economic Analysis of Demad for Meat and Fish in Rivers State, Nigeria. *9(2): 137-145. Journal of Vocational Education and Technology.*

T. Yamane (1967). Statistics, an Introductory Analysis, 2nd ed., Harper and Row, New York, 289 p.

Verbeke, W., and Vakier, I. (2005). Individual determinants of Fish Consumption: An Application of the Theory of Planned Behaviour *Appetit 6*http://dx.doi.org/10.1016/j.appet.2004.08.006. PMid: 15604034 Functional foods: are consumers willing to sacrifice taste for health? 126-131 in Food Quality and Preference.

Enhancing the Seed Yield and Nutritional Quality of Bambara Groundnut (*Vigna subterranea* (L.) *verdc*.) for Food Security through Agronomic Zinc Biofortification and Liming

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Abstract
Agronomic zinc biofortification of crops is evolving and very imperative as zinc is a very important element in human nutrition and health. A 3 x 4 factorial experiment was laid out in a Randomized Complete Block Design at the Teaching and Research Farm of the Department of Crop Science, Faculty of Agriculture, University of Calabar to evaluate the effect of three rates of Calcitic lime (0, 5 and 10 t/ha) in a factorial combination with four rates of soil applied $ZnSO_4$ (0, 10, 20 and 30 kg/ha) on the seed yield and nutritional quality of a landrace of Bambara groundnut (Vigna Subterranea (L.) Verdc). Data collected were analyzed statistically using analysis of variance (ANOVA) and significantly ($P \leq 0.05$) different means were separated using New Duncan's Multiple Range Test Method. Results revealed that lime and zinc applied at 5 t/ha and 20kg Zn/ha, respectively, significantly produced higher grain yield as well as increasing zinc concentration of Bambara groundnut grains which are very vital in the diet and nutrition of mankind to curb the ravaging effect of hidden hunger and malnutrition among the rural populace and was therefore suggested for recommendation by farmers in Southeastern Nigeria.

Keywords: Bambara groundnut, Zinc, Lime, Biofortification, Growth and Yield.

INTRODUCTION

Agronomic zinc biofortification of leguminous food crops such as Bambara groundnut and beans is evolving to curb the ravaging effect of malnutrition especially among children and pregnant women, Talsma (2014). Zinc is a very important element in human nutrition and health. Estimate by Telles de Moura *et al*. (2023) indicated that more than two billion persons in the world are affected by zinc deficiency.

The recent stagnation or decline in farm productivity in many parts of Nigeria is a major concern. Bambara groundnut is still considered as one of the non-prioritized, neglected and underutilized leguminous crop species in Nigeria, despite the high nutritional value (Baloyi and Swanepoel, 2023; Dodd *et al*., 2023; Talucder *et al*. 2024), opined that the production of Bambara groundnut like other food legumes such as groundnut has not been popular as a result of intensive soil cultivation without effective soil management programmes which has led to reduction in soil pH resulting in acidification and severe soil degradation. At low pH, the root of plants stops to grow and pod yield declines abruptly while at pH of 5.0, root inuring occurs which impedes the growth of lateral root and total suppression of the root system which greatly hampers the depth of rooting and branching propensity, hence, the reduction in Bambara groundnut yield and widening the gap of malnutrition and hunger.

This research was therefore initiated to determine the response of Bambara groundnut to varying rates of $CaCo_3$ and Zinc fertilizer as soil amendment to fortify the crops, increase yield and meet the unprecedented increase in demand for Bambara groundnut to narrow the gap of malnutrition and hunger in the humid rainforest area of the Tropics.

MATERIALS AND METHODS

Experimental site and land preparation

The experiment was conducted during the early rainy season at the Teaching and Research Farm of the Faculty of Agriculture, University of Calabar, Calabar. Land preparation was carried out manually using cutlass, hoe and spade.

Treatments and Experimental Design

The experiment was laid out as a 4 x 3 factorial in a Randomized Complete Block Design (RCBD) replicated thrice. Treatments comprised four rates of Z_nSO_4 (0,10, 20 and 30kg/ha and three rates of calcitic lime $CaCO_3$ (0, 5 and 10 tonnes/ha) as liming materials thus, having a total of 36 experimental units. Unit plots measured 1.3m x 4.1 m (5.33 m^2) each separated by 1.0 m wide paths while blocks were spaced 2.0 m apart. Treatments were randomly assigned to plots in each block using random number tables.

Treatment Application, Sowing and Plot Maintenance

The liming materials were uniformly applied on finished seed beds and incorporated properly into the soil with a hand-held hoe and trowel two weeks before seeds were sown. Healthy uniform size cream coloured Bambara groundnut seeds were sown one per hole 3-5 cm deep at 30cm x 50cm to give a total of 32 plants per bed or 66,667 plants/ ha. Each level of zinc thoroughly mixed with 2 kg filler material and applied at 30 kg/ha by band one week after germination. Plots were weeded regular using hand held hoe to keep weed population below threshold level. The developing pods were earthen at weeding and cross bunds were constructed to control erosion within plots.

Proximate analysis was carried out on seed of Bambara groundnut harvested to determine the level of Zinc and Phosphorus presence.

Data Collection and Statistical Analysis

Data were collected from the net plot of Bambara groundnut stands. The agronomic parameters taken included: number of seeds per plant and seed yield (t/ha). Data generated were analyzed statistically using analysis of variance (ANOVA) and significantly ($P \leq 0.05$) different means were separated using New Duncan's Multiple Range Test Method (DMRT) as described by Sukkaew *et al*. (2022).

RESULTS AND DISCUSSION

The effects of zinc and lime application on the yield indices of groundnut is shown in Table 1. The effect of liming was not significant on number of seeds per plant of Bambara groundnut (Table 1). However, zinc application above 20 kg/ha significantly reduced number of seeds per plant. Interaction between lime and zinc was also found to be significant on number of feeds per plant. Higher number of seeds per plant were recorded in plots amended with 5 t/ha time and 20 kg/ha zinc.

One hundred seed weight (g) and seed yield (t/ha) were significantly affected by lime and zinc application (Table

1). Application of lime and zinc fertilizer significantly ($P \leq 0.05$) and consistently increased the weight of 100 seeds and seed yield of Bambara groundnut relative to unamend soil. However, zinc application beyond 20 kg/ha significantly reduced the weight of 100 seeds and seed yield of Bambara groundnut.

Interaction between lime and zinc was also found to be significant on the weight of 100 seed and seed yield per hectare. Results showed that Bambara groundnut grown in plots amended with 10 t/ha lime + 20 kg/ha Zn and 10 t/ha lime + kg/ha Zn significantly produced higher seed weight and seed yield per ha, respectively. It was further revealed that, without lime application, increases in rates of zinc application did not result in significant increase in the seed yield of Bambara groundnut. Similarly, there was a corresponding increase in the amount of Zinc (mg/kg) and Phosphorus (mg/kg) present in seed of Bambara groundnut in accordance to the applications of Zinc and Lime applied to the soil.

Table 1: Effect of lime and zinc on 100 seed weight (g), seed yield (t/ha), zinc (mg/kg) and phosphorus (mg/kg) concentration of seeds of Bambara groundnut

Treatment	100 seed weight (g)	Seed yield (t/ha)	Zinc (mg/kg)	Phosphorus (mg/kg)
Lime (tonnes)				
L_0	583^b	1.07^b	33.75^c	37.00^c
L_5	721^a	1.47^a	39.92^a	44.62^b
L10	750^a	1.50^a	35.50^b	53.00^a
Zinc (kg/ha)				
Z_0	517^b	1.03^b	12.89_d	73.44^a
Z10	783^a	1.68^a	28.56_c	46.33^b
Z20	844^a	1.62^a	50.22^b	44.11^c
Z30	594^b	1.05^a	53.89^a	15.61^d
Lime ×Zinc				
L0 ×Z0	517^c	1.01^b	11.00^i	64.67^c
L0 ×Z10	617^c	1.13^b	$2I.00^g$	34.33^h
L0 ×Z20	817^b	1.13^b	50.00^c	36.00^h
L0 ×Z30	583^c	1.01^b	53.00^b	13.00^j
L5 ×Z0	517^c	1.07^b	15.00^h	76.00^b
L5 ×Z10	850^b	1.84^a	34.67^e	46.00^f
L5 ×Z20	917^{ab}	1.90^a	54.00^b	41.00^f
L5 ×Z30	600^c	1.07^b	56.00^a	15.50^{ij}
L10 ×Z0	517^c	1.01^b	12.67^i	79.67^a
L10 ×Z10	883^{ab}	2.07^a	30.00^f	58.67^d
L10 ×Z20	1000^a	1.84^a	46.67^d	55.33^e
L10 ×Z30	600^c	1.07^b	52.67^b	18.33^i

* abcd means with different subscripts differ significantly at 5% NDMRT. **Keys**: L_0 = Lime 0 tones: L_5 = Lime. 5 tones, L_{10} = Lime 10 tones; Zn_0 = Zinc 0 kg; Zn_{10} = Zinc 10kg: Zn_{20} = Zinc 20 kg; Zn_{30} = Zinc 30kg

Higher rates of ZnSO4 (30 kg/ha) significantly increased leaf width and facilitated early anthesis, supporting findings by Egedigwe-Ekeleme *et al*. (2023) and Hassen *et al*. (2023). However, higher ZnSO4 doses negatively affected yield, possibly due to nutrient imbalance (Ekwere *et al*., 2017; Elango et al., 2022). Moderate rates of lime (5 t/ha) and zinc (10 kg/ha) improved nutrient availability, growth attributes, and yield (Kumar et al., 2022). The positive correlation between soil-applied zinc and grain Zn concentration aligns with Amiri et al. (2016) and Saboor et al. (2021), confirming the safety of Zn inclusion in Bambara groundnut without phytotoxicity.

CONCLUSION AND RECOMMENDATIONS

Considering the nutritional importance of Zn in human diet, a high grain yield of 1.90 t/ha and grain Zn concentration of 54.00 mg/kg were obtained with 5 t/ha lime and 20 kg Zn/ha application and thus, could be suggested for recommendation by farmers for sustainable Bamabara groundnut production to curb the ravaging effect of hidden hunger and malnutrition among the rural populace.

REFERENCES

Amiri, A., Baminasab, B., Ghobadi, C. & Khoshgoflarmanesh, A. H. (2016). Zinc soil application enhance photosynthetic capacity and antioxidant enzyme activities in almond seedlings affected by salinity stress. *Photosynthetica*, 4, 267 – 274. https://doi.org/10.1007/S11099-016-0078-0

Baloyi, N. G. & Swanepoel, P. A. (2023). Variability assessment of Bambara groundnut (*Vigna subterranean* L.) Verde landraces based on the qualitative trait seed coat colour. *South African Journal of Botany,* 163, 165 – 171. http://doi/10.1016/j.sajb.2023.10.052

Dodd, J., Sweby, P. K., Mayes, S., Murchie, E. H., Karunaratne, A. S., Massawe, F. & Tindall, M. J. (2023). A multiscale Mathematical model describing the growth and development of bambaranut. *Journal of Theoretical Biology (560).* https://doi.org/10.1016/j.jtbi.2022.111373.

Dvorak, P., Tlustos, P., Szakova. J., Cerny, J. & Balik, J. (2003). Distribution of soil fractions of Zn and its uptake by potatoes, maize, wheat and barley after soil amendment by sludge and inorganic Zn salt. *Plant, Soil and Environment,* 49, 203-212.

Egedigw – Ekeleme, C. A., Famurewa, A. C., Egedigwe, U. O., Onuora, C. A & Agbo, A. O. (2023). Comparative Studies on the amino acids pesticide residue content, biogenic and toxic element in an underutilized nut; Bambara groundnut *(Vigna subterranean). Journal of Trace Elements and Minerals* (3). https://doi.org/10.1016/j.jtemin.2023.100051.

Ekwere, O. J., Ndon, B. A. & Ndaeyo, N. U. (2017). Effects of some liming material sources and rates on soybeans *(Glycine max (L) Merril)* performance in an acid ultisol. In: Proceedings of the fourth national annual conference of the Crop Science Society of Nigeria. N. U. Ndaeyo, I. O. Udo G. N. Udom, E. E. Bassey and L. I. Akpheokhai (Eds.) University of Uyo, Nigeria, September 10-14, 2017, 94-99.

Elango, D., Devi, K. D., Jeyabalakrishnan, H. K., Rajendra, K., Haridass, V.K.T., Dhamaraj, D., Charuchandran, C.V., Wang, N., Fakude, M., Mishra, R., Vembu, K. & Wang, X. (2022). Agronomic, Breeding, and biotechnological interventions to mitigate heavy metal toxicity problems in Agriculture. *Journal of Agriculture and Food Research* (10). https://doi.org/10.1016/j.jafr. 2022.100374.

Hassen, A. I., Bopape, F. I., Vuuren, A. V., Gerrano, A. S. & Morey, L. (2023). Symbiotic interaction of Bambara groundnut (*Vigna subterranean)* landraces with rhizobia spp from other legume hosts reveals promiscuous nodulation. *South African Journal of Botany,* 160, 493 – 503.

Kumar, S., Dikshit, H. K., Mishra, G. P. & Singh, A. (Eds) (2022). Biofortification of staple crops. Singapore: Springer. Doi: 10.1007/978-981 – 16-3280-8.

Saboor, A., Ali, M.A., Hussain, S., El Enshasy, H. A., Hussain, S., Ahmed N., Gafur, A., sayyed, R. Z., Fahad, S., Danish, S. & Datta, R. (2021). Zinc nutrition and arbuscular mycorrhizal symbiosis effects on maize (*Zea mays L.)* growth and productivity. *Saudi Journal of Biological Sciences,* 28, 6339 – 6351.

Sukkaew, W., Thanachit, S., Anusontpornpern, S. & Kheoruenromne, I. (2022). Response of cassava (*Manihot esculanta* Grants) to calcium and potassium in a humid tropical upland loamy sand soil. *Annals of Agricultural Sciences,* 67, 204 - 210.

Talsma, E. F. (2014). Yellow cassava efficacy of provitamin: A rich cassava on improvement of Vitamin A status in Kenyan school children, 148. Wageningen, Netherlands: Wageningen University and Research.

Talucder, M. S. A., Ruba, U. B. & Robi, Md A. S. (2024). Potentiality of neglected and Underutilized species (NUS) as a future resilient food; A systematic review. *Journal of Agriculture and Food Research. https/doi.org/10.1016/j.jafr.2021.101116.*

Tells de Moura, O. V., Berbara, R. L. L., Torchia, D. F., Da Silva, H. F. D., Tolde castro, T. A. V., Tavares, O. C. H., Rodrigues, N. F., Zinta, E., Santos, L.A. & Garlia, A. C. (2023). Humic foliar application as sustainable technology for improving the growth yield and abiotic stress protection of agricultural crops: A review. *Journal of the Saudi Society of Agricultural Sciences, 22, 493 – 513.*

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21-25 OCT. 2024
PROCEEDINGS

Awareness on the Use of Information and Communication Technologies among Agricultural Extension Specialists in South West, Nigeria.

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Abstract
The study assessed the awareness on the use of ICTs by agricultural extension agents in South West, Nigeria. The specific objectives include describe the socio-economic characteristics of the agricultural extension agents and ascertain agricultural extension agents' awareness of ICTs use in their works. Primary data was used for the study and were collected through the administration of questionnaires. A multistage-stage random sampling technique was employed to select 120 agricultural extension agents from South Western Nigeria. Data collected were analyzed using descriptive. The results of the analysis revealed that majority of agricultural extension agents were between the ages of 41 – 50 years. A large proportion of the agricultural extension agents about 83.3% were male with only 16.7% female. Majority (75.0%) were married all (100%) of the agricultural extension agents in the study area had one form of formal education or the other, 47.7% of them had Bachelor Degree 8.3% had PhD. Majority (66.7%) of the agricultural extension agents have been in service above 21 years. 75.0% had grade levels of between 10 and 15. All (100%) of agricultural extension agents were aware in the use of one form of ICTs or another in performance of their duties. As a matter of policy, all agricultural scientists and extension agents must possess proven skills in the utilization of ICT facilities like computer, Internet and use of drone.
Keywords: agricultural extension agents, awareness, information and communication technologies

INTRODUCTION
The availability of agricultural information among its users for agricultural and rural development cannot be over emphasized. Agricultural information creates awareness among farmers about agricultural technologies for adoption which is needed for overall development of agriculture and for the improvement of living standard of farmers (Kehinde *et al*, 2015). Adequate awareness on any given innovation or technology is a key to the success in adoption and utilization of the technology. Therefore, for human performance to be effective and efficient some knowledge is needed on how, why and when certain things have to be done. The provision or availability of such knowledge is as important as its application to daily life. Agricultural extension agents as well as farmers need to get aware of the necessary information in order to improve methods in

activities, increase productivity and performance. However, awareness to effective channels of acquiring information can improve and enable individuals in knowledge which would also enable them to confront their predicaments. Agriculture being a discipline requires the awareness and access for information that its users would adopt in anticipation of the improvement in its various activities. The ICTs namely personal computers, the internet and mobile have the potentials to enhance farmers' ability to collate demands; collaborative learning; exchange of time sensitive information, for example, market prices and disease outbreaks; make extension systems and structures more efficient; engage farmers in assessing own needs, solutions; facilitating multi-stakeholder brainstorming; exploring alternative production technologies; facilitating access to markets and credits; training and demonstration; community learning; search, select and compile information for individual clients; early warning for disasters, weather forecast; and peer to peer sharing and exchange among extension (Umar et al, 2015). The specific objectives include describe the socio-economic characteristics of the agricultural extension agents and ascertain agricultural extension agents' awareness of ICTs use in their works.

METHODOLOGY

The study was conducted in South Western, Nigeria. This comprises of six states namely; Ekiti, Lagos, Ogun, Ondo, Osun and Oyo.

Primary data was used for the study

These were collected through the administration of questionnaires to agricultural extension agents in the study area.

Sampling Procedure and Sample Size

Multistage-stage random sampling technique was employed to select respondents for the study thus:

Stage I: The six states in the region were purposely selected for the study.

Stage II: 20 agricultural extension agents were selected from each state. The Table 1 below show the distribution of the respondents.

Table 1: Distribution of the respondents

S/N	States	No of Agricultural Extension Specialists	Percentage
1	Ekiti	20	16.7
2	Lagos	20	16.7
3	Ogun	20	16.7
4	Ondo	20	16.7
5	Osun	20	16.7
6	Oyo	20	16.7
	Total	**120**	**100.0**

RESULTS AND DISCUSSIONS

The result from table 2 shows that, majority (50%) of the agricultural extension agents were between the ages of 41 – 50 years while 4.2% were between the ages of 20 – 30 years. The results are in line with the findings of Umar 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 Awareness and Use of Information and Communication Technologies among Extension Agents in Kaduna State of Nigeria. Age may influence the use of ICTs because older persons including agricultural extension agents especially those living in rural areas may have the tendency of adhering to their already practiced old methods.

Table 2: Socioeconomic characteristics of respondents

Variables	Frequency	Percentage
Age (years)		
20- 30	5	4.2
31-40	40	33.3
41-50	60	50.0
51-60	0	0,0
61 and above	15	12.5
Gender		
Male	100	83.3
Female	20	16.7
Marital status		
Single	20	16.7
Married	90	75.0
Widow	9	7.5
Divorce	1	0.8
Educational qualification		
HND	40	33.3
B.sc	50	41.7
Masters	20	16.7
PhD	10	8.3
Duration in service (years)		
0-5	2	1.7
6-10	8	6.7
11-15	20	16.7
16-20	10	8.3
2 1and above	80	66.7
Grade level		
8-10	20	16.7
11-15	90	75.0
16 and above	10	8.3

The results of gender in Table 2 reveals that, majority (83.3%) of the composition of agricultural extension agents in the study area consist of male with about 16.7% female. This may be connected with gender disparity found in the public service in Nigeria. It also agrees with Umar et al., (2015) who reported that males dominated the agricultural workforce in Nigeria. Marital status of agricultural extension agents in Table 2 indicates that, majority (75.0%) of agricultural extension agents were married while 0.8 % were divorced. This is in line with findings of Kehinde et al, 2015. Adequate education enhances agricultural extension agents' understanding of use of ICTs and sources of information on improved innovation for agricultural practices. Table 2 indicates that majority (41.7%) of the respondents had Bachelor Degree while 8.3% had PhD. The finding of this study is in line with Umar et al, 2015 that indicated that the entire respondents had one educational qualification or the other and were therefore literates and could utilize ICTs to improve their work. Duration in service is the length of time measured in years that an individual had been in a particular profession or related activity that led to his/her increase in knowledge or skill Duration in service of agricultural extension agents in years is presented in Table 2. It shows that, majority (66.7%) of the agricultural extension agents have been in service above 21 years while 1.7% falls between the age range of 0 and 5 years. Based on Table 2, shows the grade level of agricultural extension agents in the study area. It reveals that majority (75%) had grade levels between 11 and 15 with only 8.3% falls between the grade levels of 16 and above. The grade level in any structure of service determines the amount of wage/salary and individual gets as reward for services rendered, it therefore implied that, agricultural extension agents with high grade levels would receive high salaries than those with lower grade levels. However, Omotosho, et al. 2012 reported low annual income of agricultural extension agents would affect their ability to afford information and commination technologies.

Agricultural extension agents' awareness of ICTs use in their performance of duties

Table 3 shows that all the agricultural extension agents were aware of use of ICTs in performance of their duties. The table 4 further reveals that, 100% of the agricultural extension agents in the study area show awareness of use of GSM mobile phone in their activities. Table 4 further reveals the distribution of agricultural extension agents on the basis of awareness of specific ICTs; it shows that, all (100%) of the agricultural extension agents in the study area show awareness of use of GSM mobile phone in their activities, 75% were aware of the use of computer and about 75% shows awareness for the use of internet in performance of their duties Similarly, majority about (41.7%), 66.7% and 91.7% showed unawareness for the use of CD-ROM, GIS and webcam respective in performance of their duties. The result is in line with the findings of Umar et al, 2015.

Table 3: Distribution of respondents by awareness of use of ICTs in performance of duty ICTs

ICTs	Frequency	Percentage
Aware	120	100
Not aware	0	0
Total	120	100

Table 4: Distribution of respondents' by awareness on specific ICTs

ICTs	Aware	Not Aware
Computer	75.0	25.0
Internet	75.0	25.0
CD Rom	58,3	41.7
GSM phone	100	0
GIS (Geographical Information System)	33.3	66.7
Webcam	8.3	91.7
Drone	1.7	98.3

CONCLUSION AND RECOMMENDATIONS

The following conclusions were drawn from the study. Majority of agricultural extension agents were middle aged and active and none below the age of 20 years. A large proportion of the agricultural extension agents in the study area were male. Majority were married with almost all of them having one form of education or another. Working experience of above 21 years is observed among the majority of agricultural extension agents, with more than half had grade levels of between 11 and 15 years. All of the agricultural extension agents were aware of the use of one form of ICTs or another in performance of their duties. It was observed in the study that a lot of extension specialists are not aware the use of drone Therefore, the study recommends as a matter of policy, all agricultural extension specialists must possess proven skills in the use of ICT facilities like computer and Internet to carry out their designated duties. This calls for in-service training on ICTs applications especially on the use of drone for all staff in agricultural extension agencies and establishments.

REFERENCES

Agwu, A. E., Adeniran, A. A., 2009, Sources of Agricultural Information Used by Arable Crop Farmers in Isale Osun Farm Settlement, Osogbo Local Government Area of Osun State. *Journal of Agricultural Extension*, *13* (1), 24 – 34

Kehinde, A. T., Ayobami, A. L., 2015, Training Needs Assessment on the Use of Social Media among Extension Agents in Oyo State, Nigeria. *Journal of Agricultural Informatics, 6* (1):100 - 111

Omotosho, K. F., Ogunlade, I. O., Muhammad, L., 2012, Assessment of Access to Information and Communication Technology among Agricultural Extension Officers in Kwara State, Nigeria, *Asian Journal Agriculture and Rural Development*. *2* (2): 220 – 225

Umar, S., Musa, M. W., Olayemi, Y. T., & Suleiman, R. (2015). Awareness and Use of Information and Communication Technologies among Extension Agents in Kaduna State of Nigeria. *Journal of Agricultural Extension*, *19*(1)

Effects of Leaf Blight Causing Fungi on Growth and Yield Parameters of C*itrullus lanatus* (Egusi melon)

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Abstract

Egusi melon (*Citrullus lanatus*) is an important vegetable crop in West Africa commonly cultivated for its nutrient-rich seeds and edible oil. Its production is hindered by leaf blight of which economic yield loss is not well documented. This study investigated the effects of three leaf blight pathogens: *Colletotrichum truncatum* (Ct), *Colletotrichum gloeosporioides* (Cg), and *Lasiodiplodia theobromae* (Lt) on the growth and yield parameters (GYP) of melon. Bara, Serewe, and Bojuri varieties artificially inoculated with the three blight causing fungi (TBCF) were evaluated on two field trials. The field was laid-out in a Randomized Complete Block Design with four replicates in a factorial experiment. Data were taken on GYP and analyzed using ANOVA at $p<0.05$. The effect of blight fungi on GYP of melon varied significantly ($P<0.05$) with pathogen and cultivar. In Serewe, only Lt significantly reduced melon's vine length (from 82.9±36.8 to 28.2±4.7 cm) and number of leaves (74.3±18.2 to 39.2±8.5). The TBCF significantly reduced the number of leaves and number of vines of Bara while only Ct and Lt reduced its vine length from 98.2±9.9cm to 42.4±7.7cm and 41.5±13.6cm, respectively. Meanwhile, none of the TBCF reduced the GYPs of Bojuri. The TBCF reduced the number of fruits per/plant (7.8±2.6 to 3.1±0.6) and weight of fruits/per plant (WFP) (8.0±5.0 to 1.6 ±0.9 kg) of Serewe cultivar. In Bara, the TBCF reduced five yield parameters whereas only Ct significantly reduced the WFP (3.1±0.8 to 1.2±0.8kg). The highest percentage seed yield reduction (95.7%) was observed in weight of seeds/plant (WSP) of Serewe by Lt, followed by 92.9% WSP reduction by the TBCF in Bara. These findings underscore a significant yield loss by blight causing Ct, Cg, and Lt in Serewe and Bara cultivars of *Citrullus lanatus,* indicating the need for effective disease management strategies.

***Keywords:* Egusi melon cultivars, Growth parameters, Colletotrichum truncatum, Lasiodiplodia theobromae**

INTRODUCTION

Citrullus lanatus (Thumb) Mansf.) (melon) is one of the most important indigenous vegetables in West Africa. It is usually referred to as Egusi in Nigeria. Nigeria is the leading producer of Egusi melon seeds, accounting for about 60% of the global annual production of 0.93 million tons (FAOSTAT, 2020). The most common Egusi melon cultivars in Nigeria are "Bara", "Serewe" and "Bojuri". Bara cultivar has the widest distribution in Nigeria, the most prominent in the Southwest and Northern regions (Denton & Olufolaji, 2000). The crop plays a vital role in income generation for subsistence farmers in Nigeria. The seeds are extensively used as a thickening agent for sauces and 'egusi' soup, in melon ball snacks ("robo" in Yoruba), and as a fermented melon seed condiment ("ogiri" in Yoruba) for seasoning (Denton & Olufolaji, 2000). Meanwhile, there is a decline in its production mainly due to disease infection. Leaf blight is one of the major constraints to melon production in Southwest Nigeria. This disease has been reported to be caused by *Didymella bryoniae,* (Kehinde, 2011), and *Colletotrichum truncatum, Colletotrichum gloeosporioides,* and *Lasiodiplodia theobromae*; (Ogunsola et al., 2020). There is however lack of documented evidence of the economic effect of the disease on the crop. Evaluating of the effects of leaf blight disease on melon will enhance effective management of the crop for high yield and productivity. The objective of this study was to determine the effects of leaf blight causal pathogens (*C. truncatum, C. gloeosporioides,* and *L. theobromae* on the growth and yield parameters of Egusi melon.

MATERIAL AND METHODS

Sources of materials

Three Egusi melon cultivars: Bara, Serewe, and Bojuri were obtained from the National Center for Genetic Resource and Biotechnology (NACGRAB), Moor Plantation, Ibadan, Nigeria. The leaf blight pathogens: *C. truncatum, C. gloeosporioides,* and *L. theobromae* used were isolated from infected Egusi melon leaf samples collected from a leaf blight survey of five States in Southwestern Nigeria (Ogunsola et al., 2020).

Planting, plant inoculation, and field management

The study site was the research field of the National Cereal Research Institute (NCRI), Moor Plantation, Ibadan. The experimental design was a RCBD in a 3 (cultivars) by 4 (pathogen treatments) factorial experiment with 4 replicates. The field was 40 x 36 m with the total area of 1440 m^2. There were six blocks, each divided into four plots of 14 m x 4 m, each split by a 2 m alley for inoculated and un-inoculated plants. There were 24 plants per plot. Test seedlings were artificially inoculated with spore suspension of three fungal isolates. Inoculation was performed 14 days after planting by spraying the adaxial and abaxial surfaces of the two youngest fully expanded leaves with a fungal spore suspension of 2.1×10^6 spores/ml until runoff, using a hand-operated sprayer. There were four treatments, three inoculated plants with the three fungi and a control. Weeds were manually controlled (Kehinde, 2008). The study was in two trials at both early and late season cropping of 2019.

Assessment of effects of leaf blight disease on growth parameters of melon varieties

The plants were visually examined for leaf blight symptom from a week after inoculation (WAI) to confirm disease establishment. The effect of blight fungi on the growth parameters of melon varieties was assessed by taking a weekly data of the vine length (cm) using a meter rule, counting the number of leaves, and number of vines. The data were taken on both inoculated and uninoculated plants from the third to fifth week after planting (WAP).

Effects of leaf blight disease on the yield parameters of melon varieties

At maturity, all fruits were manually harvested and processed. The effect of blight pathogens on the yield parameters was investigated by taking data on six parameters: number of fruits per plant, weight of fresh fruit per plants (kg), weight of seeds per fruits (g), weight seeds per plant (kg), number of fruits per hectare, and weight of seeds per

hectare (kg). The fruits were weighed immediately after harvest. Percentage seed yield reduction was calculated using the formula: $\text{Percentage yield reduction} = \frac{\text{WC}-\text{WI}}{\text{WC}} \times \frac{100}{1}$
Where, WC = Weight of seed per plant for control, WI = Weight of seed per plant for inoculated plants

Data analysis
Data on growth and yield parameters were subjected to ANOVA using the PROC GLM statement of Statistical Analysis System (SAS, 2008). The means were separated by Students Newman Keuls at $p < 0.05$.

RESULTS AND DISCUSSION
The seeds of the three melon cultivars germinated at 5 days after planting. The *C. truncatum, C. gloeosporioides*, and *L. theobromae* produced leaf blight symptoms on some of the three cultivars which appeared from the fourth WAI.

Effects of leaf blight pathogens on growth parameters of melon varieties
The cultivars varied significantly ($P < 0.05$) in their response to the leaf blight disease in which Serewe and Bara showed significant reduction in growth parameters by all or at least one of the three fungi whereas Bojuri did not (Table 1). In Serewe, only *L. theobromae* significantly reduced melon's vine length (from 82.9±36.8 to 28.2±4.7 cm) and number of leaves (74.3±18.2 to 39.2±8.5) whereas the three fungi did not reduce the number of vines. All pathogens significantly reduced the number of leaves and number of vines of Bara while only *C. truncatum* and *L. theobromae* reduced its vine length from 98.2±9.9cm (negative control) to 42.4±7.7cm and 41.5±13.6cm, respectively.

Effects of leaf blight causal organisms on the seed yield parameters of melon
The three blight pathogens also produced varied effects on the yield parameters of *Citrullus lanatus* depending on the pathogen and cultivar ($P < 0.05$). Similar trend to the growth parameter was observed in the yield parameters in which the pathogens significantly reduced yield traits in Serewe and Bara whereas that of Bojuri was not reduced (Table 2). The blight fungi significantly and similarly reduced the number of fruits per plant of Serewe from 7.8±2.6 (negative control) to 3.1±0.6 (by *C. gloeosporioides),* 3.3±0.5 (*L. theobromae*) and 3.6±1.3 (*C. truncatum*). They also reduced the weight of fruits/plant from 8.0±5.0 to 1.6±0.6 (*C. truncatum),* 2.1±0.1 (*C. gloeosporioides),* and 2.7±0.8 (*L. theobromae*) of this cultivar. For Bara, the three blight causing fungi caused significant reduction in all the six yield parameters evaluated with the exception of weight of fruits per/plant which was only reduced by *C. truncatum* from 3.1±1.1 to 1.2±0.8 kg. The blight producing fungi caused percentage seed yield reduction of between 0 and 95.7 in the three melon cultivars (Table 3). The highest yield reduction (95.7%) was observed in weight of seeds per/plant of Serewe by *L. theobromae*, followed by 92.9% reduction in same parameter in Bara by the three pathogens. Reduction of weight of seeds per/fruit of Bara by *C. truncatum* (57.1%), *C. gloeosporioides* (42.9%), and *L. theobromae* (53.6%) was also observed.

Table 1: Effects of leaf blight causing fungi on the yield parameters[a] of *Citrullus lanatus* cultivars

Cultivar	Pathogen	No. fruits /plant	Wt fruits /plant (kg)	Wt seeds /fruit (g)	Wt seeds /plant (kg)	No fruits /hectare	Wt seeds /hectare (Kg)
Serewe	*Colletotrichum truncatum*	3.6±1.3b	1.6±0.6b	70.0±0ab	1.3±1.0a	19000±5484a	591.9±97.4a
	C. gloeosporioides	3.1±0.6b	2.1±0.1b	105.0±5.8a	0.9±0.6a	11256±6745a	620.0±124.1a
	Lasiodiplodia theobromae	3.3±0.5b	2.7±0.8b	65.0±5.8b	0.1±0a	16250±2598a	515.0±242.5a
	Negative Control[b]	7.8±2.6a	8.0±5.0a	95.0±36.9ab	2.3±1.4a	20438±2909a	749.4±118.9a
Bojuri	*Colletotrichum truncatum*	3.1±1.4a	1.1±0.9a	110.0±11.5a	1.1±0.9a	14625±7938a	951.9±241.8a
	C. gloeosporioides	2.8±1.4a	1.8±0.3a	100.0±11.5a	0.2±0a	14000±6928a	877.5±470.5a
	Lasiodiplodia theobromae	2.4±0.6a	1.7±0.5a	85.0±28.9a	0.2±0a	11750±2887a	823.8±59.2a
	Negative Control	3.0±1.4a	2.1±0.2a	112.5±35.9a	0.7±0.4a	14894±7167a	916.3±433.3a
Bara	*Colletotrichum truncatum*	2.6±1.1b	1.2±0.8b	65.0±0.1b	0.1±0b	15250±2598b	416.3±24.5b
	C. gloeosporioides	3.7±0.4b	2.6±0.2ab	80.0±11.5b	0.1±0b	18500±1732b	653.1±163.8b
	Lasiodiplodia theobromae	3.4±0.2b	2.5±0.2ab	60.0±0.1b	0.1±0b	17000±866b	709.4±243.2b
	Negative Control	5.8±1.1a	3.1±0.8a	140.0±45.5a	1.4±0.4a	23000±3048a	1243.1±129.7a

[a]No. fruits, number of fruits; Wt seed, weight of seeds; Wt fruit, weight of fruits. Mean values with the same letters along each column for each cultivar are not significantly different according to Student Newman Keuls (P<0.05)

Table 2: Percentage seed yield reduction of *Citrullus lanatus* cultivars by leaf blight causing fungi

Cultivar	Pathogen	Weight of seeds /fruit	Weight of seeds /plant	Weight of seeds /hectare
Serewe	*Colletotrichum truncatum*	26.3	43.5	21
	C. gloeosporioides	0	60.9	17.3
	Lasiodiplodia theobromae	31.6	95.7	31.3
Bojuri	*Colletotrichum truncatum*	2.2	0	0
	C. gloeosporioides	11.1	71.4	4.2
	Lasiodiplodia theobromae	24.4	71.4	10.1
Bara	*Colletotrichum truncatum*	57.1	92.9	0
	C. gloeosporioides	42.9	92.9	47.5
	Lasiodiplodia theobromae	53.6	92.9	42.9

The effect of three leaf blight disease pathogens on the growth and seed yield of three egusi melon varieties were evaluated in two field trials. Both *L. theobromae* and *C. truncatum* caused a significant growth reduction in the Bara and Serewe. The results indicated higher susceptibility of Bara and Serewe to the three blight causing fungi while the growth and yield parameters of Bojuri were not reduced despite the development of blight symptoms. The highest yield reduction (95.7%) was observed in weight of seeds per/plant of Serewe by *L. theobromae*, followed by 92.9% reduction in the same parameter in Bara by the three fungi. Although, the ability of the three fungi to produce leaf blight have been reported, there is scarcity of information on their capacity to reduce the yield of melon cultivars. This study thus provided evidence of economic yield loss of *Citrullus lanatus* varieties by *C. truncatum, C. gloeosporioides,* and *L. theobromae* causal organisms of leaf blight. Yield loss by these pathogens on other crops have been earlier reported. A significant reduction in seed germination, seed quality, and yield of soybeans by *C. truncatum* was reported (Manandhar & Hartmans, 1999). Severe yield losses in melons have also been observed in Thailand and India due to anthracnose caused by *C. truncatum* (Manandhar & Hartman, 1999). The inability of the three leaf blight pathogens to significantly reduce growth and yield parameters in Bojuri cultivar might be attributed to the genetic potential of the cultivar to tolerate blight disease and possibility of the presence of antifungal secondary metabolites. The delayed onset of blight symptoms in the cultivars till 4 to 5 weeks after planting, might allow the plants to develop some tolerance to these pathogens over time according to Odubanwo et al. (2013). The broad leaf morphology of the Bojuri cultivar, unlike the other two, might have also reduced the length of exposure to the isolate activity in the plant. Mossler & Nesheim, (2005) emphasized that yield losses correlate with disease severity and the duration of plant exposure to infection. The varied effect of the pathogens on the growth and yield of the melon cultivars also suggests differences in the aggressiveness or virulence of the blight pathogens as well as the genetic variation and defense mechanisms of the cultivars. These sstudy provided a yield reduction of 0 to 95.7% by leaf blight disease on melon cultivars in Nigeria. This will be useful in developing effective management measures for the control of the disease. Planting Bojuri cultivar can also be recommended for locations with high leaf blight infection depending on the preference of the cultivar.

CONCLUSION AND RECOMMENDATIONS

This study proven the ability of leaf blight pathogen: *C. truncatum, C. gloeosporioides,* and *L. theobromae* significantly reduced the growth and yield parameters of Serewe and Bara melon cultivars. The three fungi only produced blight symptom on Bojuri but did not significantly impair its growth and yield parameters. These results underscore a significant yield loss by blight causing the blight causing fungi on Serewe and Bara cultivars of melon necessitating the need for effective blight disease management measure.

REFERENCES

Berkane, A., Cruenca-Estrella, M., Gomez-Lopez, A., Petrikkou, E., & Mellado, E. (2002). Comparative evaluation of two different methods of inoculum preparation for antifungal susceptibility testing of filamentous fungi. *Journal of Antimicrobial Chemotherapy,* 50(5), 719-722

Denton, L. & Olufolaji, A. O. (2000). Nigeria's most important vegetable crops. In: Agronomy in Nigeria M.O. Akoroda (ed). University of Ibadan. Pp 85-93.

FAOSTAT (2020). "Food and Agriculture Organization, Statistical database", Rome: Food and Agricultural Organizations of the United Nations. Accessed 25 February 2024

Kehinde, I. A. **(**2008). Identification and control of field and storage fungal pathogens of Egusi melon: *Citrullus lanatus* (Thumb) Mansf. in Southwestern Nigeria. PhD. Thesis. Dept. of Crop Protection and Environmental Biology, University of Ibadan. 211pp.

Kehinde, I. A. (2011)**.** Response of melon cultivars to natural infection by diseases in Southwestern Nigeria. *International Journal of Biology,* 3(4), 47-55

Manandhar, J. B. & Hartman, G. L. (1999). Anthracnose. In: Hartman, G.L. Sinclair, J.B., & Rupe, J. C (eds) *Compendium of Soybean Diseases.* 4th edition. St. Paul, APS Press, USA. Pp; 13-14.

Mossler, M. A & Nesheim, O. N. (2005). *Florida crop/pest management profile*: Squash Electronic Data Information Source of UF/IFAS Extension (EDIS). CIR.1265. [Online] Http/edis.ifas.ufl.edu/. Retrieved June. 5, 2024.

Odubanwo, B.O., Popoola, A. R., Ojo, D. K. & Ganiyu, S.A. (2013). Yield performance of soybean accessions onfield naturally infected with bacterial pustules (*Xanthomonas axonopodis* pv. glycinea) *African Crop Science Conference proceedings* 11, 309-315

Ogunsola, J.F., Ikotun, B., & Ogunsola, K.E. (2020). Incidence of leaf blight disease of Egusi melon in South-West Nigeria. *African Crop Sciences Journal* 28(2), 255–265. https://doi.org/10.4314/acsj.v28i2.10

Ogunsola, J. F. & Ogunsola, K. E. (2023). Antifungal activity of *Phyllanthus amarus Passiflora foetida* and *Costusafer* against Colletotrichum species causing leaf blight on *Citrullus lanatus* (Egusi melon). *Journal of Plant*

Diseases and Protection. 130(2), 301-313. https://doi.org/10.1007/s41348-022-00690-9

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Early Application of Brassinolides Improved Performance and Yield of Bambara Groundnut (V*igna subterranea* L. Verdc) in Southeastern Rainforest Agro-Ecology

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Abstract
Evaluation of the effectiveness of brassinolide, sprayed at different growth stages on the performance of bambara groundnut, was carried out in a Screen house, in the 2015 early cropping season, at the University of Calabar Teaching and Research Farm, Calabar, Southeastern rainforest agro-ecological zone of Nigeria. Four treatments described as; zero spray (control), spraying at the seedling (3WAP), vegetative (6WAP) and flowering (9WAP) stages respectively, were laid out in a randomized complete block design and replicated thrice. Data on crop growth and yield parameters were analyzed using GenStat 10.3 DE edition (2011), and post-hoc test on significant treatment means utilized Fisher's Least Significant Difference (F-LSD) ($P \leq 0.05$). From results, significant ($P \leq 0.05$) effects of treatments on plant height, number of leaves, canopy spread, leaf area index, petiole length, days to 50 % flowering, number of pods per plant, pod length, seed weight per plant, dry matter yield and seed yield per hectare in both screen house and field experiments were observed. Brassinolide sprays at the seedling stage resulted in significantly ($P \leq 0.05$) taller plants, with more branches and highest number of leaves, canopy spread and leaf area index. This was followed by spraying at the vegetative stage, flowering stages with the least values from the control. Plants sprayed at the seedling stage also produced the highest number of pods per plant, largest seed sizes and weight per plant, highest dry matter yield and highest seed yield per hectare in both screen house and field experiments. Screen house trial yield was of the order: seedling stage ((1.07 t/ha) > vegetative stage (0.73 t/ha) > flowering stage (0.25 t/ha), corresponding to 55.73, 46.20 and 22.13 %, respectively. Brassinolide spraying is more effective during early plant growth.
Keywords: Climate proofing, plant hormones, food security, yields

INTRODUCTION

Brassinolides (BRs) are steroidal and natural phytohormones, ubiquitous in the plant kingdom. Generally, they are referred to as plant growth regulators or hormones which can affect a wide range of developmental processes in plants, such as germination, rhizogenesis, growth, flowering, and fruit setting (Awais *et al*., 2023). Under normal conditions, EBL stimulates various plant metabolic processes including ATP synthesis, ROS metabolism, biosynthesis of nucleic acid, and CO_2 assimilation. Moreover, it regulates various key enzymes involved in photosynthesis, cell cycle, and homeostatic response in plants (Siddiqui *et al*., 2018). Even though EBL's mechanism of action in plants is not fully understood yet, it is recommended as environmentally safe, eco-friendly and exogenously applicable on leafy plants by a number of international organizations (EFSA, 2020). Considering the commercial application of EBL in agriculture as a potential strategy to enhance growth and yield is still relatively new and unexplored. Furthermore, crop-specific response to exogenous application of EBL and optimum dose needs to be further evaluated. Bambara groundnut or Bambara nut (*Vigna subterranean* (L.) Verdc; *syn Voandzeia subterranean* Thousars) is an annual pulse, and a member of *Fabaceae* family. It is of immense potential in enhancing food security especially in drought prone agricultural systems as an intercrop with cereals (Linnemann, 1988). It is drought resistant in nature, growing successfully below 500 mm rainfall conditions per annum. However, under very low rainfall, it is susceptible to the risk of total crop failure (Sessay and Sungu, 2000). Bambara groundnut is an extremely adaptable to hot dry climate and marginal soils (Azam-Ali, *et al*., 2001), and highly tolerant to pests and diseases, and can be produced easily with minimal inputs (Ntundu *et al*., 2006). Bambara groundnut is the most neglected and under-researched of all the grain legumes widely cultivated in Nigeria. The crop has remained at peasant level, despite its long history of cultivation in Africa (Tanimu & Aliyu, 1997). Food shortages presently being experienced due to rising human population indicates that not only the production of popular staples be increased but that the hitherto neglected crops like bambara groundnut be accorded adequate attention for enhanced productivity. One of the present research efforts is geared towards yield improvement. This study therefore sought to evaluate the effects of brassinolide on the performance and yield of Bambara nut.

MATRIALS AND METHODS

Screen house and field experiments on Bambara groundnut were conducted at the Faculty of Agriculture Teaching and Research Farm, University of Calabar during the 2015 late cropping season from August-December (04^o – 57’N and longitude 08^o – 19’E, 37 m ASL). The BL (24-epibrassinolide) was obtained from Xenan Xinyu Chemical Technology Company Limited (Ltd), Henan Province, China. Cream coloured Bambara groundnut landrace (Black eye) seeds were obtained from the Department of Crop Science, University of Agriculture, Makurdi Benue State, Nigeria. Plastic buckets (96 cm wide and 32 cm deep), were used to plant Bambara groundnut seeds in the screen house. The buckets were base perforated for drainage, filled with 6.5 kg top soil collected from the site of the field experiment, leaving about 5 cm to the brim of the buckets. A solution of brassinolide was prepared and applied according to the manufacturer’s specification. A spray solution was made by dissolving 12.5g of the nutrient in 10 litres of clean tap water. Two seeds were sown in each bucket and thinned to one per bucket one week after emergence. Before sowing, the buckets were watered adequately with twenty liters of water and left overnight before planting the following day. A group of six buckets arranged in three rows of two buckets each constituted a unit plot in the screen house experiment and the middle row was used for sampling. Regular watering with twenty-five liters of water once a week was carried out in the screen house to prevent moisture stress since the experiment was not exposed to natural rainfall. Spraying of plants was done between 8 am and 9 am each time using a knapsack sprayer. Spraying was done in such a way that sprayed plants were completely drenched and the time of spraying was according to the recommendation of the manufacturer to have good result. Data were collected for growth and yield variables, analyzed using GenStat 10.3 DE edition (2011), and post-hoc test on significant treatment means utilized Fisher’s Least Significant Difference (F-LSD) ($P \leq 0.05$)

RESULTS AND DISCUSSSION

The physico-chemical properties of the soil at the experimental site before planting are shown in Table 1. The soil had high sand content, low total Nitrogen below critical value, with base saturation of 88.0%. Sandy soils are basically poor in nutrient sufficiency and water retention for cropping and are often marginal soils. Results (Table 2) indicate that plant height, leaf area index and petiole length at 15 weeks after planting (WAP) were significantly higher ($p<0.05$) for seedlings that received BR treatments than for other periods of treatment application. Flowering occurred earlier when BG was treated with BR at seedling stage, immediately followed by BG that received BR at 6 WAP, compared to all others. Control and spraying at 9 WAP were not different for days to flowering ($p>0.05$). The dry matter was significantly higher for BG that received BR at seedling stage and this translated into significantly higher seed yield (1.92 t/ha), with the control (Zero BR) being the least of all parameters recorded (Table 2). The significant increase in the height of bambara groundnut in plots treated with BR compared with the control where BR was not applied may be attributed to the promotion of cell expansion and cell elongation by the hormone. This agrees with the findings of Hola (2010) who reported that BR increased the height of "two field grown inbred lines of maize" (*Zea mays* L.) during the vegetative and early reproductive phases of their development, when BR was applied during the early growth stage. BR application at seedling stage was most effective on all parameters assessed, and the effectiveness decreased as the plants grew older. Enhanced crop growth obtained by early application of BR could be due to the boosting effect of the growth hormone at the time biological N fixation had not commenced effectively and the plants were still depending on native N content of the soil which was very low. The effectiveness of BR when applied at the seedling stage was reflected in increased plant height, leafiness, which had positive effects on soil moisture conservation, high weed smothering capacity and creation of microclimatic conditions that could enhance rapid growth of the crop. Plants that did not receive BR at early stages obviously suffered from nutrients stress and exhibited reduced growth which was absent in plants treated earlier. This agrees with Vadhini and Rao (1998) who reported the BRs induced growth promotion was found to be associated with increased levels of carbohydrates, soluble protein and nucleic acids that initiate early healthy growth and development. Early application of BR did not only stimulate vegetative growth, but also improved dry matter yield (both seed and shoot dry matter) of bambara groundnut as was also reported by Arteca and Arteca (2001) and Nakaya *et al.* (2002). BR-induced plant growth has been reported to be associated with increased metabolic activities like the photosynthetic process (Sairam, 1994), protein synthesis and nucleic acid production (Sengupta *et al*., 2011). The significant increase in number of pods per plant, pod length, seed weight per plant, dry matter yield (root and shoot inclusive) and seed yield obtained could be attributed to enhanced metabolic activities of the treated bambara groundnut plants.

CONCLUSION AND RECOMMENDATIONS

The stage of spraying significantly ($P \leq 0.05$) affected both the growth and yield components measured. Bambara groundnut plants sprayed BR at seedling stage had significantly ($P \leq 0.05$) higher growth and yield parameter values in the experiments. This suggests that spraying BR at the seedling stage is more beneficial for optimal performance of bambara groundnut and should be inculcated into Bambara groundnut production.

REFERENCES

Awais, A., El-Kamil, T., Thobayet, S., Alshahrani, S., & Seleiman, M. F. (. 2023). Enhancement of morphological and physiological performance of *Zea mays* L. under saline stress using ZnO nanoparticles and 24-epibrassinolide seed priming. *Agronomy*, 13:771. doi: 10.3390/agronomy13030771.

Siddiqui, H., Ahmed, K. B. M., & Hayat, S. (2018). Comparative effect of 28-homobrassinolide and 24-epibrassinolide on the performance of different components influencing the photosynthetic machinery in *Brassica juncea* L. *Plant Physiology & Biochemistry,*129:198–212. doi: 10.1016/j.plaphy.2018.05.027.

European Food Safety Authority (EFSA) (2020). Anastassiadou M., Arena M., Auteri D., Brancato A., Bura L., Carrasco Cabrera L., Chaideftou E., Chiusolo A., Marques D.C., *et al*. Peer review of the pesticide risk assessment of the active substance 24-epibrassinolide. *EFSA Journal*, 18:e06132. doi: 10.2903/j.efsa.2020.6132.

Linnamann, A. R. (1988). Cultivation of bambara groundnuts vogue Subterianea L. Verdc. In Northern Nigerian Tropical Communication, 15: 1-4.

Sessay, A. & Zungu, H. (2000). Estimating leaf area per plant in Bambara groundnut (*Vigna subterranean*) using leaf numbers and leaf weight. *UNISWA Research Journal of Agricultural Science and Technology*, 3(7): 63-65.

Arteca, J. M. & Arteca, R. N. (2001). Brassinosteroid induced exaggerated growth in hydroponically grown *Arabidospsis* plants. *Physiology of Plant*, 112:104-112.

Azam, Ali, S. N., Aguilar-Manjarrez, J. & Bannayan-Avval, M. (2001). A global mapping system for Bambara groundnut production. *FAO Agricultural Information Management Series*, 1.

Ntundu, W. H., Shillah, S. A., Marandu, W. Y. F. & Christiansen, J. L. (2004). Morphological diversity of Bambara groundnut (*Vigna subterranea* (L.) Verdc). Landraces in Tanzania. *Genetic Resources and Crop Evolution*, 53(2): 367-378.

Tanimu, B. & Aliyu, L. (1997). Country Reports – Northern Nigerian. In: J. Heller, F. Begeman and J. Mushonga (eds.) Bambara groundnut (*Vigna subterranea* (L.) Verdc). Proceedings of the workshop on conservation and improvement of Bamabara groundnut (*Vigna subterranea* (L.) Verdc) 14-16 November, 1995, Harare, Zimbabwe (pp. 45-49) 4, Biodiversity International.

Hola, D., Rohova, O., Kocova, M., Kohout, L. & Kvasnica, M. (2010). The effect of brassinolides on the morphology development and yield of field-grown maize. *Plant Growth Regulation*, 61: 29-43.

Vardhini, B. V. & Rao, S. S. R. (1998). Effect of brassinosteroids on growth, metabolite content and yield of *Arachis hypogaea*. *Phytochemistry*, 48: 927-930,

Nakaya, M., Tsukaya, H., Murakama, N. & Kato, M. (2002). Brassinosteroids control the proliferation of leaf cells of *Arabidopsis thaliana*. *Plant Cell Physiology*, 43: 239-244.

Sairam, R. K. (1994). Effect of homobrassinolide application on plant metabolism and grain yield under irrigated and moisture – stress conditions of two wheat varieties. *Plant Growth Regulation*, 14: 173-181.

Sengupta, K., Banik, N.C., Bhui, S. & Mitra, S. (2011). Effect of brassinolide on growth and yield of summer green crop. *Journal of Crop and Weed*, 7(2): 152-154.

Table 1: Physico-chemical characteristics of the soil before planting and post harvesting at the experimental site

Physical and chemical properties	Pre-planting
Physical Properties	
Sand (%)	73.0
Silt (%)	16.0
Clay (%)	11.0
Texture	Sandy soil
Chemical Properties	
pH	5.2
Total Nitrogen (%)	0.10
Available Phosphorus (mg/Kg)	33.25
Organic Matter (%)	2.12
Exchangeable Potassium (cmol/Kg)	0.11
Exchangeable Calcium (cmol/Kg)	4.1
Exchangeable Magnesium (cmol/Kg)	2.0
Exchangeable Sodium (cmol/Kg)	0.09
Aluminum ion (cmol/Kg)	0.68
Hydrogen ion (cmol/Kg)	0.16
Exchangeable Cation Exchange Capacity (ECEC)	7.14
% Base saturation (Bs)	88

Table 2: Effect of spraying stages of BR (plant hormone) on some growth and yield variables of bambara groundnut (*Vigna subterranean* (L.) Verdc)

Growth variables at 15 WAP						
Treatment	Plant ht. (cm)	Leaf area index	Petiole length (cm	50% flowering	Dry matter (g)	Seed yield kg/ha
Control (no spray)	33.68	0.508	2.74	50.60	17.70	0.85
Spraying @ 3 WAP	53.60	0.637	3.44	48.10	19.81	1.92
Spraying @ 6 WAP	40.88	0.621	3.01	49.20	18.62	1.58
Spraying @ 9 WAP	35.46	0.542	2.74	50.80	18.03	1.12
$LSD_{0.05}$	4.44	0.014	0.25	1.80	0.80	0.25

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Analysis of Climate Change Adaptation Measures in Rice Producing Areas in Niger State

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Abstract
The study examined the adaptation measures used by the rice producers in Niger State, Nigeria. A multistage random sampling method was employed to choose 150 rice producers (25 male 25 female each from zones A) of Niger State. The study make used of primary data , like group interview, personal phone calls, and questionnaire, which were administer to rice producers. The result shows that the adaptation measures used by rice producers include planting early maturing rice varieties, drought pest disease resistant varieties, early planting, pre – rain planting and late rain irrigation planting. Though few of the respondents have access to extension services, hence the study suggested providing for the rice producers enough extension knowledge, carrying out research on those adaptation measures adopted by rice producers to get the farmers acquainted with the scientific methods of practicing climate smart agricultural methods, putting in place financial and technical support to assist the producers in using those methods in modern ways to suit these climate changes in the study area..

Keywords: Climate change, rice production, adaptation, measures and extension services.

INTRODUCTION

Climate change has become serious issue as flooding, intermittent breakage of rainfall or drought is seen across the country in current years. Climate change especially in cultivated crops particularly in rice including root and tuber crops differ from decrease in taste and value and even low yield including land degradation. Climate is not longer more reliable like before when season is delineated with clear dry and raining seasons separately (Okonze 2012). Even though majority of the farmers still depend on this scanty climate signs for crop production leading to waste of crop materials. NIMET (2012), argued that weather related disasters may ramify everywhere in few years to come if the trend of climate changes is allow to go on without mitigation. Investigation has revealed that climate change trend is fast increasing. This calls for urgent means of finding solutions to the ugly situation. If cannot be completely avoided but should be minimized. Researchers from different parts of the country have difference measures of mitigating climate change. Adaptation may reduce unwanted impacts of climate change although these adaptations were not given serious attention. The adaptation measures used by rice producers in the study area include planting early maturing rice varieties, use drought pest disease resistant varieties, early planting, pre – rain planting and late rain irrigation planting

According to Nandi *et al* (2012) rice seem to be the most vital world's food crop, being the most consumed food for over 50% of the world population, particularly Philippine, china, India and many other countries in Africa and Asia. Rice is the most popular eaten food across the all zones in Nigeria irrespective of economic classes. Consumption of rice continue to increase in Nigeria due to higher preference of consumers for rice, rapid population increase, urbanization and increase in income level (Kamai *et al.,*2020). These measures are all related to irrigate rice production in the study area. In Nigeria irrigated rice farming has long time history, since colonial era but was not recognized not until during the starvation and drought of seventies that much effort were made to irrigation system in Nigeria (Balogun*,et al.* 2021). Irrigated rice production in Nigeria become more operational with the introduction of Anchor Borrowers program which increase rice production in Nigeria and reduce the poverty level of small farm holders in the country drastically (Abdulmumini, 2021).

MATERIALS AND METHODS

The research was carried out in Katcha, Badeggi, Chanchaga and Rabba communities in zones A of Niger State which is located in southern Guinea savannah within latitudes 6^0 30'.and 11^0 20' N and Longitudes 2^0 30' and 10^0 30' E. These local communities are areas where crop production is main occupation especially rice production as the major source of income. The study area has many rice producers as their major occupation.. The study area has November – April as dry and May – October as raining seasons. The temperature range between 36^0 and $37^{c..}$ The impact of climate change has greatly affected the production of rice in the study area. The sampling size for the research was obtained using a multistage random sampling method that includes stage one and two. The first stage 3 local governments were randomly selected and one community chosen from each local government. These are Badeggi in Katcha local government, Chanchaga village in Lavun local government and Rabba in Mokwa local government. The second stage was selection of 50 rice farmer (25 male and 25 female) from each local government given a total of 150 rice producers. Descriptive statistics like frequency distribution, percentages mean and standard deviation were used to summarize the data.

RESULT AND DISCUSSION

Socioeconomic characteristics of rice farmers.

Table 1 shows the component of various factors for both male and female rice farmers. The variable considered were age farm size, marriage status, educational status, family size, farming experience, membership of the co-operative, annual income and access to extension services. The result depicts the age range of male to be 41 - 50 years while females were within the ranges of 51 to 60 years having 40% each in these categories, Average ages of male was 47 as against female which was 49. Majority of male have secondary education while female have primary with 44% and 40% respectively In the similar way both male and female have family sizes of between 6-10 and 1-5 persons equivalent to 46.6% and 40% for male and female respectively. Farm size depicted that majority of male have between 3-4 hectares 46.6% while 46.6 of the female have between 1-2 hectares been the majority. The result also show that 80% of both male and female producers were married but reverse is the case with been the member of cooperative society with male having majority as member and female having majority as non-member of cooperative with 68% and53.3% respectively. In farming experience category majority of male have farming experience of 21-30 years (40%) and female have experience of 1-10 years (66.6%). This indicated that some of the male were even born in farming. The result also revealed that majority have no access to extension services as the data show that 97.3% and 93.3 of both male and female have no access to extension and have average annual income of 201,000-300,000 naira. The data have similarities in the result but with notable dissimilarities in socioeconomic factors particularly in farm size and farming experience.

Table 1: Socio- economic characteristics of respondents (n- 150)

Variable	Male		Female	
	Frequency	Percentage	Frequency	Percentage
Age (years)				
30 – 40	25	33.3	17	22.6
41 – 50	30	40	25	33.3
51 – 60	15	20	30	40
61 – 70	5	6.6	3	4
Mean	38	25	38	25
Education				
Primary	20	26.6	30	40
Secondary	33	14	25	33.3
Tertiary	7	9.3	15	20
Non- formal	10	13.3	5	6.6
Farm size (ha)				
< 2	15	20	35	446.6
2 – 4	35	46.6	20	26.6
5 -6	20	26.6	5	6.6
Above6	5	6.6	15	20
Family size				
1-5	25	33.3	30	40
6-10	35	46.6	28	37.3
>10	10	22.6	17	22.6
Marital status				
Single	5	6.6	2	4
Married	60	80	60	80
Divorced	5	6.6	3	4
widowed	5	6.6	10	13.3
Member of				
cooperative	51	68	35	46.6
Yes	24	32	40	53.3
No				
Farming experience				
1 – 10	10	13.3	50	66.6
11 – 20	10	13.3	15	20
21 – 30	30	40	8	10.6
31 – 40	25	33.3	2	2.6
Access to extension				
No	73	97.3	70	93.3
Yes	2	2.6	5	6.6
Annual income				
100,000 – 200,000	5	6.6	3	4
201,000 – 300,000	10	13.3	6	8
Above 301,000	60	80	66	88

Source: Field survey, 2024

Farmers view on effect of climate change on the yield of rice

Climate change has been observed by the rice producer to have great negative impacts on the cultivation and yield of rice in so many ways like through variations in temperature, erratic rainfall and climate intensity on soil that may lead to soil erosion, floods and drought. Chukwuemeka, (2022) stated that climate change is a serious problem to agriculture and food security because of heavy reduction and waste of crops.

The result in Table 2 show that majority of the rice producers both male and female pointed out that climate change decreases rice yield (75%) and also lead to late planting and late harvesting as indicated in the Table.

Table 2: Farmers view of climate change on rice yield.

Variable	Male		Female	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Increase rice yield				
Yes	0	0	0	0
No	75	100	75	100
Decrease rice yield				
Yes	75	100	75	100
No	0	0	0	0
late planting of rice				
Yes	45	60	55	73.3
No	30	40	20	27.6
late harvesting				
Yes	48	64	45	60
No	27	36	30	40

Source: Field survey, 2024

Farmers source of information on weather

Table 3 depicts that majority of the rice farmers both male and female received information about weather from radio 50.6% and 69.3% followed by the research institutes 20% and 13% respectively. These were closely followed by cooperative societies as they share ideas. Extension, printed media and television were less significant in information sharing as shown in the Table 3.

Table 3: Farmers source of information on climate

Variable	Male		Female	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Farmer cooperative society	10	13.3	6	8
Extension agent	5	6.6	3	4
Research institute	15	20	10	13.3
Television	2	2.6	2	2.6
Radio	38	50.6	52	69.3
Printed Median	5	6.6	2	2.6

Source: Fiel survey, 2024

Mitigation and adaptation measures of climate to increase rice yield

Table 4 depicts the mitigation and adaptation measures used by rice farmers. The result revealed that majority of respondent both male and female 25.3% and 13% adopted planting early maturing rice varieties. This is closely followed by use of irrigation farming which is 21.3% and 80% for male and female respectively. This result indicates that majority of female farmers prefers dry season farming which is irrigation. Other measures adopted includes planting drought pest diseases resistance rice variety 25.3%, early planting, pre- rain planting and late- rain planting which were all 9.3% respectively.

Table 4: Adaptation measures adopted by farmers (n- 150)

Variable	Male		Female	
	Frequency	Percentage	Frequency	Percentage
PEMRV	19	25.3	10	13.3
DPDRRV	19	25.3	5	6.7
EP	7	9.3	-	-
PRP	7	9.3	-	-
LRP	7	9.3	-	-
IP	16	21.3	60	80

Source: Field survey, 2024. Key: PEMRV – Planting early maturing rice variety; DPDRRV – Drought pest disease resistance rice variety; EP- Early planting; PRP – Pre-rain planting; LRP – Late rain planting; IP – Irrigation planting

CONCLUSION AND RECOMMENDATIONS

The study investigated the mitigation measures the rice producers adopted to reduce if not completely avoid the threat of climate change in their rice fields. The result shows that most of the farmers were aware of the climate change and took different measures. Most of the rice farmers were not enlighten and properly educated and guided on these strategies. The study therefore recommends giving farmers enough knowledge on climate smart agriculture by extension agents especially on these measures adopted by them.

REFERENCES

Abdulmumini, A. B. (2012). Assessment of Anchor Borrowers Financial Scheme on rice farmers' productivity in Lavun Local Government Area of Niger State. *Journal of Management Sciences*, *1*(1), 111–123.

Balogun, O., Ayo Bello, T. A., Abasilim, C., Abimbola, O., Afodu, & Akinwole, O. (2021). Assessment of the performance of Anchor Borrowers Program (ABP) beneficiary and non-beneficiary rice farmers in Badagry Local Government Area, Lagos State, Nigeria. *Ife Journal of Agriculture*, *33*(2), 62–76.

Chukwuemeka, O. S., & Agoh, E. C. (2022). Perception of climate change and adaptation strategy among small-holder cassava farmers in rural communities of Bendel L.G.A, Abia State, Nigeria. *Nigeria Agricultural Journal*, *53*(3), 92–98.

Kamai, N., Omoigui, L. O., Kamara, A. Y., & Ekeleme, F. (2020). *Guide to rice production in Northern Nigeria*.

Nandi, J. A., Haruna, S. K., & Abudu, S. (2012). Analysis of socioeconomic factors influencing farmers' adoption of rice varieties with higher yielding and weed suppressing ability in Kano River Irrigation Project (KRIP). *Journal of Agriculture, Forestry and Social Science*, *10*(1), 23–29.

Nigeria Meteorological Agency (NIMET). (2012). *Nigeria climate review*. NIMET: Abuja.

Ukonze, J. A. (2012). Impact of climate change on cocoyam production in South Eastern Nigeria. *International Journal of Education, Science and Public Policy in Africa (UESPPA)*, *2*(1), 161–168. Bloomsburg, PA: WWWglobalmarkmakers.com.

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21-25 OCT. 2024
PROCEEDINGS

Determinants of Cashew Nuts Value Addition Among Cashew Farmers In Kogi State

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Abstract
This study analysed factors that determine value addition to cashew nuts among cashew farmers in Kogi State. Sample size of 200 respondents was collected using random sampling. Data were collected using structured questionnaire and analysed using Descriptive and Inferential Statistics. The result showed that 78% of cashew farmers were male, with average age of 50 years. Average farming experience was 10 years and average household size was 7 persons. Also, 45.5% had no formal education, 53.3% belonged to co-operative societies. The pseudo R^2 of 70.1 and χ^2 of 25.31 with probability value of 0.0583 indicated that all variables in the model significantly influenced the probability of cashew nut value addition at 1% significance level. Educational level with $p>/z/$ of 0.001, membership of cooperatives (0.000), and extension contact (0.020) were the determinants of cashew nuts value addition. It is recommended that more farmers' co-operative societies in addition to the existing ones should be formed to afford cashew farmers opportunity for learning diverse methods of improving the quality of cashew nuts. Such co-operatives can also serve as informal lending institution to its members.
Keywords: Cashew, Addition, Value-chain, Farmer, Nuts

INTRODUCTION

Cashew (*Anarcadium occidentale*), for many years has been used both as food and cash crop for income generation (Justina and Eghosa, 2017). It is usually grown for its kernels which when roasted has a pleasant taste. In Nigeria, cashew grows successfully in virtually all the agro-ecological zones including the semi-arid areas but with high concentration in the middle belt areas in smallholder farms and plantations (Russel, 2019). Value addition in agriculture is fundamentally market-driven and it requires government support through building institutions, market information, skilled manpower, capital formation and technology (Russel, 2019). Cashew nut processing allows for the development of important by-products which can increase its added value. The liquid inside the shell-Cashew Nut Shell Liquid (CNSL) represents 15% of the gross weight and has some attractive possible medicinal and industrial uses. CNSL is one of the few natural resins which is heat resistant and is used in braking systems and in paint manufacture. It contains a compound known as *anacardium* used for treating dermatological disorders. The main markets for CNSL are the United States, the European Union (mainly the United Kingdom), Japan and the Republic of Korea. Together these account for over ninety (90) percent of world trade, most of which is supplied by India and Brazil. Cashew fruit peduncle often called the false yellow or red in colour consist of a soft juicy pulp with the seed which develops below the peduncle.

The seed is kidney shaped and resembles a large bean. Marketing in Agriculture is the performance of all the activities involved in the production and conveyance of goods from points of production till they reach the ultimate consumers. Poor trading systems of crops partly lead to inefficient agricultural commodity marketing in Nigeria. Cashew nut marketing involves several players and channels. It starts from the sale of raw cashew nuts by gatherers and farmers to the retailers who then sell to the wholesalers till it reaches the level of the processors, for selling of the processed and graded kernels to the ultimate consumers. Lack of storage and processing facilities for cashew nuts has negated its production in Kogi State. Also, there is inadequate empirical information on the determinants of value addition to cashew nuts in the study area, hence, this study was designed to assess determinants of value addition to cashew nuts by cashew farmers in Kogi State. The specific objective was to identify the determinants of cashew nut value addition in the study area.

METHODOLOGY

Study Area

This study was conducted in Kogi State, which is one of the six states that constitute the North Central region of Nigeria, its headquarters is in Lokoja, the State capital. Kogi State comprises of 21 Local Government Areas (LGAs). It lies between latitudes $5^0$18'E to $7^0$49'E of the equator and longitudes $6^0$31'N to $8^0$42'N of the meridian. It shares boundaries with Niger, Nasarawa, Plateau States and Federal Capital Territory (FCT) to the North and Benue to the East. To the west, it is bounded by Kwara, Ondo and Ekiti States and to the South by Enugu, Anambra and Edo States. It has a population of 3,314,043 (NPC, 2006). Major crops cultivated in Kogi State are: yam, cassava, maize, rice, cowpea, pigeon pea, groundnut, bambara nut, sweet potato, beniseed, melon, tomatoes and fruits and leafy vegetables such as okra, pepper, fluted pumpkin and spinach. Tree crops grown in the state are: cashew, oil palm. Cattle, sheep, goats and poultry are the major animals reared.

Population and Sampling Procedure

The population for this study comprised of all cashew farmers registered under the Cashew Farmers Association (CFA) in Kogi State. Multistage sampling technique was used for collecting sample of 200 respondents for the study. The first stage involved selection of two agricultural zones, B and zone C in accordance with Kogi State Agricultural Development Project (KADP) extension structure. This was due to high preponderance of cashew farmers in those areas. In the second stage, three communities were randomly selected from each of the chosen zones and the third stage involved selecting 10% of the sample frame, giving total 200 respondents as in Table 1.

Table 1: Sample Distribution of Respondents

Zone	Block	Sample frame	Sample size (10% of sample frame)
A	*Ankpa*	300	30
	Dekina	400	40
	Egume	300	30
B	Ejule	300	30
	Ajaka	360	36
	Idah	340	34
Total		2000	200

Source: Kogi ADP Extension Structure (2022).

Method of Data Collection

The data used for this study were primary data, which were collected through a structured questionnaire, personal observation and interview schedule

Methods of Data Analysis

Data collected were analyzed using both Descriptive Statistics and Probit Regression Model

Model Specification

Probit Regression Model:

This model was used to analyze the factors that determine value addition to cashew nuts by cashew farmers. Probit Model is specified implicitly as:

$$Y=\Sigma\beta X+\varepsilon_i \quad (1)$$

Where;

Y = value addition to cashew nut (value addtion=1, no value addition=0)

X_1-X_6 = vector of explanatory variables (the predictors)

β_0- β_6 = coefficients (Parameters to be estimated)

β_0 = Constant

ε_i = Error term.

In explicit form, Probit Model is specified as:

$Y=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\varepsilon_i$

(2)

Where:

$Y=1$, if a farmer adds value and $Y=0$, if no value is added

X_1= age of farmers (years)

X_2 = educational level of cashew farmers (number of schooling years)

X_3=farming experience (years)

X_4=co-operative society membership (1=member, 0=non-member)

X_5=extension contact (visited by extension agent=1, not visited = 0)

X_6=information on value addition

β_0 = constant (intercept)

β_0-β_6 = the coefficient corresponding to X_1-X_6

ε_i = error term.

RESULTS AND DISCUSSION

The Socio-Economic Characteristics of Respondents in Kogi State

Table 2 below is the distribution of cashew farmers in Kogi State according to Age, Farming experience and Household size. Average age of respondents was 50 years, implying that most of the farmers were in their productive age. This is similar to the finding Akubo et al (2024) who found that the mean age of poultry farmers in Kogi State was 45 years. Also, average farming experience of respondents was 10 years. This implies that cashew farmers have considerable years of farming experience in cashew production. This is consistent with Iyaji et al (2022) who found that the mean age of cashew farmers in Kogi State was about 10 years. Also, the respondent had average household size of 7 persons, implying that the respondents had relatively large household size which could serve as a source of labour for the production of cashew nut.

Table 2: Distribution of Respondents Based on Age, Farming experience and Household size

Variable	Frequency	Percentage	**Mean**
Age			
21-40	51	25.5	
41-60	106	53.0	50
61-80	43	21.5	
Total	200	100	
Farming experience			
1-10	115	57.5	
11-20	83	41.5	10
>20	2	1.00	
Total	200	100	
Household size			
1-5	50	25.0	
6-10	108	54.0	7
>10	42	21.0	
Total	200	100	

Source: Field Survey, 2022.

Distribution of Cashew Farmers in Kogi State Based on Sex, Education and Cooperative Membership

The result in figure 1 shows that majority (78%) of the respondents were male, implying that cashew production in Kogi State was predominantly carried out by the male farmers. This agrees with the findings of Agbongiarhuoyi et al (2015), who reported that 69% of cashew farmers are male. Findings on educational level shows that most (45.5%) of the respondents had no formal education. This implies that majority of the respondents may not understand the importance of value addition to their produce. Iyaji et al (2022) noted that educated farmers are more receptive to new and improved technologies which can improve both the quality and the quantity of their produce than farmers with no formal education. Table 2 also shows that most (53.3%) of the respondents belonged to co-operative societies. Membership of co-operative societies could afford farmers opportunity to share experiences with one another on issues pertaining to cashew nut production and value addition. The possible reasons that majority of the farmers joined cooperative society could be to satisfy their basic need which sometimes could be achieved only collectively.

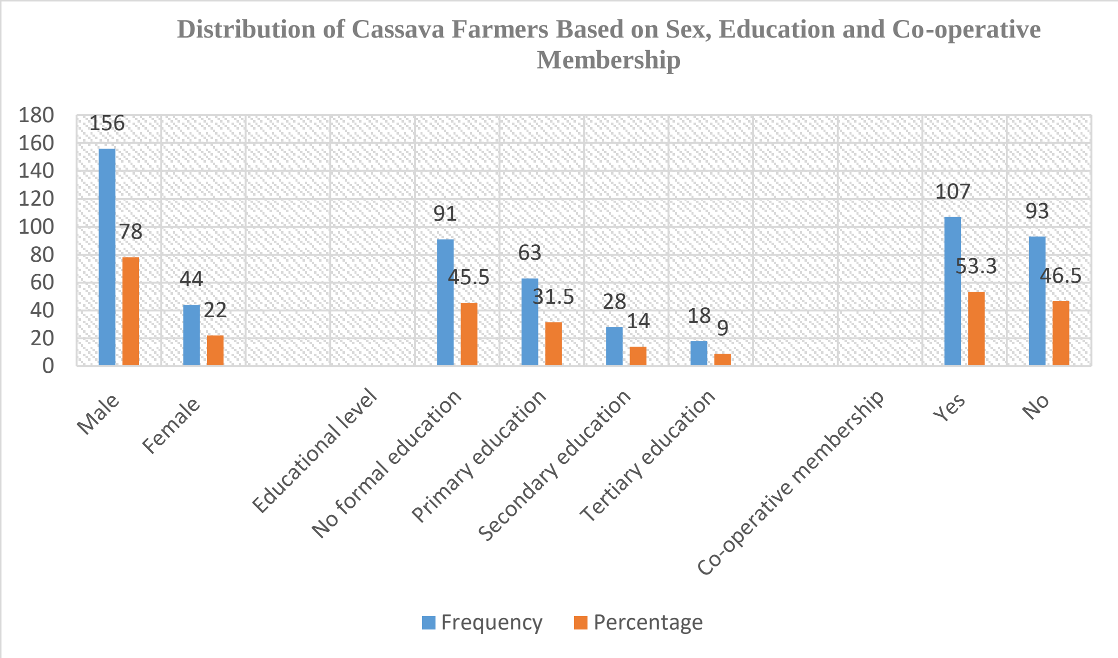

Figure 1: Bar Charts Showing Distribution of Cashew Farmers in Kogi State Based on Sex, Education and Cooperative Membership.

Determinants of Cashew Nuts Value Addition among Cashew Farmers in Kogi State

Estimates of Probit Regression analysis on factors that affect farmer's decision to add value to cashew nut is presented in Table 3. The pseudo R^2 value of 70.1 and χ^2 value of 25.31 with the probability value of 0.583 indicate that all variables included in the model significantly influence the probability of cashew nut value addition at 1% significance level. Out of the six explanatory variables included in the model, four significantly influenced the likelihood of cashew nut value addition decision. These are farming experience (0.001), level of education (0.000), membership of cooperative society (0.020) and information on value addition (0.010). The results in Table 3 showed that the coefficient of farming experience (0.001) was positive and significant at 1% significance level, implying that for every additional one year in farming, the rate of value addition increases. This could also be because the more cashew farmers gain experience; the more they become interested and think of how to add value so as to be able to make good returns on investment. The coefficient of level of education was positive (0.000) and significant at 1%. By implication, an increase in the years of formal education will increase the likelihood of farmer's adding value to cashew nut. The coefficient of membership of cooperative society was positive (0.020) and significant at 5%. This implies that being a member of cooperative society will enhance the probability of adding value to cashew nut. This might increase their ability to share experiences with other farmers on issues pertaining to cashew nut value addition.

Table 3: Determinants of Cashew nut Value Addition among Cashew Farmers in Kogi State

Variable	Coefficient	Std error	t	p>|z|
Age	180.49	172.22	1.05	0.234
Farming experience	355.60	91.03	3.91***	0.001
Educational level	453.03	267.81	1.67***	0.000
Co-operative membership	275.04	53.29	5.16**	0.020
Extension contact	-116.36	175.35	-0.66	0.601
Value addition information	1058.99	308.66	3.43***	0.010
Constant	-3.16478	2.20365	-1.4362	0.115
LR chi^2 (6)	25.31			
Prob > chi^2	0.0583			
Pseudo R^2	0.701			

Source: Field Survey, 2022.
** implies statistically significant at 5% level
*** implies statistically significant at 1% level

CONCLUSION AND RECOMMENDATIONS

Most of the cashew farmers in Kogi State do not have formal education, they have fairly large households, adequate farming experience, and they are relatively young and actively involved in co-operatives. Factors that encourage farmers to embrace value addition to cashew nuts were found to be co-operative society, education, farming experience, information on value addition.

It is recommended that cashew farmers in the study should form more co-operative societies to afford them opportunities to learn new methods of improving the quality of cashew nuts. Such co-operatives can also serve as informal lending institution to its members. Education of cashew farmers should be encouraged because orientation is a vital factor that contributes to cashew value addition. Hence, extension agents should provide education to cashew farmers so as to expose them to the need to improve the value of their cashew nuts in order to have a better return on investments.

REFERENCES

Agbongiarhuoyi, A. E., Aigbekaen, E. O., & Akinbile, L. A. (2015). Awareness of cashew products potentials and market information among farmers in Kogi State, Nigeria. *ARPN Journal of Agriculture and Biological Science*, *3*(4), 10–15.

Akubo, D., Aliyu, A. K., Adebayo, O. M., Agbana, J. A., Iyaji, J., & Zubair, A. (2024). Determinants of participation in contract farming among poultry farmers in Kogi State, Nigeria. *International Journal of Agricultural and Veterinary Science*, *3*(1), 64–75.

Iyaji, J., Akubo, D., Akowe, I. I., Alabi, O. B., & Olatunbosun, B. A. (2022). Assessment of cashew nut value chain in Kogi State, Nigeria. *International Journal of Agricultural Economics, Management and Development (IJAEMD)*, *10*(2), 1–11.

Justina, O. L., & Eghosa, O. U. (2017). Cost effectiveness of intercropping patterns by cashew farmers in Oyo State, Nigeria. *International Journal of Forest, Animal and Fisheries Research (IJFAF)*. Cocoa Research Institute of Nigeria, Idi-Ayunre, Ibadan, Oyo State, Nigeria.

Russel. (2019). *Cashew nut processing* (3rd ed.). Food and Agriculture Organization, Agricultural Services Bulletin. FAO.

Determination of Moisture Ratio and Drying Rate of African Yam Bean (AYB) (*Sphenostylis stenocarpa*) at Various Temperature and Air Velocity Using Tuber Fluidised Bed Dryer

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Abstract
African yam bean (AYB) tubers of 3mm and 5mm slice thickness were dried at 50, 60 and 70^oC air temperatures and air velocity of 1, 1.5 and 2 (m/s) velocities in fluidized dryer. The moisture ratio and the drying rate of the AYB tubers during drying was calculated. There was a rapid rate of moisture removal, this rate continued to reduce until it came to a constant moisture removal rate. Experimental result showed drying of AYB tuber falls in falling rate period. The rate of drying continuously decreased as drying proceeds.
Keywords: AYB tuber, Drying rate, Moisture ratio, Fluidised bed dryer

INTRODUCTION

African yam bean (AYB) (*Sphenostylis stenocarpa*) is a tuberous legume which belongs to the family Fabaceae. It is also known as *Okpududu* and *Azanma* (Igbo, Nigeria), *Girigiri* (Hausa, Nigeria) and *Sese* (Yoruba, Nigeria). Nigeria is more prominent for AYB production, as it is extensively cultivated in the Western, Eastern, Southern and northern states of the country (Saka and Ajibade, 2004).

AYB tubers with a high moisture content, tends to spoil easily after harvest, hence the need for their drying to increase their shelf life (Adewale and Dumet, 2011). Drying is a complicated process with simultaneous heat and mass transfer, and food drying is especially very complex because of the differential structure of products. In practice, a food dryer is considerably more complex than a device that merely removes moisture, and effective models are necessary for process design, optimization, energy integration and control (Sharma *et al.,* 2005). The aim of this work is to determine the drying behaviour (drying rate, moisture ratio) tuber using fluidised bed dryer at different temperatures and air velocities.

MATERIALS AND METHODS

Materials

AYB tubers were obtained from a local farm in Enugu, cold-stored at atmospheric temperature with moist soil and immediately transported to Minna, Niger State. The AYB was washed and sliced using a stainless-steel knife. Slices (3 and 5mm thick) were cut perpendicular to the tuber axis. The drying experiment was carried out using the laboratory fluidized bed dryer as shown at the Department of Agricultural and Bioresources Engineering, Federal University of Technology Minna, Niger State.

Drying procedure

The drying experiments were carried out at three operational temperatures: 50, 60 and 70°C assisted by hot air blown at 1, 1.5 and 2 (m/s). All the experiments were conducted in three replicates. The fluidised dryer was set to the specified conditions. About 200g of the prepared samples were dried. During the drying process, moisture loss was measured periodically in 20 minutes intervals during the first 6 hours and later on 30 minutes intervals using laboratory moisture meter. All weighing processes were completed in less than 10s. Drying continued until constant weight (approximately) of AYB slices were obtained. All these were done to determine the moisture ratios and drying rates.

Determination of moisture content

The moisture content was determined using the Official Methods of Analysis of Chemist (AOAC, 2005) using equation 1:

$$\% \text{ Moisture} = \frac{(weight\ of\ can + fresh\ sample) - (weight\ of\ can + dried\ sample}{weight\ of\ sample} \times 100 \quad (1)$$

Moisture ratio (MR)

The dimensionless moisture ratio (*MR*), which is defined as the ratio of the moisture still present in a material at any particular time to the total free water which was initially available in the material before the commencement of the drying process, was calculated using Equation 2 (Akpinar *et al.,* 2003):

$$MR = \frac{\text{moisture content at any given time} - \text{equilibrium moisture content}}{\text{the initial moisture content of the product} - \text{equilibrium moisture content}} \quad (2)$$

Drying rate

The drying rate (DR) of AYB slices can be defined as moisture content variation with time, and calculated using the following equation (Evin, 2012):

$$DR = \frac{M_{t+\Delta t} - M_t}{t + \Delta t} \quad (4)$$

where;

M_t and $M_{t+\Delta t}$ were the moisture content at t and moisture content at $t + \Delta t$, respectively, and t was drying time.

RESULTS AND DISCUSSION

Drying Kinetics of Fluidised bed drying of AYB Tuber Slices

Moisture ratio

AYB tuber slices of 3mm and 5mm thickness were dried using fluidised bed dryer at air velocities of 1, 1.5 and 2 m/s and air temperatures of 50˚C, 60˚C and 70˚C. At each drying air velocity and temperature combinations the moisture ratio was determined. The initial moisture contents of the AYB samples ranged within 82.59 - 87.88 g H_2O/g dry solid for 3mm slice thickness and 86.42 - 88.91 g H_2O/g dry solid for 5mm. They were all dried to 7.37 – 9.00 g H_2O/g dry solid in all drying experiments.

It was observed that at the start of the drying process, there was a rapid rate of moisture removal, this rate continued to reduce until it came to a constant moisture removal rate. The high rate of moisture removal at the initial stage was as a result of a large drying force for mass transfer (high amount of residual moisture within the samples). The reduction in drying rate is a result of reducing drying force for mass transfer (lesser amount of residual moisture within the samples). Drying times (time taken to attain equilibrium moisture content) observed for the 3mm slice thickness at 1m/s air velocity were recorded at 600, 540 and 480 minutes; for the 1.5 m/s air velocity, drying time were recorded at 570, 540 and 450 minutes and for the 2m/s air velocity, it was recorded at 570, 510 and 420 minutes for drying temperatures of 50^{o}C, 60^{o}C and 70^{o}C respectively. Drying time for 5mm thickness at 1m/s air velocity were recorded at 720, 630 and 540 minutes, for the 1.5m/s air velocity, it was recorded at 660, 570 and 510 minutes, then for the 2m/s air velocity it was recorded at 630, 510 and 460 minutes for drying temperatures of 50^{o}C, 60^{o}C and 70^{o}C respectively.

Drying rates

As with most typical drying processes for agricultural products, three drying rates period was observed in the drying of the AYB tuber slices; namely the initial, constant rate and falling rate periods. Two falling rate were observed for 70^{o}C at 2m/s (5mm) and also at 1.5 and 2m/s (3mm), while both constant rate period and falling rate periods were observed at each of the remaining drying temperature irrespective of drying air velocity and slice thickness. The surface of AYB slices were heated through combined convection and conduction from the surrounding air in the fluidised dryer. The inner part of the slices were heated by conduction and coupled with the low thermal conductivity of AYB resulted in low moisture diffusion rate that was not able to replenish the moisture evaporated at the surface. Thereafter, the first falling rate occurred and eventually the surface moisture dried up and created a harden layer on the surface. This further impeded the diffusion of moisture from the inner part of the fruits and resulted in the second falling rate period.

Adak *et al*. (2017) reported that low thermal conductivity of fruit and case hardening are main factors slowing down the drying rates. Furthermore, low drying temperature and slow diffusion rate would result in occurrence of the constant rate period before the onset of falling rate period (Togrul, 2005). This can be observed from drying at temperature of 50^{o}C (1m/s and 2m/s air velocity) 3mm slice thickness, where constant rate period was observed due to the lower drying temperature. Also, similar findings were reported by Togrul (2006) where only falling rate period was observed in Infrared drying of carrot at temperature range of 50˚C to 80˚C and internal moisture diffusion was the dominant mode of moisture transfer mechanism.

In general, the drying rates for 3mm slice thickness at different temperature (50, 60, 70) ranged from 0.1795 to 0.000125, 0.3968 to 0.000092 and 0.5844 to 0.0000395 gH_2O/g dry solid.min for 1m/s air velocity, 0.2735 to 0.0000087, 0.4017 to 0.00005 and 0.4017 to 0.000057 for 1.5 m/s, and 0.244 to 0.000032, 0.31515 to 0.0000706 and 0.55465 to 0.0000643 gH_2O/g dry solid.min for 2 m/s air velocity.

On the other hand, the drying rates for 5mm slice thickness at different temperature (50, 60, 70) ranged from 0.3592 to 0.000075, 0.4017 to 0.0000397 and 0.5844 to 0.0000241 gH2O/g dry solid.min for 1m/s, 0.3592 to 0.0000151, 0.4017 to 0.0000211 and 0.2158 to 0.0000373 gH2O/g dry solid.min for 1.5 m/s air velocity and finally, 0.3592 to 0.0000429, 0.4017 to 0.000149 and 0.5844 to 0.0000391 gH2O/g dry solid.min for 2 m/s air velocity.

CONCLUSION AND RECOMMENDATIONS

The following conclusions have been drawn; all the drying process of AYB tuber falls in falling rate period, which implies that moisture removal from the material was governed by diffusion phenomenon. Drying rates of AYB tuber was affected more by the thickness and temperature compared air velocity. It was observed that drying time decreased as the temperature and air velocity increased i.e., lowest drying time (420 minutes) was at 70^{o}C, 2m/s air velocity, 3mm thickness and highest time was at 720 minutes (5mm thickness) 50^{o}C, 1m/s air velocity.

REFERENCES

Adak, N., Heybeli, N., & Ertekin, C. (2017). Infrared drying of strawberry. *Food Chemistry*, *219*, 109–116.

Adewale, B. D., & Dumet, D. (2011). *Descriptors for African yam bean, Sphenostylis stenocarpa (Hochst ex. A. Rich.) Harms*. http://old.iita.org/cms/articlefiles/1488–ayb%20descriptors

Akpinar, E. K., Bicer, Y., & Yildiz, C. (2003). Thin layer drying of red pepper. *Journal of Food Engineering*, *59*, 99–104.

AOAC. (2005). *Official methods of chemical analysis* (18th ed.). Association of Official Analytical Chemists.

Diamante, L. M., Ihns, R., Savage, G. P., & Vanhanen, L. (2010). A new mathematical model for thin layer drying of fruits. *International Journal of Food Science and Technology*, *45*, 1956–1962.

Evin, D. (2012). Thin layer drying kinetics of *Gundelia tournefortii* L. *Food and Bioproducts Processing*, *90*, 323–332.

Saka, J. O., & Ajibade, S. R. (2004). Survey of underutilized grain legume production systems in the Southwest agricultural zone of Nigeria. *Journal of Agricultural and Food Information*, *6*(3), 93–108.

Sharma, G. P., Verma, R. C., & Pathare, P. B. (2005). Thin-layer infrared radiation drying of onion slices. *Journal of Food Engineering*, *67*(3), 361–366.

Togrul, H. (2005). Simple modeling of infrared drying of fresh apple slices. *Journal of Food Engineering*, *71*, 311–323.

Togrul, H. (2006). Suitable drying model for infrared drying of carrot. *Journal of Food Engineering*, *77*, 610–619.

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21-25 OCT. 2024
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Socio-economic Drivers of Decision to Invest in Catfish Processing among Smoked-Fish Vendors in Benue State, Nigeria

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Abstract

The study analyzed the socio-economic drivers of decision to invest in catfish processing among smoked-fish vendors in Benue State, Nigeria. Using Cochran's formula, a sample size of 384 vendors was determined, and selected via multistage sampling technique. The data for the study were collected via structured questionnaire. The logit model was employed to analyze the socio-economic drivers of decision to invest in catfish processing among smoked-fish vendors. The findings indicate that vendors' age, marketing experience, non-market income, and processing experience positively influence the likelihood of investing in catfish processing, with respective marginal effects of 0.79, 0.66, 0.000084, and 0.79 percentage points. Conversely, educational level and household size negatively impact this decision, with marginal effects of -1.10 and -2.48 percentage points, respectively. The study recommends that the Benue State government implement policies to manage household sizes through family planning education and support services, and provide low-interest loans to diversify income sources. Additionally, the State's Ministry of Agriculture should enhance vendors' processing experience through practical training sessions and access to modern processing equipment and technology.

Keywords: Socio-Economic Drivers, Investment Decision, Catfish Processing, Smoked-Fish Vendors, Benue State, Nigeria

INTRODUCTION

Nigeria has a large market for smoked fish given her population of over 200 million people. However, smoked fish importation into Nigeria has ranked the country the largest importer of smoked fish in Africa (Oluwarore, 2018; Hamid, 2020). According to Jaiyeola (2022), fish products including smoked fish worth $2.14 billion were imported into Nigeria between 2020 and 2022. This importation of smoked fish in Nigeria may still continue for some time as report by Hamid (2020) revealed that supply from captured fisheries in the country has been erratic and on the decline in recent years. The report by Hamid (2020) also revealed that the growth rate in aquaculture is not yet sufficient for the ever increasing demand for fish and fish products.

In order to close the gap between domestic production and supply of smoked fish in the country, policies targeted at these critical components: processing, marketing, and distribution, in the catfish value chain in the country are pertinent. This is because increased fish production without commensurate effort to improve efficiencies of processing and marketing would still amount to widening demand-supply gap of fish and fish products in country.

Previous studies (not limited to Iheke and Nwagbara, 2014; Omotesho *et al*., 2017; Obot *et al*., 2021; and Omeje *et al*. 2022) on catfish processing in Nigeria focused on the processing activities of fish farmers in the fish value chain. None of these studies looked at the catfish processing activities of vendors of smoked catfish. Also, there exist information gap in relation to the determinants of catfish processing decision among vendors of smoked catfish. Hence, this study aimed at bridging this research gaps. The broad objective of the study was to analyze the drivers of decision to invest in catfish processing among smoked-fish vendors in Benue State, Nigeria. Specifically, the study sought to identify and analyze the socio-economic drivers of decision to invest in catfish processing among smoked-catfish vendors in the study area.

METHODOLOGY

Study Area

The study was conducted in Benue State which lies within the lower river Benue trough in the middle belt region of Nigeria. It geographical coordinates are Longitude 7°47′ and 10°0′ East. Latitude 6°25′ and 8°8′ North and occupies a land mass of 34,059 km^2. The State is one of the North Central States in Nigeria with a projected population of 6,141,300 in 2022 (NPC, 2022). Benue is rich in agriculture and grows crops such as sweet potatoes, cassava, soya bean, guinea corn, yams sesame, rice and groundnuts. Also, the rearing of livestock such as fish, pig, cattle, goat, and sheep abound in the State. Businesses that are involved in catfish processing also abound in the State.

Population of the Study

The population of the study consisted of all vendors of smoked catfish in Benue State, Nigeria. However, due to the large number of this population, Cochran's Formula for estimating sample size of unknown population was utilized to determine the sample size of 384 smoked catfish vendors.

Sampling Technique and Data Collection

Multi-stage sampling technique was employed to select the sample of 384 vendors of smoked catfish. The data for the study were collected using structured questionnaire.

Analytical Techniques

The logit model was used to identify and analyse the socio-economic drivers of decision to invest in catfish processing among smoked-catfish vendors in the study area. The logit model was specified as follows:

$$\ln\left(\frac{Pi}{1-Pi}\right) = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + \mu_i \quad (1)$$

Where;
ln = Base of natural logarithm
P_i = the probability that a vendor invest in catfish processing or not (1= vendor processed catfish, 0 = vendor does not process catfish)
X_1 = age (years); X_2 = marketing experience (years); X_3 = educational level (years); X_4 = household size (number); X_5 = non-market income (₦); X_6 = processing experience (years); μ_i = error term

The *a priori* expectations were that the coefficients of age, and household size would be negative while those of marketing experience, educational level, non-market income, and processing experience would be positive.

RESULTS AND DISCUSSION

Determinants of Catfish Processing Decision among Vendors

Results of the determinants of catfish processing decision are presented in Table 1. Logit regression was run using six explanatory variables to examine the determinants of catfish processing decision in the study area. The log likelihood value is -33.09443; and the associated Chi-square value (84.03) is statistically significant at 1 % level of probability. This implies that the model can be relied upon to examine the determinant of catfish processing decision in the study area. The coefficient of age was significant at 1% level and positively related to decision to invest in catfish processing. The positive sign of the coefficient agrees with the *a priori* expectation, implying that additional age of the vendor increases the likelihood of investing in catfish processing by 0.79 percentage points. Aged marketers are more likely to have acquired experience, knowledge, skills and resources required to add value to catfish than the younger marketers. This finding is in tandem with Eze *et al.* (2022) who posited that age increases the probability of value adding decision to agricultural produce and attributed this to access to resources such as capital, family labour, equipment, building, land, and other required inputs that increases with age.

Marketing experience and processing experience had positive coefficients and significant at 10% and 5% respectively, indicating that as the vendor years of marketing and processing smoked catfish increases, the vendor is 0.66 and 0.79 percentage points respectively, more likely invest in the business of processing catfish. This is expected as vendors with more years of experience must have acquired more skills, knowledge and resources needed to add value to catfish. This is in tandem with Acharjee *et al.* (2022) who observed a positive relation between experience and decision to add value to agricultural products.

Educational level had a negative coefficient and significant at 1% level. This indicates that as the vendor's level of education increases, the decision to invest in catfish processing decreases by 1.10 percentage points. Increase in the level of education is expected to increase the likelihood of value addition as it enhances information acquisition and quality of decision-making (Acharjee *et al.*, 2022). However, educated vendors who are less likely to invest in catfish processing are those with large household size. This large household size implies more months to take care of and increased family expenditure and hence less resources to invest in value addition (Adeyonu *et al.*, 2016).

Household size had a negative coefficient and significant at 1% level, implying that as the household size of the vendor increases, the vendor is 2.48 percentage points less likely to invest in catfish processing. This large household size implies more mouths to take care of and increased family expenditure and hence less resources to invest in value addition. This finding is in consonance with Adeyonu *et al.* (2016) who observed a negative relationship between value addition decision and household size and attributed this to higher consumption which leaves little or no resources to add value to raw agricultural products.

The non-market income of the vendor had a positive coefficient and significant at 1% level, implying that as the vendor's income from non-marketing sources increases, the vendor is 0.000084 percentage points more likely to invest in catfish processing. This is expected as more income and revenue provide the needed capital to undertake value addition activities. This finding corroborates Eze *et al.* (2022) who observed a positive relationship between income and value addition on agricultural products.

Table 1: Determinant of catfish processing decision

Variables	Coefficient	Standard error	Z-value	Marginal effect
Age	0.21***	0.074	2.86	0.79
Marketing Experience	0.18*	0.10	1.75	0.66
Educational level	-0.29***	0.086	-3.41	-1.10
Household size	-0.67***	0.16	-4.14	-2.48
Non-market income	0.000023***	0.0000059	3.82	0.000084
Processing experience	0.21**	0.090	2.36	0.79
Constant	0.80^{NS}	2.74	0.29	
Log likelihood	-33.09443			
LR chi-square	84.03***			
Prob > chi-square	0.0000			
Pseudo R-Square	0.5594			

Source: field survey, 2024. *** = sig@1%; ** = sig@5%; * = sig@10%; NS = not significant

CONCLUSION AND RECOMMENDATIONS

Evidence from the study shows that the socio-economic characteristics of smoked-catfish vendors in the study area influence their decision to process to catfish. These vendors' age, marketing experience, income from non-marketing sources, and their processing experience increases the likelihood of them processing catfish by 0.79, 0.66, 0.000084, and 0.79 percentage points respectively, while their educational level, and household size decreases this probability by 1.10 and 2.48 percentage points respectively.

Based on the findings of the study, the following were recommended that the Benue State government should come up with policies that help vendors in household size management. This can be achieved through promoting family planning education and support services such as childcare and healthcare to alleviate the burden of large household sizes on these vendors, in addition to providing them with low-interest loans to diversify their income sources. This will allow more resources to be available for them to invest in the business of catfish processing.

The Benue State ministry of agriculture through its extension department should come up with programs that enhance the processing experience of these vendors particularly the younger ones. This can be realized through conducting practical training sessions on advanced processing techniques as well as facilitating access to modern processing equipment and technology. This will help to improve the quality and efficiency of catfish processing in the State.

REFERENCES

Acharjee, D.C., Alam, G.M.M., Gosh, K., Haque, A.B.M.M. and Hossain, M.I. (2022). Fish Value Chain and the Determinants of Value Addition Decision: Empirical Evidence from Bangladesh, *Journal of the World Aquaculture Society,* 1-14

Adeyonu, A. G., Ajala, A. O., Adigun, G. T., Ajiboye, B. O. and Gbotosho, O. O. (2016). Determinants of Sweet Potato Value Addition among Smallholder Farming Households in Kwara State, Nigeria. *Journal of Tropical Agriculture, Food, Environment and Extension,* 15(1): 17-22.

Eze, A.V., Macharia, I. and Ngare, L. (2022). Factors Influencing Value Addition to Cashew Products Processed in the South East Zone, Nigeria: A Multinomial Logistic

Regression Approach. *International Journal of Agricultural Science and Food Technology,* 8(1):59-71

Hamid, M.Y. (2020). Analysis of Smoked Fish Marketing in Mubi North Local Government Area, Adamawa State, Nigeria. *International Journal of Forest, Animal and Fisheries Research*, 4(4): 52-63.

Iheke, O.R. and Nwagbara, C. (2014). Profitability and Viability of Catfish Enterprises in Abia State of Nigeria. *Journal of Agriculture and Social Research*, 14(1): 31-36

Jaiyeola, T. (2022). *Nigeria Imports $3.49 billion Fish, Eggs, Milk, Others*. Retrieved from https://www.punchng.com/nigeria-imports-3.49bn-fish-eggs-milk-others/ December 27, 2022.

NPC (2022). *Nigeria Population Projections and Demographic Indicators*. Retrieved on 13th June, 2024 from https://nationalpopulation.gov.ng/publications

Obot, A., Osuafor, O., Nwigwe, C. and Ositanwosu, C. (2021). Analysis of Agricultural Policy on Catfish Value Chain in Akwa Ibom State, Nigeria. *International Journal of Research and Innovation in Applied Science*, 6(1): 96-101

Oluwarore, K. (2018). *Nigeria: Importing Fish Amidst Abundant Ocean Resources, the Paradox of a Nation*. Retrieved from https://earthjournalism.net/stories/nigeria-importing-fish-amidst-abundant-ocean-resources-the-paradox-of-a-nation Accessed on December 27, 2022

Omeje, J.E., Adike, A.I., Jimmy, S.P. and Manuwuike, Q.M. (2022). Economics of Smoked Farmed Catfish in Kainji Lake Basin, Nigeria. *Journal of Agricultural Extension*, 26(3): 1-15

Omotesho, K.F., Babasola, O.J., Adesiji, G.B. and Olaoye, I.J. (2017). Factors Associated with Catfish Farmers' Attitude towards Value Addition in Kwara State, Nigeria. *JAFAG*, 34(3): 245-252

Yield traits as a Selection indices for Yellow Root Cassava Genotypes at Single Row Trial of Breeding Stage in Umudike

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Abstract

*Cassava is an important starchy root crop and a major staple for more than 70 million people in Nigeria. New yellow-fleshed genotypes are being developed to combat vitamin A deficiency. The study was carried out to investigate yield traits as selection indices for yellow root cassava genotypes at single row trial of breeding Stage in Umudike. Nine (9) selected yellow root cassava genotypes and 2 released cassava varieties were evaluated for root yield, dry matter, and other yield qualities. The experiments were conducted using a Randomized Complete Block Design (RCBD) with two replications. The data collected were subjected to analysis of variance (ANOVA) using General Linear Model (GLM) procedure in SAS software, 2002. Genotype NR200004 shows the highest fresh root yield of 19.33t/ha. Three genotypes NR200008 (32.54%), NR200005 (34.38%) and NR200004 (35.24%) had dry matter content above the two check varieties. Genotype NR200010 (0.56) had harvest index better than the check varieties. All the genotypes were susceptible to cassava bacterial blight (CBB) and cassava anthracnose disease. Significant positive correlation was observed between harvest index and FRY (r = 0.64801**), DMC (r = 0.74776***). The analysis of variance shows significant difference among genotypes for cassava mosaic disease.*

Keywords: yellow root, location, harvest parameters, pest, disease

INTRODUCTION

Cassava (*Manihot esculanta*) is a native of South America that is largely cultivated in the tropics for its starchy and tuberous roots, which are utilized as food (Osuafor *et al.*, 2020). With an approximated 59 million tons of cassava production, Nigeria is the largest producer in West Africa, according to researchers. Nigeria's cassava production stands for 20.4% of the globe's total output since 2017 (Olutosin and Sawicka, 2019), Nigeria has become the world's largest producer of cassava as a result of this proportion.

Considering Nigeria's prominence on the global map when it comes to cassava crop, cassava delicacies have become expensive in Nigeria as a result of the Covid-19 outbreak and escalating insecurity challenges, forcing many people to rely on alternate foods such as *Elibo* (cassava and maize flour). This shows that cassava output should be increased for both domestic and export markets (Uchemba *et al*., 2021). In order to satisfy the forecasted increase in demand for cassava food and non-food products, and to harness the enormous potential offered by the crop, cassava production in sub-Saharan Africa must be increased (Khandare and Choomsook, 2019; Otekunrin and

Sawicka, 2019; FAOSTAT, 2020). Some of the constraints inherent to its production include pests (Kalyebi *et al*., 2018; Koros *et al*., 2018) and diseases caused by bacteria (Fanou *et al*.,2018) and viruses (Alicai *et al*., 2019) leading to significant yield losses. Conventional cassava breeding is based on phenotype-based recurrent selection, which relies on the production of full-sib and/or half-sib progenies followed by successive clonal selection stages, including single row trials, preliminary, advanced, and uniform yield trials (Ceballos *et al*., 2016).Many cassava varieties have been developed and released through conventional breeding (Malik *et al*., 2020). Breeding cassava is a challenging task due to the heterozygous genetic make-up of the crop. The objectives of the study were to (i) the influence of genotypes on fresh root yield (FRY), dry matter (DM), cassava mosaic disease (CMD), cassava bacterial blight (CBB), cassava anthracnose disease (CAD), and cassava and greenmite (CGM).

MATERIALS AND METHOD

Selected nine selected yellow root genotypes were identified for the purpose of this trial and two checks (TME419 and UMUCASS46). Cassava planting stakes of 20-30 cm in length were planted on July 2021 laid out in Randomized Complete Block Design (RCBD) with a plot size 1m × 5m (5m^2). The experiment was replicated two times. A planting distance of 1 m x 1 m was maintained making 5 stands per plot. Pre and post-emergence herbicide was used after planting. Weeding of the farm was done manually. The plants were scored for resistance to major cassava disease and pests 1,3,6,9 and 12 MAP. Determination of dry matter, fresh root yield, dry matter content, dry root yield, and harvest index of the cassava genotypes were carried out at harvesting using specific gravity method.

Statistical analysis

The data collected were subjected to analysis of variance (ANOVA) using General Linear Model (GLM) procedure in SAS software, 2002 to test for the treatment of effect and significant interaction of the variables considered.

RESULTS AND DISCUSSION

Six of the evaluated genotypes were resistant to cassava mosaic disease (CMD) while three were susceptible to CMD; all the genotype was susceptible to cassava bacterial blight (CBB) and cassava anthracnose disease. (Table 1) .Two genotypes had fresh root yield better than the mean 12.33t/ha and the checks varieties. Genotype NR200004 shows the highest fresh root yield of 19.33t/ha while NR200002 revealed the least value of 2.67t/ha. Three genotypes had dry matter content above the two check varieties (Table1).Harvest index ranged from 0.17 to 0.56 with NR200010 recording the highest value of 0.56 and NR200001 with the least value of 0.17. NR200010 (0.56) had HI better than the check varieties (Table 1). Significant positive correlation was observed between harvest index and FRY (r= 0.64801**), DMC (r = 0.74776***), but cassava mosaic disease is negatively correlated to cassava bacterial blight (r = -0.13246), harvest index (r= --0.54436), FRY (r = -0.32384) and DMC(r = -0.40032) (Table 2). The analysis of variance shows significant difference among genotypes for cassava mosaic disease (Table 3).

Table 1.Mean performance of selected yellow root cassava genotypes to disease, and yield attributes at single row trial of breeding stage in Umudike

GENOTYPES	CMD	CBB	CAD	HI	FRY(t/ha)	DMC (%)
NR200001	3.00	2.00	2.00	0.17	10.67	13.46
NR200002	3.00	2.00	2.00	0.21	2.67	12.88
NR200008	2.50	2.50	2.00	0.38	7.00	32.54
NR200005	1.00	2.50	2.00	0.48	9.67	34.38
NR200006	1.00	2.00	2.00	0.33	16.00	26.12
NR200007	1.00	2.00	2.00	0.53	6.17	27.15
NR200004	1.00	2.00	2.00	0.52	19.33	35.24
NR200009	1.00	2.50	2.00	0.28	10.00	12.18
NR200010	1.00	2.00	2.00	0.56	17.33	26.06
TME419	1.00	3.00	2.00	0.52	26.00	30.93
UMUCASS46	1.00	2.00	1.50	0.55	23.67	30.95
LSD (0.05)	0.44	1.04	0.44	0.43	36.48	23.06

Key: CBB: cassava bacterial blight, CMD: cassava mosaic disease, CAD: cassava anthracnose disease, FRY: fresh root yield, DMC: dry matter content, HI: harvest index

Table 2: Correlation among disease, yield related traits of selected yellow root cassava genotypes evaluated at single row trial of breeding stage in Umudike

Source	**CMD**	**CBB**	**CAD**	**HI**	**FRY (t/ha)**	**DMC (%)**
CMD	1	-0.13246	0.11720NS	-0.54436	-0.32384	-0.40032
CBB		1	0.08718NS	0.12094NS	0.05907NS	0.20740NS
CAD			1	-0.13237	-0.12471	-0.11093`
HI				1	0.64801**	0.74776***
FRY (t/ha)					1	0.28861NS
DMC (%)						1

*(P<0.05), ** (P<.001), *** (P<.0001), ns - not significant, CBB: cassava bacterial blight, CMDS: cassava mosaic disease, FRY: fresh root yield, DMC: dry matter content, CAD: cassava anthracnose disease, HI: harvest index

Table3. Analysis of variance of yellow root cassava genotypes reaction to disease, and yield Components at single row trial of breeding stage in NRCRI, Umudike

Source	**DF**	**CMD**	**CBB**	**CAD**
REP	1	0.041NS	1.04NS	0.04NS
GENOTYPES	11	1.405***	0.22NS	0.04NS
ERROR	11	0.04	0.22	0.04
R^2		0.97	0.58	0.52
CV%		13.99	21.40	10.42

*(P<0.05), ** (P<.001), *** (P<.0001), ns- not significant, CMDS: cassava mosaic disease, CBB: cassava bacterial blight, CAD: cassava anthracnose disease, CV: coefficient of variation

CONCLUSION

All the genotype was susceptible to cassava bacterial blight (CBB) and cassava anthracnose disease. Three genotypes had dry matter content above the two check varieties.

ACKNOWLEDGMENTS

The Author is grateful to NRCRI, Umudike, HarvestPlus Project and Prof. Egesi, C.N for their support.

REFERENCES

Alicai, T., Szyniszewska, A. M., Omongo, C. A., Abidrabo, P., Okao-Okuja, G., & Baguma, Y. (2019). Expansion of the cassava brown streak pandemic in Uganda revealed by annual field survey data for 2004 to 2017. *Scientific Data*, *6*, 327. https://doi.org/10.1038/s41597-019-0334-9

Ceballos, H., Pérez, J. C., Barandica, O. J., Lenis, J. I., Morante, N., & Calle, F. (2016). Cassava breeding I: The value of breeding value. *Frontiers in Plant Science*, *7*, 1227. https://doi.org/10.3389/fpls.2016.01227

Fanou, A. A., Zinsou, V. A., & Wydra, K. (2018). Cassava bacterial blight: A devastating disease of cassava. In *IntechOpen* (pp. 14–36). London.

Kalyebi, A., MacFadyen, S., Parry, H., Tay, W. T., De Barro, P., & Colvin, J. (2018). African cassava whitefly, *Bemisia tabaci*, cassava colonization preferences and control implications. *PLoS ONE*, *13*(e0204862). https://doi.org/10.1371/journal.pone.0204862

Khandare, V., & Choomsook, P. (2019). Cassava export of Thailand: Growth performance and composition. *International Journal of Research and Analytical Reviews*, *6*, 847–857.

Koros, J. C., Runo, S. M., Yusuf, M., & Orek, C. O. (2018). Screening selected cassava cultivars for resistance against cassava viruses and cassava green mites under advanced yield trials in Kenya. *IOSR Journal of Biotechnology and Biochemistry*, *4*, 37–52. https://doi.org/10.9790/264X-0405023752

Malik, A. I., Kongsil, P., Nguyễn, V. A., Ou, W., & Srean, P. (2020). Cassava breeding and agronomy in Asia: 50 years of history and future directions. *Breeding Science*, *70*, 145–166. https://doi.org/10.1270/jsbbs.18180

Olutosin, A. O., & Sawicka, B. (2019). Cassava, a 21st century staple crop: How can Nigeria harness its enormous trade potentials? *Acta Agriculturae Slovenica*, *3*(8), 194–202.

Osuafor, O. O., Obianefo, C. A., & Dike, A. B. (2020). Food security and poverty status of cassava processors in Awka North Local Government Area of Anambra State, Nigeria. *The Bangladesh Journal of Agricultural Economics*, *41*(1), 1–16.

Otekunrin, O. A., & Sawicka, B. (2019). Cassava, a 21st century staple crop: How can Nigeria harness its enormous trade potentials? *Acta Scientifica Agricultura*, *3*, 194–202. https://doi.org/10.31080/asag.2019.03.0586

Uchemba, V. U., Nenna, G. M., & Obianefo, A. C. (2021). Adoption of improved cassava production technologies among small-scale farmers in Anambra State, Nigeria. *Journal of Plant Sciences*, *9*(4), 119–127.

Crossability Potentials of Selected Yellow Cassava Progenitors in NRCRI, Umudike, Nigeria

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Abstract
Hand pollination was carried out among six three genotypes/ varieties of cassava in reciprocals to investigate the influence of crossability potentials of selected yellow cassava progenitors. The experiment was conducted at National Root Crops Research Institute. Nine yellow flesh varieties (UMUCASS36, UMUCASS37, UMUCASS38, UMUCASS44, UMUCASS45, UMUCASS46, TMS011206, TMS982132, and TMS961089A) with high beta-carotene content and two white flesh varieties (GAME CHANGER and OBASANJO-2) with high dry matter content were crossed in a reciprocal, with selfing to produce nine hundred and fifty three hybrid seeds. The highest seed collected was recorded in the cross between NR1S1061 X UMUCASS36 (52) and TMS1659 X UMUCASS36 (97) which are the best female and male parents in terms of seed collected respectively. Population G5, G9, G13, G14, G16, G20, G21, G23, G29, G35, G39, G40, G43. G45, G47, G58, and G59 had the lowest seeds. In this regard, a total of 894 seeds were generated from cross pollinated comprising of 35 families, also, 56 seeds were recorded for partially inbred from 3 families while 7,121 seeds gotten from 5 families for open pollinated
Keywords: Crossabilty, fruit setting, time of flowering, progeny, hybridization

INTRODUCTION

Cassava is one of the leading staples in the world with a global total production of 252 million metric tonnes (FAOSTAT, 2012). Though with the current national estimate of 55 million cassava production in 2013 (NRCRI, 2013), the cassava genotypes grown by farmers in Nigeria are mostly local cultivars and few improved released varieties by NRCRI Umudike in collaboration with International Institute of tropical Agriculture (IITA),Ibadan (NRCRI, 2013). Improving the local cultivars (landraces) that flower requires a hybridization programme to generate hybrid progeny for recombination and selection. However, the success of a breeding programme depends largely on the choice of progenitors/parents used. Parental genotypes are usually selected on the basis of their performance or the performance of their F1 progeny (Ceballos *et al*., 2004).

However, experience has shown that cassava botanical seeds have low germination rate both in nursery and in the field (Ceballos *et al*., 2004; Kawano, 1978; Njoku *et al*., 2014) which eventually leads to loss of possible important genes, as well as wastage of land. Moreover, standard germination test by floatation do not always adequately predict seedling emergence under greenhouse and field conditions, and total percentage loss has not yet been established. The aims of the study were to investigate the effect of cassava genotypes on seed set, seed germination, and to ascertain the level of variability among progenitors in cross combination.

MATERIALS AND METHOD

Sixty-three cassava progenitors were selected and evaluated at National Root Crops Research Institute (NRCRI) Umudike research field, which lies within the humid rainforest agroecology of Nigeria (Njoku *et al*., 2014). They comprised four widely cultivated released white root cassava cultivars and fifty-nine yellow root cassava genotypes (thirteen released while others are yet to be released). The sixty-three cassava genotypes which were developed at NRCRI, Umudike have good agronomic, nutritional and disease resistance attributes. Cassava planting stakes were planted on November 2022 laid out. All the cultivars were selected based on their characteristics of good performance in terms of dry matter, pest and disease resistance, plant architecture, nutritional quality and flowering ability.

The six selected progenitors were then planted in a crossing block at NRCRI, Umudike in July, 2021.Manual weeding was performed as required. Controlled hand pollination was done according to the standard procedure described by Kawano (1980). Pollination bags were used to enclose flowers about to open to prevent fertilization by stray pollen upon opening. Pollen from the corresponding male parent was collected in the morning (7 to 8 am) and pollination was done later in the day between 11 am and 2 pm after female flowers had opened by dusting pollen on the stigma of a matching female. One male flower was used to pollinate up to three female flowers. Each flower branch was marked by a tag indicating cross combination with female parent listed first and followed by date of pollination and pollinator. Developing fruits were covered with netting bags three to four weeks after pollination to catch the dehisced seeds .Seeds were collected after two months, sorted, labeled and stored till the time of sowing. All the cultivars were selected based on their characteristics of good performance in terms of dry matter, disease resistance, stay green, drought resistance, early bulking potentials, nutritional quality and flowering ability (Table 1).

RESULTS AND DISCUSSION

Table 2 shows the cross combination and number of seeds collected in each cross during the development of the hybrid populations at Umudike between November 2021 and February 2022.Majority of the pollinated flowers did not develop into fruits. This may be probably because of the late in pollination which was offseason (November 2021 to February, 2022) and a lot of seed abortions. However, less than one seed was obtained per pollination on average in this study. This is far below the expectation according to submission by Ceballos *et al*. (2004) who stated that one or two seeds are obtained per pollination on average. The highest seed collected was recorded in the cross between NR1S1061 X UMUCASS36 (52) and TMS1659 X UMUCASS36 (97) which are the best female and male parents in terms of seed collected respectively (Table 2). Population G5, G9, G13, G14, G16, G20, G21, G23, G29, G35, G39, G40, G43. G45, G47, G58, and G59 had the lowest seeds (Table 2). However, the dry season and harmattan aids drying of the seeds, hence, the drying period for the seeds was reduced. Opening of mature flowers and drying of matured fruits depend on environmental conditions (Ceballos *et al*., 2004; Olasanmi *et al*., 2014). Number of seeds per female flower is genotype dependent; therefore, selection of highly fertile genotypes as female parents is a critical factor. The number of parents used in this study may not reflect the wide genetic variations often found among clones used as parents in cassava breeding programme. A total of 894 seeds were generated from cross pollinated comprising of 35 families, also, 56 seeds were recorded for partially inbred from 3 families while 7,121 seeds gotten from 5 families for open pollinated (Table 2).

Table 1.Description of some parent cultivars used in a cross mating design

Selected parents	Source and morphological description
UMUCASS36	Vitamin A cassava, yellow roots, moderate CMD resistance and high yielding. Released 2011
UMUCASS37	Vitamin A cassava, yellow roots, high CMD resistance, early bulking and high yielding. Released 2011
UMUCASS38	Vitamin A cassava, yellow roots, moderate CMD resistance and high yielding. Released 2011
TMS011206	High yellow roots, moderate CMD resistance, pink skin and high yielding. Released 2012
TMS982132	High yellow roots, moderate CMD resistance, high yielding, early bulking and drought tolerant. Released 2012
TMS961089A	High yellow roots, moderate CMD resistance, high dry matter and high yielding. Released 2009
UMUCASS45	Vitamin A cassava yellow roots, high CMD resistance, high yielding, early bulking and stay green. Released 2014
UMUCASS46	Vitamin A cassava roots, high CMD resistance, high yielding, early bulking, stay green and drought tolerant. Released 2014

CMD: cassava mosaic disease

Table 2: Number of seeds collected and cross combination in Sixty-two developed at NRCRI Umudike in 2021

Population	Cross combination	No of seeds collected
G1	S2109-9XTMS141092	15
G2	S2109-9XUMUCASS46	12
G3	S2109-17XUMUCASS36	31
G4	S2109-17XUMUCASS46	9
G5	S2109-17XTMS141092	4
G6	S2109-50XUMUCASS36	27
G7	S2109-50XGAME CHANGER	6
G8	S2109-50XOBASANJO-2	8
G9	S2109-50XTMS141092	2
G10	S2109-5-XUMUCASS46	32
G11	S2109-57XUMUCASS36	10
G12	S2109-57X UMUCASS46	8
G13	S2176-1X UMUCASS36	3
G14	S2176-1X UMUCASS46	3
G15	S2059-18X UMUCASS36	31
G16	S2002-2X UMUCASS36	2
G17	UMUCASS45X UMUCASS36	22
G18	UMUCASS45XTMS141092	14
G19	UMUCASS46XTMS141092	7
G20	UMUCASS46X UMUCASS36	2
G21	UMUCASS46XGAME CHANGER	1
G22	SECURITYX UMUCASS36	33
G23	SECURITYXTMS141092	3
G24	UMUCASS36X UMUCASS46	16
G25	UMUCASS37X UMUCASS36	37
G26	UMUCASS37XTMS141092	7
G27	TMS141092X UMUCASS46	4
G28	UMUCASS38XTMS141092	6
G29	UMUCASS38X UMUCASS36	2

Population	Cross combination	No of seeds collected
G30	NR1S1061X UMUCASS36	52
G31	NR1S1061X UMUCASS46	17
G32	NR1S1061XTMS141092	16
G33	NR1S1131X UMUCASS36	20
G34	NR1S1131XTMS141092	9
G35	NR1S1131XGAME CHANGER	2
G36	NR070282X UMUCASS36	38
G37	NR070282X UMUCASS46	20
G38	TMS950379X UMUCASS46	7
G39	TMS011206X UMUCASS36	3
G40	TMS011206X UMUCASS46	2
G41	TMS1569XUMUCASS36	97
G42	NR100388X UMUCASS36	15
G43	NR100388X UMUCASS46	1
G44	NR170007X UMUCASS46	20
G45	NR170007X UMUCASS36	3
G46	TMS070337X UMUCASS36	19
G47	TMS070337XUMUCASS46	1
G48	TMS141092X UMUCASS46	9
G49	TMS050303X UMUCASS36	5
G50	NR1S1205X UMUCASS36	36
G51	NR100384X UMUCASS36	30
G52	TMS961089AX UMUCASS36	29
G53	TMS130896X UMUCASS36	26
G54	TMS982132X UMUCASS36	17
G55	TMS130016X UMUCASS36	16
G56	TMS950475X UMUCASS36	7
G57	B1-95X UMUCASS36	6
G58	NR100387X UMUCASS36	3
G59	NR100172X UMUCASS36	2
G60	TMS30572XGAME CHANGER	6
G61	TMS30572X UMUCASS46	3
G62	TMS30572XTMS141092	3

Table 3: Seeds generated from Hybridization block (crossing block) at NRCRI Umudike in 2021

S/no	Types of seeds	Number of families	Number of seeds
1	Cross pollination	35	897
2	Partial inbred	3	56
3	Open pollinated	5	7,121
	Total	**41**	**8,074**

CONCLUSION

Most breeding programs start with the evaluation of available genetic variability, and how easily this variability can be fixed in the genotypes is very important.

ACKNOWLEDGMENTS

The Author is grateful to NRCRI, Umudike, HarvestPlus Project and Prof. Egesi, C.N for their support

REFERENCES

Ceballos, H., Iglesias, A. C., Pérez, J. C., & Dixon, A. G. O. (2004). Cassava breeding: Opportunities and challenges. *Plant Molecular Biology*, *56*, 506–516.

Food and Agriculture Organization of the United Nations (FAO). (2012). *Standardized food balance sheet from the FAO Basic Foodstuff Services, Commodities and Trade Division*. Rome, Italy: FAO.

Kawano, K., Narintaraporn, K., Narintaraporn, P., Sarakarn, S., Limsila, A., Limsila, J., Suparhan, D., & Watananonta, W. (1978). Yield improvement in a multistage breeding program for cassava. *Crop Science*, *38*, 325–332. https://doi.org/10.2135/cropsci1998.0011183X003800020007x

National Root Crops Research Institute (NRCRI). (2013). *Annual report on genetic improvement of root and tuber crops in Nigeria*. Umudike, Nigeria: National Root Crops Research Institute.

Njoku, D. N., Vernon, G. E., Offei, S. K., Asante, I. K., Egesi, C. N., & Danquah, Y. (2014). Identification of pro-vitamin A cassava (*Manihot esculenta* Crantz) varieties for adaptation and adoption through participatory research. *Journal of Crop Improvement*, *28*(3), 212–220. https://doi.org/10.1080/15427528.2014.888694

Olasanmi, B., Akoroda, M. O., Egesi, C., Okogbenin, E., & Fregene, M. (2014). Cross-compatibility among six improved cassava (*Manihot esculenta* Crantz) varieties. *Journal of Root Crops*, *40*, 15–22.

AGRICULTURAL SOCIETY OF NIGERIA
58TH ANNUAL CONFERENCE
UNIVERSITY OF ABUJA, NIGERIA
21-25 OCT. 2024
PROCEEDINGS

Nutritional and Sensory Evaluation of Ginger (*Zingiber Officinale*) Spiced on Smoked Catfish (*Heterobranchus longifilis)*

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Abstract
This study was conducted in Usmanu Danfodio University, Sokoto, to determine the effectiveness of ginger (Zingiber officinale) spice mixture on the shelf-life of smoked Heterobranchus longifilis at different concentrations 0g, 5g 10g, 15g and 20g respectively. 5kg of Heterobranchus longifilis weighing 500-1000g was obtained from Sokoto fish market of Wamako Local Government Area for the study. The fish were divided into five treatments and coated with appropriate quantities of ginger paste to the stated concentrations. They were then soaked for 30min-1 hour and were stored in ambient temperature of (25-30^{0}c). The mean values obtained for the proximate analysis of the fresh samples were: moisture (57.04±1.99), ash (1.70±0.27), lipids (1.80±0.27), fibre (0.10±0.22), crude protein (18.29±0.57), Nitrogen Free Extract (21.41±2.62) and Total Volatile Base Nitrogen (34.44±1.60). The result obtained indicated that there were significant difference (P<0.05) in terms of organoleptic qualities, mineral composition and microbial load between the fresh and smoked catfish. In the minerals, there were significant difference in sodium, potassium while there was no significant difference in the magnesium, calcium and phosphorus. The microbial count reduces as the number of storage days increases. The result also showed that samples treated with ginger paste had lower microbial load than the control. Ginger has anti-oxidant and anti-fungal properties which can extend the shelf life of smoked Heterobranchus longifilis. It can be recommended that ginger (Zingiber officinale) should be used in smoking fish as it increases its shelf-life.

Keywords: Ginger, Sensory evaluation, Zingiber officinale and Heterobranchus longifilis.

INTRODUCTION

African catfish (*Heterobranchus longifilis*) is one of the most important species that are cultured both in and outside its natural environments. It is highly favoured by fish farmers due to its rapid growth, robust resistance to diseases, and adaptability to a broad range of environmental conditions, including extreme temperatures and low oxygen levels. Catfish is mostly served in different forms such as barbeque, roasted fish, fish sauce, fish pepper soup, smoked fish, among other forms of preparation (Olaniyi *et al*., 2016). Smoking can preserve fish to some extent, but smoked fish products can still be contaminated by microbes and lose nutrients if not protected from their environment (Babic Milijasevic *et al*., 2019). Unfortunately, traders neglect this potential hazard to consumers and the loss of freshness associated with smoked fish by displaying or selling their products without proper protection (Ikutegbe and Sikoki, 2014). The objective of this study is to evaluate the effects of ginger (*Zingiber officinale)* spices on nutritional value and sensory evaluation of smoked *Heterobranchus longifilis.*

MATERIALS AND METHOD

Study Area

The research was conducted in Usmanu Danfodiyo Universty Main campus Sokoto, Sokoto State, Nigeria. Sokoto is located to the extreme North-western part of Nigeria between longitude 11'30' to 13'50E and latitude 4' to 6'0, N (Anonymous, 2002). Sokoto share common border with Niger Republic to the North, Kebbi State to the South-West and Zamfara to the East. The total land mass is about 32,000sqkm. Sokoto State has population of 3,696,999 people (2006, census). Vegetationally, the State falls within the savannah zone, rainfall starts late and early with mean annual rainfall ranging between 55mm and 1,300mm with temperature ranges of 35'C to 41'C.

Preparation of Fish Samples

5kg of *Heterobranchus longifilis* weighing 500-1000g was obtained from Sokoto fish market of Wamako Local Government Area. The fish samples were first gutted and washed with water to remove slime and dirt. The first, second, third and fourth group were soaked in 5%, 10%, 15% and 20% Ginger solution respectively for 30min/1 hour for the fish tissue to absorb significant quantities of salt and ginger.

Smoking Process

Chunks of fuel wood was arranged in the combustion chamber of the kiln with fire to produced heat under the racks. The fish was arranged on the drying racks in the smoking chamber. The door of the kiln was covered, to allow heat and smoke to take effect on the fish (Sefa-dedeh *et al*., 1995). The fish was smoked until brown. The fish was uncovered and turned over individually. However, the turning of the fish helps to allow smoke deposition on both sides of the fish (Njai and Njie, 1998). The fish was covered again and smoked until fully brown and well cooked. After the whole process, the fire was lowered; the fish was uncovered and left to cool. After cooling, the treated fish and the control were arranged packaged in cartoon and stored for further experiments.

Procedure for Proximate Analysis

The proximate analysis of the sample was done at Agricultural Chemical Laboratory which is located at N 13º07.716" E 005º12.265" elevation 288m height above sea level (Researchers modification). After the preparation of the *H. longifilis* using ginger, they were taken for analysis of moisture, protein, fat as described by James (1995).

Sensory Analysis and Scoring Procedure

This was undertaken to determine the taste, odour, texture and colour of the samples. Taste panel of fifteen (15) members were utilized on scoring of the samples and scores at every two weeks interval for the period of 8 weeks were made. The products were scored on a 5 point hedonic scale questionnaire, 8 – excellent, 6 – good, 4 – fair, 2 – poor and 0 – bad according to Ihuahi *et al.* (2005) and Eyo (2001).

Data Analysis

The data collected was subjected to statistical analysis using one way analysis of variance (ANOVA) and Duncan's multiple range tests was used for mean separation. The statistical analysis will be conducted by using IBM SPSS version 20 software.

RESULTS AND DISCUSSION

Table 1: Proximate analysis of smoked *Heterobranchus longifilis* spiced with different concentration of ginger

	Treatments					
Parameters	**Fresh sample**	**0%**	**5%**	**10%**	**15%**	**20%**
Moisture	57.04±1.99^{b}	9.75±0.65^{a}	9.25±0.65^{a}	9.63±1.34^{a}	10.75±1.71^{a}	10.13±1.25^{a}
Ash	1.70±0.27^{a}	4.25±0.65^{b}	5.25±0.65^{b}	4.88±2.18^{b}	4.88±0.48^{b}	4.63±0.85^{b}
Lipids	1.80±0.27^{a}	7.13±0.75^{b}	6.88±1.38^{b}	6.88±1.11^{b}	6.88±0.85^{b}	6.75±0.65^{b}
Fibre	0.10±0.22^{a}	2.00±0.58^{b}	1.88±0.48^{b}	2.00±0.41^{b}	2.13±0.48^{b}	1.88±0.25^{b}
C.P	18.29±0.57^{a}	37.87±3.28^{b}	36.00±1.63^{b}	37.43±1.95^{b}	37.32±2.28^{b}	37.83±3.61^{b}
NFE	21.41±2.62^{a}	39.00±2.41^{b}	40.75±1.87^{b}	39.20±3.98^{b}	38.06±3.01^{b}	34.3±8.11^{b}
TVB-N	34.44±1.60^{a}	84.00±9.35^{b}	82.95±3.86^{b}	81.55±88.19^{b}	85.05±7.44^{b}	83.30±9.18^{b}

Mean±SD with the same letters are not significantly different (p>0.05)

Table 2: Sensory attributes of smoked *Heterobranchus longifilis* spiced with different concentration of ginger

Parameters	**Treatments**	Storage Period In Days			
		1st	**14th**	**28th**	**42nd**
Taste	0%	7.60±0,83^{b}	5.07±1.49^{b}	6.80±1.27^{a}	5.07±1.49^{b}
	5%	7,07±1.03^{b}	4.40±1.12^{b}	7.20±1.01^{a}	4.40±1.12^{b}
	10%	6.80±1.65^{b}	4.80±0.1.01^{b}	6.93±1.03^{a}	4.80±1.01^{b}
	15%	6.93±1.49^{b}	3.07±1.28^{a}	6.40±1.12^{a}	3.07±1.28^{a}
	20%	5.60±1.55^{a}	4.67±1.45^{b}	6.53±1.60^{a}	4.67±1.447^{b}
Odor	0%	7.20±1.01^{b}	3.60±1.12^{b}	5.47±1.19^{a}	3.60±1.12^{b}
	5%	6.13±1.19^{a}	2.80±1.01^{ab}	6.40±1.55^{a}	2.80±1.01^{ab}
	10%	6.53±1.41^{ab}	2.40±0.83^{a}	5.73±1.49^{a}	2.40±0.83^{a}
	15%	5.73±1.49^{a}	3.33±1.63^{ab}	5.47±1.41^{a}	3.33±1.63^{ab}
	20%	5.87±1.60^{a}	3.07±1.28^{ab}	5.47±0.92^{a}	3.07±1.28^{ab}
Texture	0%	7.60±0.83^{b}	3.47±1.41^{ab}	6.13±1.19^{a}	3.47±1.41^{ab}
	5%	7.20±1.01^{b}	4.00±1.31^{ab}	6.67±1.23^{a}	4.00±1.31^{a}
	10%	7.07±1.03^{b}	3.20±1.01^{a}	6.80±1.27^{a}	3.20±1.01^{a}
	15%	6.80±1.47^{ab}	3.87±1.60^{ab}	6.80±1.01^{a}	3.87±1.60^{ab}
	20%	6.13±1.19^{a}	4.40±1.12^{b}	6.40±1.12^{a}	4.40±1.12^{b}
Appearance	0%	7.07±1.03^{a}	3.33±0.98^{a}	5.73±1.49^{a}	3.33±0.98^{a}
	5%	6.53±1.41^{a}	3.20±1.01^{a}	6.13±1.19^{a}	3.20±1.01^{a}
	10%	6.67±1,63^{a}	5.20±1.27^{b}	6.40±1.55^{a}	5.20±1.27^{b}
	15%	6.53±1.19^{a}	5.47±0.92^{b}	5.87±1.41^{a}	5.47±0.92^{b}
	20%	6.13±1.19^{a}	3.60±1.72^{a}	6.67±1.23^{a}	3.60±1.72^{a}

Means±SD with the same letters in the same column have no significant difference (p>0.05)

Table 3: Mineral composition of smoked *H. longifilis* spiced with different concentration of ginger

	Treatments					
Parameters	**Fresh Sample**	**0%**	**5%**	**10%**	**15%**	**20%**
Sodium	109.00±3.35^{a}	116.88±17.37^{ab}	111.25±5.20^{ab}	117.50±9.79^{ab}	121.25±11.27^{ab}	140.625±40.18^{b}
Potassium	1490.00±54.77^{a}	1800.00±248.33^{b}	1450.00±122.47^{a}	1537.50±62.92^{a}	1550.00±81.65^{a}	1587.50±110.86^{a}
Calcium	0.96±0.042^{a}	0.89±0.09^{a}	0.91±0.63^{a}	0.95±0.82^{a}	0.98±0.05^{a}	0.98±0.03^{a}
Magnesium	1.94±0.02^{a}	1.89±0.18^{a}	1.80±0.24^{a}	1.81±0.93^{a}	1.80±0.15^{a}	1.84±0.14^{a}
Phosphorus	3.10±0.01^{a}	3.73±0.65^{a}	3.67±0.59^{a}	3.70±0.62^{a}	3.73±0.63^{a}	3.91±0.88^{a}

Means±SD with same letters are not significantly different (p>0.05)

Table 4: Mean total viable counts of colonies of smoked *H. longifilis* using ginger spiced (log 10^5 cfu/g)

Days	Fresh sample	0%	5%	10%	15%	20%
1st	160	108	97	96	84	57
14th	208	102	94	94	73	41
28th	106	112	92	96	86	58
42nd	140	99	89	87	84	30

Proximate Composition of Smoked *Heterobranchus longifilis*

The result obtained in proximate analysis Table 1 showed that the fresh sample moisture content is (57.04±1.99) while the highest moisture content of the smoked sample is (10.75±1.71). The observed reduction in moisture content between the fresh and the smoked samples was due to loss of the moisture during smoking as observed also by Salan *et al*. (2006). The moisture content of each sample differ significantly ($p<0.05$) for each week. The percentage of smoked crude protein level is higher than that of the fresh sample; this shows that smoked fish have highest protein than fresh fish. Highest lipid concentration was recorded in 0% ginger concentration (7.13±0.75), while others 5%,10%,15% and 20% which are not significantly different from each other at $p>0.05$ are both significantly different from the fresh sample (1.80±0.27).The percentage of the total protein, ash and fats were significantly higher in smoked fish's samples than fresh samples, which was in line with report of (Aliya, 2012) that smoking results in concentration of nutrients like protein and fat (Gokoglu *et al*., 2004).

Microbial Count of Smoked *Heterobranchus longifilis*

The presence of moisture in smoked fish permits the growth of moulds during storage (Eyo, 2001). The total viable count of the fresh samples ranged from (log 10^5)106 to 108 cfu/g. Also treated smoked samples ranges from 30 to 108 cfu/g. This result shows that the higher the concentration of ginger the higher the anti-fungal effects. This result agrees with earlier result of (Ngbenebor, 1990) where clove and ginger individually and in combination reduced the fungal loads of smoked fish. This result indicates also indicates that the ginger which is a natural spice clearly have anti-fungal properties that can compare with synthetic antimicrobial agents like potassium sorbate, citric acid and sodium metabisulphite which anti-fungal agents as reported earlier (Omojowo *et al*., 2009a, Omojowo *et al*., 2009b). The ability of the ginger to inhibit mould growth would in a way enhance the overall quality of the product. The results showed that the microbial load in the smoked fish products reduces as the storage days increases.

Sensory Evaluation

Sensory method are considered to be the most useful and dependable criteria for assessing the degree of freshness for quality determination. Human being is capable to detect from visual signs of deterioration such as loss of freshness and changes during storage period. Sensory quality assessment is an easy, quick and efficient method of getting idea about the quality of the product. This methods responds or tendency of sense organ for accepting the food products. The quality assessment as well as sensory evaluation (score) was carried out in a well conducive, well ventilated and well lightened environment to enable panelists judge appropriately. It is carried out at every two weeks intervals using following 9-points hedonic scale such as taste, odor and texture. The scores from the panelist revealed that the freshly smoked sample treated with 5% ginger was not significantly ($p>0.05$) different from the control in terms of taste, odor and texture. However, the 5% ginger is significantly rated higher ($p<0.05$) tan the 10%, 15% and 20% respectively in acceptability.

Minerals Composition

The result of the mineral composition presented in table 4.4 indicates that the fish products are rich in calcium in 15% and 20% ginger concentrations having the highest level (0.98±0.05) and (0.98±0.03) respectively while the control has the lowest calcium level (0.89±0.0.09) Calcium is required for maintaining and building bone and tooth, it also perform the functions of adjusting the acid-base balance, blood coagulations and transporting nerve impulse. The highest value of Sodium was observed in 20% ginger concentration (140.63±40.18) while 5% contains the least value of Na is (111.25±5.20). P is highest in 20% (3.91±0.88) whereas lowest (3.67±0.59) in 5% ginger concentration. Generally, the minerals occurred at low level within the international limits thereby making these products safe for consumption (FAO, 1992).

CONCLUSION

This present study has demonstrated that ginger (*Zingiber officinale*) extract has antioxidative and microbial properties that can delay oxidative rancidity and inhibit mould growth, thus, extending the shelf life of the smoked fish (*Heterobranchus longifilis*). This is justified by the number of mould count of the ginger treated samples, compared to the untreated samples. Organoleptically, the general pattern of consumer preference to the products indicates that the ginger treated samples were most acceptable in relation to the storage stability.

ACKNOWLEDGEMENT

All parties who would have contributed in this research are hereby appreciated by the author.

REFERENCES

Olaniyi, W. A., Olukayode, A. M. and Omitogun, O. G. (2016). Comparison of proximate composition and sensory attributes of *Clariid* catfish species of *Clarias gariepinus*, *Heterobranchus bidorsalis*, and their hybrids. *Food Science and Nutrition.* 5(2): 285–291. https://doi.org/10.1002/fsn3.391

Babic Milijasevic, J., Milijasevic, M. and Djordjevic, V. (2019). Modified atmosphere packaging of fish - An impact on shelf life. *IOP Conference Series: Earth and Environmental Science*. *333*(1). https://doi.org/10.1088/1755-1315/333/1/012028

Ikutegbe, V. and Sikoki, F. (2014). Microbiological and biochemical spoilage of smoke-dried fishes sold in West African open markets. *Food Chemistry*. 161. 332–336. https://doi.org/10.1016/j.foodchem.2014.04.032

Anonymous, (2002). Sokoto State Government. Government Printing Press.

Sefa-dedeh, J. (1995). Traditional fish processes: Technology, quality & evaluation. *In Workshop on Seeking Improvement in Fish Technology in West Africa.* IDAF Technical Report. No: 66

Njai, S.E. and Njie, M. (1998). Overview of artisanal fish processing in the Gambia. Fisheries Department, Gambia. Pp. 1-10. Unpublished.

James, S. C. (1995). Analytical Chemistry of Food. Chapman and Hill Printers. London, England.

Ihuahi, J.A., Omowojo, F. S. and Ugoala, A. E (2005). Effect of Spice Treatment on the quality of Hot-smoked Catfish (*Clarias gariepinus)* National Institute for Freshwater Fisheries Research NIFFR, In: Fish proceeding, Quality Control and package for International Market. Pp.363-368.

Eyo, A. A. 2001. Fish processing technology in the tropics, University of Ilorin Press. 403pp.

Salan, O. E, Juliana, A. G. and Marillia, O. (2006) Use of Smoking to add value tosalmoned trout. Braz. Architecture Biology Technicol 2006; Volume 49(1): pp.57-62.

Aliya, G., Humaid, K., Nasser, A., Sami, G., Aziz, K., Nashwa, M. and Ponnerasser, S. S. (2012). Effect of the freshness of starting material on the final product quality of dried salted shark. *Advance Journal Food Science.* Technology, Volume 4(2): pp. 60-63.

Gokoglu, N., Pinar, Y. and Emel, C. (2004). Effects of Cooking Methods on the Proximate Composition and Mineral contents of Rainbow Trout (*Onchorhychus mykiss*). Food Chemistry, Volume 84: pp. 19-22.

Negbenebor, C. A (1990). Raw material supply for fish and animal processing Industries. In Proceedings of a workshop organized by the N/E Chapter of NIFST, Maiduguri, Nigeria. Pp. 12-24

Omojowo, F. S., Olokor, J. O. and Ihuahi, J. A. (2009a). Microbial Qualities of Potassium Sorbate on Treated Smoked Tilapia (*Oreochromis niloticus*). *World Journal of Biological Research,* Volume 2: Pp. 1-4.

Omojowo, F. S., Idris, G. L. and Ihuahi, J. A. (2009b). Comparative Assessment of Potassium Sorbate and Sodium Metabisulphite on the Safety and Shelf Life of Smoked Catfish. *Nature and Science,* Volume **7**(10): Pp. 10-17.

FAO (1992). Fermented fish in Africa. A study on processing, marketing and consumption. FAO Fisheries Tech. paper 329, FAO, Rome.

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Determinants of Value Addition Decisions and Levels Among Rice Farmers in Benue State, Nigeria: a Heckman Two-Step Selection Model Approach

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Abstract

Value addition in agriculture is crucial for enhancing productivity, income, and food security, particularly for smallholder farmers. However, in Benue State, smallholder rice farmers face numerous challenges in adopting value addition strategies, resulting in suboptimal economic outcomes. This study thus examined the determinants of value addition decisions and the extent of value addition among rice farmers in Benue State using the Heckman two-step selection model to account for selection bias. Data were collected from 379 rice farmers using structured questionnaires, and the analysis revealed that age, farming experience, annual farm income, annual non-farm income, total cost, and total return significantly influenced value addition decisions and levels. The findings indicate that older farmers (β= 0.06) are more likely to engage in value addition, while those with greater farming experience (β = -0.30) are less likely, likely due to larger household sizes. Income from farm (β =0.000015) and non-farm (β = 0.000011) sources positively influenced the level of value addition, while higher production costs (β = -0.00099) reduced it. The study recommended the formation or strengthening of farmer cooperatives to these farmers access shared processing facilities, market collectively, and reduce overhead costs related to value addition; and that Benue State government should introduce rice milling and packaging equipment leasing services so that smallholder rice farmers who cannot purchase these equipment can hire them at subsidized rate. This would encourage more farmers to engage in value addition activities.

Keywords: Value Addition, Decision, Rice Farmers, Heckman Selection Model, Benue State, Nigeria

INTRODUCTION

Value addition in agriculture has been recognized as a critical pathway to improving productivity, income, and food security for smallholder farmers (Bosompem et al., 2024). In Nigeria, where rice is a major staple crop, Egwu (2018) revealed that the ability of farmers to engage in value addition activities such as milling, packaging, and branding is crucial to enhancing their market competitiveness, reducing post-harvest losses, and increasing incomes. However, many smallholder rice farmers, especially in Benue State, face significant challenges in adopting value addition strategies, leading to suboptimal market outcomes and diminished economic returns (Terdoo, 2024).

This low level of engagement may be due to a combination of socio-economic factors, lack of technical know-how, and insufficient infrastructure (Rukwe et al., 2023). However, a comprehensive understanding of these socio-economic factors and how they affect both the decision to engage in value addition and the level of engagement remains underexplored.

To address this research gap, this study sought to analyze the determinants of value addition decisions and the level of value addition among rice farmers in Benue State, Nigeria, using the Heckman two-step selection model. The Heckman model is particularly suited for this analysis as it accounts for selection bias, which may arise when only a subset of farmers who add value are observed, thus leading to biased estimates if traditional models are used (Heckman, 1979). By identifying the factors that influence both the decision to engage in value addition and the extent of such engagement, this study will provide valuable insights for policymakers and development practitioners seeking to enhance rice value chains in Nigeria.

METHODOLOGY

Study Area

This study was conducted in Benue State of Nigeria. The State, created in 1976, is located in the Middle Belt of Nigeria. It is located between latitudes 4° and 14° North of the Equator and longitudes 2.75 and 14.5° East of the Greenwich Meridian. According to the 2006 census results, Benue State has a population of about 4.2 million (NBS, 2006) and a projected population in 2023 of 7.3 million people using a growth rate of 3.2 %. The State has a total area of about 30955 km^2 and administratively it is divided into 23 Local Government Areas with its headquarters at Makurdi.

The State is referred to as the "*Food Basket of the Nation*" because of the abundance of its agricultural resources and about 80% of the State population is estimated to be involved directly in subsistence agriculture. The State is a major producer of food and cash crops like yam, cassava, rice, groundnuts and maize.

Population of the Study

The population of the study consisted of 7468 registered rice farmers in Makurdi, Gboko, Gwer-East, Otukpo, Agatu, and Kwande Local Government Areas of Benue State under review by Benue Value Chain Development Programme (VCDP) in 2021.

Sampling Technique and Data Collection

Multi-stage sampling technique was employed to select the sample of 379 rice farmers. The data for the study were collected using structured questionnaire.

Analytical Techniques

The Heckman two-step selection model was used to identify and analyse the socio-economic factors influencing value addition decision and level among rice farmers in the study area. The Heckman selection model was specified as follows:

Value addition decision equation:

$$P_i = a+b_1X_1+b_2X_2+b_3X_3+b_4X_4+\mu_i \qquad (1)$$

Where;

P_i = the probability that a respondent participated in value addition (1= participated; 0= did not participate)

a = constant of the equation; b_1-b_4 = coefficient of the predictor variables; X_1 = sex (male = 1; female = 0); X_2 = age (years); X_3 = farming experience (years); X_4 = educational level (years); and μ_i = error term

Level of value addition equation:

$$Y_i = a+b_1X_1+b_2X_2+b_3X_3+b_4X_4+\mu_i \quad (2)$$

Where;
Y_i = level of value addition (quantity of paddy in kg); a = constant of the equation; b_1-b_4 = coefficient of the predictor variables; X_1 = annual farm income (Naira); X_2 = annual non-farm income (Naira); X_3 = total cost (Naira); X_4 = total return (Naira); and μ_i = error term

RESULTS AND DISCUSSION

Determinants of Value Addition Decisions and Level of Value Addition among Actors in Rice Value Chain

The estimates of Heckman two-step model for the likelihood of value addition decisions and level of value addition among rice farmers in the study area are presented in Table 1. The Wald Chi2 was 1486.31 and significant at 1%, thus rejecting the null hypothesis of independent equations. The coefficient of the Mills Lambda was significant at 5% level. The significance of the Mills Lambda rejects the hypothesis that assumes that the first stage and second stage decision of the farmers are not related.

The coefficient of age was significant at 1% and positively related to the probability of value addition decision on paddy rice among rice farmers. The implication is that, as the age of the farmer increase, he/she is 2.00 percentage points more likely to add value to paddy rice. Aged farmers are more likely to have acquired experience, knowledge, skills and resources required to add value to paddy than the younger farmers. This finding is in tandem with Eze *et al.* (2022) who posited that age increases the probability of value adding decision to agricultural produce and attributed this to access to resources such as capital, family labour, equipment, building, land, and other required inputs that increases with age.

The coefficient of farming experience was significant at 1% and negatively related to the probability of value addition decision on paddy rice, implying that as years of farming experience of the framer increases, he/she is 10.61 percentage points less likely to add value to paddy rice. Farmers with more years of experience in farming are expected to have acquired more knowledge, skills and resources needed to add value to paddy (Acharjee *et al.,* 2022). However, farmers with more years of farming experience and are less likely to add value to paddy are those with larger household size. This large household size implies more mouths to take care of and increased family expenditure and hence less resources to invest in value addition. This finding is in consonance with Adeyonu *et al.* (2016) who observed a negative relationship between value addition decision and household size and attributed this to higher consumption which leaves little or no resources to add value to raw agricultural products.

The coefficient of annual farm income and annual non-farm income were significant at 1% and positively associated with the level of value addition decision on paddy rice among rice farmers. Similarly, the coefficient of total return was significant at 10% and positively associated with the level of value addition on paddy rice. The implication is that, as the annual farm income, annual non-farm income, and return of these farmers increase by ₦1, their level of value addition on paddy rice increases by 0.000015kg, 0.000011kg, and 0.000060kg respectively. This is expected as more income and revenue provide the needed capital to undertake value addition activities. This finding corroborates Eze *et al.* (2022) who observed a positive relationship between income and value addition on agricultural products.

The coefficient of total cost was negative and significant at 1%. The negative sign of the coefficient shows that as total cost increases, the level of value addition on paddy rice by rice farmers decreases by 0.000099kg. Increased cost of production reduces available income needed for other investment opportunities. Hence, as the total cost of production increases, income available to be channeled to value addition on paddy rice is negatively affected. This is in tandem with Hussani *et al.* (2020) who revealed high cost of resources as one of the key constraints to rice actors' investment in rice value addition in Kebbi State, Nigeria.

Table 1: Determinants of Value Addition Decisions and Level of Value Addition among Rice Farmers.

	Value addition decisions equation			**Level of value addition equation**	
Variable	**coefficient**	**Standard error**	**Marginal Value**	**coefficient**	**Standard error**
Sex	0.22^{NS}	0.17	7.77		
Age	0.06***	0.02	2.00		
Farming experience	-0.30***	0.04	-10.61		
Level of Education	-0.0040^{NS}	0.08	-0.14		
Constant	-0.38^{NS}	0.64			
Annual farm income				0.000015***	1.22×10^{-6}
Annual non-farm income				0.000011***	1.55×10^{-6}
Total cost				-0.00099***	0.00016
Total return				0.000060*	0.000033
Constant				-4.91^{NS}	2.33
Diagnostic statistics					
Mills Lambda	-1.06**	0.44			
Wald Chi2	1486.31***				

Source: Field Survey Data, 2023. *** = Significant @ 1%; ** = significant @ 5%; * = significant @ 10%; NS = not significant

CONCLUSION AND RECOMMENDATIONS

The study provides significant insights into the determinants of value addition decisions and levels among rice farmers in Benue State, Nigeria, using the Heckman two-step selection model. The findings reveal that socio-economic factors influence both the decision to engage in value addition and the extent of engagement in value addition activities, which is essential for enhancing market competitiveness and increasing the incomes of smallholder rice farmers.

Based on the findings of the study, the following were recommended:
1. Formation or strengthening of farmer cooperatives should be encouraged. Through such cooperatives, farmers can access shared processing facilities, market collectively, and reduce overhead costs related to value addition.
2. Benue State government should introduce rice milling and packaging equipment leasing services so that smallholder rice farmers who cannot purchase these equipment

can hire them at subsidized rate. This would encourage more farmers to engage in value addition activities.

REFERENCES

Acharjee, D.C., Alam, G.M.M., Gosh, K., Haque, A.B.M.M. and Hossain, M.I. (2022). Fish Value Chain and the determinants of Value Addition Decision: Empirical Evidence from Bangladesh, *Journal of the World Aquaculture Society,* 1-14

Adeyonu, A. G., Ajala, A. O., Adigun, G. T., Ajiboye, B. O. and Gbotosho, O. O. (2016). Determinants of Sweet Potato Value Addition among Smallholder Farming Households in Kwara State, Nigeria. *Journal of Tropical Agriculture, Food, Environment and Extension,* 15(1): 17-22.

Bosompem, M., Arhin, P., Nunoo, J. and Amoah, K.K. (2024). Smallholder Farmers' Participation in Cassava Value Addition Practices: What Drivers Matter in Ghana? *Journal of Agriculture and Food Research*, 16: 1-10.

Egwu, W.E. (2018). Profit Analysis and Determinants of Value Added Rice among Farmers in Abakaliki Metropolis, Ebonyi State, Nigeria. *Nigerian Agricultural Journal*, 49(1): 273-278.

Eze, A. V., Machara, I. and Ngare, L. (2022). Factors influencing value Addition to Cashew Products Processed in the South East Zone, Nigeria: A Multinomial Logistics Regression Approach. *International Journal of Agricultural Science and Food Technology,* 8(1): 59 – 71.

Hussaini, A.S., Oladimeji, Y.U., Sanni, S.A. and Abdulrahman, S. (2020). Determinants of Rice Farmers' Investment in Value Addition and its Effect on Poverty status in Kebbi State, Nigeria. *Nigeria Journal of Basic and Applied Science,* 28(1):75-84

National Bureau of Statistics (NBS) (2019). Labour force statistics: employment by sector report-Q3; Available from: *http://www.nigerianstat.gov.ng/*

Rukwe, D.T., Barau, A.D., Aboki, E., Adi, Z.A. and Luqman, M.M. (2023). Economics of Rice Value Addition among Farming Households in Taraba State, Nigeria. *Journal of Agricultural Economics, Environment and Social Science*, 9(2): 131-146.

Terdoo, F. (2024). Vulnerability and Adaptation of Rice Value Chain in Benue state, Nigeria. *African Journal of Economic and Sustainable Development*, 9(3): 178-200.

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Correlation and Regression Analysis of Irrigated Onion (*Allium cepa* L.) in Response to Nitrogen Fertilizer Rate and Plant Population

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Abstract

Association between growth and yield parameters of irrigated onion to nitrogen fertilizer and plant population was studied during 2019/2020 dry season. The experiment was conducted at the Institute for Agricultural Research (IAR), Ahmadu Bello University, Samaru, Zaria (11º11'N, 07º38' E, 684 M), Northern Guinea Savanna of Nigeria and at the Irrigation Research Station (IRS), Kadawa (11°39'N, 08°02'E, 500 M) in the Sudan Savanna of Nigeria. The treatments consisted of five levels of nitrogen (0, 40, 80, 120 and 160 kg N ha^{-1}), factorially combined with four levels of plant population (160,000; 250,000; 444,444 and 1,000,000 plants ha^{-1}) in a Randomized Complete Block Design (RCBD) replicated three times. Correlation results revealed the highest contributor of bulb yield at Samaru as shoot dry matter, total dry matter and leaf area index while at Kadawa it was bulb dry weight, number of leaves, shoot dry matter, total dry matter and leaf area index. This shows that each improvement on any of these parameters could translate into an increase in bulb yield. Other significant contributors to bulb yield at both locations were plant height and bulb diameter while relative growth rate was positive but not significant. Regression analysis revealed a quadratic response of bulb yield to nitrogen fertilizer and plant population at both locations, indicating that, optimum level of nitrogen was attained at 114.08 and 150.5 kg N ha^{-1} at Samaru and Kadawa respectively. Similarly, optimum plant population was attained at 750,000 plant ha^{-1} at Samaru while 666,666 plant ha^{-1} was obtained at Kadawa.

Keywords: correlation, regression, nitrogen, plant population, irrigation.

INTRODUCTION

Onion (*Allium cepa* L.) belongs to the family Alliaceae and is believed to be originated from central Asia. (Brewster, 2008). Onion is known for its medicinal properties and nutritional value as it is rich in proteins, carbohydrates, minerals and vitamins, thiamine, riboflavin, niacin and ascorbic acid. (Randle, 2000). According to FAOSTAT, (2019) onion is the second most produced vegetable after tomato (*Solanum lycopersicum*) with world production estimated to 99.94 million metric tons in 2019 where China leads with 24.91 MMT.

In Africa, Egypt (3.08 MMT) is the leader of onion production while in West Africa, Niger republic (1,011,577 tons) and Nigeria (1,004,153 tons) are the mains producers of onion with an obtainable yield of 14 - 30t ha^{-1} (FAOSTAT, 2019), depending on cultivars, environment and management. Onion is a versatile crop which tolerate wide range of soil. However, a well-drained sandy loam soil rich in organic matter is preferred. It is a cool-season crop which require temperatures between 13 and 24°C and soil pH of 6.0 to 6.8 for optimum development. (Shanmugasundaram and Kalb, 2001).

In Nigeria, onion is produced in almost all the savanna zone especially in Gombe, Sokoto, Kaduna, Kano, Plateau and Borno states. However, the performance of the crop is impacted by some limiting factors especially nutrients as nitrogen and plant population. In fact, onion crop requires high nitrogen availability for optimum development, (Greenwood et al., 1980) and high yield is achieved with appropriate rate of nitrogen otherwise excess of N affect onion quality, yield and leads to nitrate leaching into groundwater. (Brewster, 2008).

In onion production, the number of plants per unit area is important to consider as optimal population is vital for plant development through adequate water and nutrient uptake as well as light interception and aeration within the canopy. (Gessesew, 2015). The establishment of optimum plant population for efficient development that would translate into higher yield is then crucial. However, the response of onion crop to nitrogen and plant population may differs with the environmental variation and cultivars. (Dessalegn and Aklilu, 2003).

This study was conducted with the aims of finding optimum rate of nitrogen with adequate plant population for maximum yield of onion; and to assess the relationship between some growth and yields traits which contribute to onion bulb yield under irrigation in Sudan and Guinee Savanna zones of Nigeria.

MATERIALS AND METHODS

Field trials were carried out under irrigation during 2019/2020 dry season at the irrigation research field of the Institute for Agricultural Research (IAR) Samaru (11°11'N, 07°38'E, 686 m above the sea level) and at the Irrigation Research Station of the Institute for Agricultural Research, Kadawa (11°39'N, 08°02'E, 500 m above the sea level) located in the Sudan Savanna ecological zone of Nigeria.

Prior to land preparation, five samples of soil were collected randomly at 0 – 30cm depth from different point and were subjected for analysis of the physical and chemical properties.

The experiment was conducted in randomized completely block design (RCBD) with three replications. The treatments consisted of a factorial combination of five rates of Nitrogen fertilizer (0, 40, 80, 120, 160 kg ha^{-1}) and plant population at four levels (160,000; 250,000; 444,444 and 1,000,000 plants ha^{-1}). Spacing of 10×10 cm, 15×15 cm, 20×20 cm and 25×25 cm was used to achieve the respective plant population. The gross plot size was 5 m^2 while net plot was 3 m^2. The space between block was 2 m and 1 m between plot.

Onion variety (Violet de Galmi) was used for this study and the seedlings were transplanted at 6WAS. The field was irrigated before transplanting to reduce seedlings transplanting shock. Check basin method of irrigation was adopted and all the basins (plots) were irrigated at 7 days interval.

Urea fertilizer (46% N) was used to supply nitrogen and was applied in two equal split doses at 2 and 5WAT. Phosphorus fertilizer using Single Super Phosphate (20% P2O5) and potassium fertilizer as Muriate of potash (60% K2O) were applied during land preparation.

Weeds were controlled using selective herbicide (Oxyflorfen at the rate of 0.35 kg a.i ha^{-1} at 2 WAT) and three manual hoe weeding at 2, 5 and 8WAT.

The assessed parameters include: plant height (cm), number of leaves, shoot dry matter (g plant^{-1}), total dry matter (g plant^{-1}), leaf area index, relative growth rate (g g^{-1} wk^{-1}) bulb dry weight (g plant^{-1}), bulb diameter (cm) and bulb yield (t ha^{-1}). The relationship between the parameters were assessed using simple correlation coefficient as described by Little and Hill (1978). Regression analysis was performed using the procedure described by Reddy and Reddi (1995).

RESULTS AND DISCUSSION

Correlation analysis

The correlation coefficient of onion bulb yield with growth and yield components during 2019/2020 dry season at Samaru and Kadawa are shown in Table 1 and 2, respectively. Onion bulb yield at Samaru was positive and highly significantly ($P \leq 0.01$) correlated with shoot dry matter, total dry matter and leaf area index while at Kadawa it was positive and highly significantly ($P \leq 0.01$) correlated with bulb dry weight, number of leaves, shoot dry matter, total dry matter and leaf area index. Similar observation was made by Tekle, (2015) who found strong and positive relationship between onion total yield with plant height, leaf number and bulb dry weight.

However, a positive and significant ($P \leq 0.05$) relationship was observed between onion bulb yield at Samaru with bulb dry weight, bulb diameter, plant height and number of leaves, as also shown by Abdissa, *et al.* (2011) while at Kadawa it was positive and significant ($P \leq 0.05$) with bulb dry weight and plant height only. The correlation between bulb yield and relative growth at both locations was positive but not significant.

Similarly, a positive a highly significant ($P \leq 0.01$) association was recorded between growth parameters as plant height, number of leaves, shoot dry matter, total dry matter, leaf area index and relative growth rate with yield component as bulb dry weight and bulb diameter at both locations except relative growth rate at Samaru which was positive and significant ($P \leq 0.05$) with bulb diameter and total dry matter while it was not significant but positive with bulb dry weight, plant height, number of leaves, shoot dry matter and leaf area index. This agrees with the finding of Tadesse, (2022) who reported a highly significant relationship between onion total bulb yield with plant height, leaf number, bulb diameter and average bulb weight.

The higher and positive relationship observed between onion yield and these growth parameters indicates that increasing nitrogen application with appropriate plant population improved plant height, number of leaves, shoot dry matter, total dry matter and leaf area index capacity by increasing the photosynthetic surface. This showed that these parameters have a positive influence on onion yield and any improvement of these characters would increase bulb yield. Consequently, this could result into more interception of light, production of assimilate from the photosynthetic area and its allocation in the bulb whereby increasing the yield. (Fageria, *et al.,* 2006).

Regression analysis

Regression equations of nitrogen (Kg N ha^{-1}) on bulb yield (t ha^{-1}) and plant population (plant ha^{-1}) on bulb yield (t ha^{-1}) during 2019/2020 dry season at both locations are presented in Figure 1. The analysis revealed a quadratic response when total bulb yield (t ha^{-1}) of onion was regressed against nitrogen rate (Kg N ha^{-1}) and plant population (plant ha^{-1}) at both locations.

The response of bulb yield to nitrogen (Fig 1a) at Samaru is shown with the equation $Y = -0.0006x^2 + 0.1369x + 6.8989$, $R^2 = 0.923$ while at Kadawa, $Y = -0.0005x^2 + 0.1505x$

+ 8.1354, R^2 = 0.852. This implies that total bulb yield increased from the control (0 Kg N ha^{-1}) to 114.08 and 150.5 Kg N ha^{-1} at Samaru and Kadawa respectively showing that the optimum nitrogen rate at Samaru was 114.08 Kg N ha^{-1} at expected yield of 14.71 t ha^{-1} while at Kadawa, the optimum nitrogen rate was 150.5 Kg N ha^{-1} with an expected yield of 19.46 t ha^{-1}.

Similarly, the response of bulb yield to plant population (Fig 1b) is presented by the equation Y = -2E-11x² + 3E-5x + 5.5658, R^2 = 0.98 and Y = -3E-11x² + 4E-5x + 6.3602, R^2 = 1, at Samaru and Kadawa respectively. This quadratic response showed that optimum plant population was attained at 750,000 plant ha^{-1} with an expected yield of 16.82 t ha^{-1} at Samaru and 666,666 plant ha^{-1} at Kadawa with an expected yield of 19.69 t ha^{-1}.

The increase in bulb yield with relation to plant population was observed from 160,000 plant ha^{-1} to 750,000 and 666,666 plant ha^{-1} at Samaru and Kadawa respectively. The decline in total bulb yield beyond the aforementioned values could explain that the optimum requirement of the crop in respect to nitrogen and plant population at Samaru and Kadawa was attained and hence no significant increase beyond this rate was observed.

CONCLUSION

The results from this experiment showed a strong relationship between onion bulb yield with plant height, number of leaves, shoots dry matter, total dry matter, leaf area index, bulb diameter and bulb dry weight and thus constitute important traits to consider when breeding for high yielding cultivars of onion as any of these traits significantly contribute to increase in onion bulb yield. The optimum rate of nitrogen and plant population that onion tolerate at Samaru and Kadawa in this experiment was achieved at 114.08 Kg N ha^{-1} for 750,000 plant ha^{-1} and 150.5 Kg N ha^{-1} for 666,666 plant ha^{-1} respectively.

REFERENCES

Abdissa, Y., Tekalign, T., & Plant, L. M. (2011). Growth, bulb yield and quality of onion (*Allium cepa* L.) as influenced by nitrogen and phosphorus fertilization on vertisol I. growth attribute biomass production and bulb yield. *African Journal of Agricultural Research, vol 6, no. 14*, pp. 3252-3258.

Brewster, J. L. (2008). Onion and others vegetable alliums. 2nd ed. Wellebourne, UK.

Dessalegn, L., & Aklilu, S. (2003). Research Experience in Onion Production. *Research Report Number*, p. 55. Addis Ababa, Ethiopia : EARO.

Fageria, N., Baligar, V., & Clark, R. (2006). *Physiology of Crop Production.* USA: CRC Press, Boca Raton, FL.

FAOSTAT. (2019). *Food and Agriculture Organization of the United Nation*. Retrieved from Crop production data: https:www.faostat.org

Gessesew, W., Woldetsadik, K., & Mohammed, W. (2015). Onion (*Allium cepa* L. Var. Cepa) Bulb Traits as Affected by Nitrogen Fertilizer Rates and Intra-Row Spacing under Irrigation in Gode, South-Eastern Ethiopia. *J Horticulture, vol. 2, no 4*, p. 160.

Greenwood, D. J., Cleaver, T. J., Turner, M. K., Hunt, J., Niendorf, K., & Loquens, S. M. (1980). Comparison of the effects of nitrogen fertilizer on the yield, nitrogen content and quality of 21 different vegetable and arable crops. *J. Agric. Sci. 95*, 471-485. doi:10.1017/S0021859600039514

Little, T., & Hills, F. (1978). *Agricultural Experimentation Design and Analysis.* New York 350: Willey and Sons.

Randle, W. (2000). Flavor session keynote address. *Proceding of the Third International Symposium on Edible Alliaceae.* Athens, Georgia, USA.

Reddy, T., & Reddi, G. (1995). *Principles of Agronomy.* New Delhi: 2nd Edition Kalyani Publishers. doi:110002

Shanmugasundaram, S., & Kalb, T. (2001). *Suggested cultural practices for onion / AVRDC Training guide, Asian Vegetable Research and development Center.* Taiwan.

Tadesse, T., Sharma, P., & Ayele, T. (2022). Effect of the irrigation interval and nitrogen rate on yield and yield components of onion (*Allium cepa* L.) at Araba Minch, Southern Ethiopia. *Advances in Agriculture*, 13 pages. doi:http://doi.org/10.1155/2022/4655590

Tekle, G. (2015). *Growth, yield, and quality of onion (Allium cepa* L.*) as influenced by intra-row spacing and nitrogen fertilizer levels, central zone of tigray.* M.Sc. Thesis, Haramaya University, Dire Dawa, Ethiopia.

Table 1: Simple correlation coefficient between some yield and growth component of onion as influenced by nitrogen fertilizer rate and plant population during 2019/2020 dry season at Samaru

	1	2	3	4	5	6	7	8	9
1	1.00								
2	0.35*	1.00							
3	0.28*	0.87**	1.00						
4	0.37*	0.84**	0.78**	1.00					
5	0.21*	0.87**	0.79**	0.84**	1.00				
6	0.45**	0.87**	0.80**	0.84**	0.85**	1.00			
7	0.47**	0.86**	0.82**	0.84**	0.85**	0.87**	1.00		
8	0.43**	0.73**	0.70**	0.85**	0.79**	0.80**	0.80**	1.00	
9	0.16NS	0.21NS	0.28*	0.09NS	0.15NS	0.10NS	0.34*	0.07NS	1.00

1: Bulb yield (t ha); 2: Bulb dry weight (g plant); 3: Bulb diameter (cm); 4: Plant height (cm); 5: Number of leaves; 6: Shoot dry matter (g plant); 7: Total dry matter (g plant); 8: Leaf area index; 9: Relative growth rate (g g^{-1} wk^{-1}); ** Significant at 1%, * Significant at 5%, Df = n-2

Table 2: Simple correlation coefficient between some yield and growth component of onion as influenced by nitrogen fertilizer rate and plant population during 2019/2020 dry season at Kadawa

	1	2	3	4	5	6	7	8	9
1	1.00								
2	0.43**	1.00							
3	0.30*	0.93**	1.00						
4	0.35*	0.91**	0.88**	1.00					
5	0.46**	0.90**	0.84**	0.89**	1.00				
6	0.55**	0.86**	0.80**	0.84**	0.90**	1.00			
7	0.52**	0.91**	0.87**	0.88**	0.94**	0.92**	1.00		
8	0.48**	0.77**	0.69**	0.70**	0.81**	0.77**	0.86**	1.00	
9	0.15NS	0.54**	0.59**	0.49**	0.51**	0.48**	0.58**	0.47**	1.00

1: Bulb yield (t ha); 2: Bulb dry weight (g plant); 3: Bulb diameter (cm); 4: Plant height (cm); 5: Number of leaves; 6: Shoot dry matter (g plant); 7: Total dry matter (g plant); 8: Leaf area index; 9: Relative growth rate (g g^{-1} wk^{-1}); ** Significant at 1%, * Significant at 5%, Df = n-2

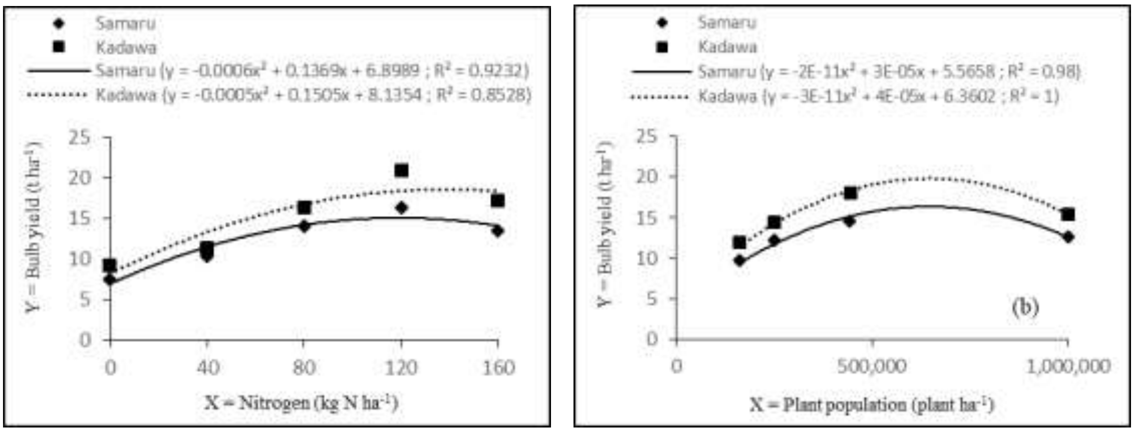

Figure 1(a) : Regression graph of onion bulb yield (t ha^{-1}) on (a) nitrogen rate (Kg N ha^{-1}) and (b) plant population (plant ha^{-1}) at Samaru and Kadawa during 2019/2020 dry season.

Factors Influencing the Adoption of Integrated Pest Management Among Cocoa Farmers in Osun State, Nigeria

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Abstract
This study examines the factors influencing the adoption of integrated pest management among cocoa farmers in Osun state, Nigeria. A multistage sampling procedure was used to select 120 cocoa farmers in the area. Structured questionnaires were drawn and administered to the selected farmers. The data were collected and analyzed using descriptive statistics and the double hurdle model. The study revealed that most farmers use chemical and cultural methods under integrated pest management and don't use biological and mechanical methods under integrated pest management. The study also showed that from the first hurdle (Probit regression), age, household size, and farm size significantly influence the probability of farmers adopting IPM techniques, while the second hurdle revealed that the coefficient of farm size, farm experience, and education level significantly influence the adoption intensity of integrated pest management techniques among the farmers. The study suggests that cocoa farmers should be trained in order to acquire the skills needed to adequately implement IPM techniques.
Keywords- Integrated pest management, Cocoa, Farmers, Double-hurdle, Nigeria

INTRODUCTION

In the 1950s and 1960s, cocoa farming experienced remarkable growth and became a prominent agricultural industry in Nigeria. From Nigeria's independence until the 1970s, the agricultural sector made up 61.5% of the Gross Domestic Product (GDP). It served as the cornerstone of the economy, ensuring food security for the population and generating surplus for export. Notable crops such as cocoa, rubber, coffee, palm kernels, and cashew nuts were exported, making a significant contribution to the country's Gross National Product (GNP). The available record shows that cocoa was one of the main sources of income in Nigeria before the country's independence in 1960. In recent times, Nigeria has slipped from being the second world largest producer of cocoa to fourth position behind Ivory Coast, Ghana, and Indonesia (International Cocoa Organization ICCO, 2012). The production of cocoa has suffered a major setback in recent years due to multiple factors which include; less emphasis on agriculture, inadequate government program on agricultural input subsidy, changes in global climate, and pest and disease incidence (Uwagboe, 2011) and this has led to the application of various insecticides to suppress pest and diseases.

Pesticides are substances or chemical agents that are very toxic, mostly organic compounds and intentionally released into the environment to combat disease vectors and pests of crops like cocoa (Bateman, 2010) they are also referred to as substances used to control pests at any state in crop production, storage, and transport (Bateman, 2010). They are designed to manage or prevent the spread of pests, including insects, weeds, fungi, bacteria, and other organisms that can damage or interfere with agricultural activities or public health (Famuyiwa et al, 2014).

Recognizing this issue, scientists embarked on developing a fresh approach to combat pests, known as integrated pest management (IPM) (Famuyiwa et al, 2014).

The concept of integrated pest management (IPM), a sustainable strategy for managing pests, has been in practice for a long time (Aneani et al. 2012) and was developed in response to steadily increasing pesticide use that resulted in pest control crises (outbreaks of secondary pests and pest resurgence following development of pesticide resistance) and increasing evidence and awareness of the full costs to human health and the environment of the intensive use of pesticides (Aneani et al. 2012). Although multiple sources define IPM as a holistic approach or strategy to combat all plant pests using all available methods with minimal applications of chemical pesticides (Adeogun et al. 2010), its aim is not to eradicate pests but to reduce and manage them below economically injurious levels (Adeogun et al. 2010). Despite the numerous economic and environmental advantages that can be gotten from the application of IPM, there is still a gap in knowledge about its usage and the factors that influenced its application, especially among cocoa farmers in Osun State, Nigeria thus necessitating the need for this research. This research was guided by the following objectives:

i. describe the socio-economic characteristics of cocoa farmers in the study area.
ii. identify the types of integrated pest management techniques adopted by the cocoa farmers in the study area.
iii. examine the rate and intensity of the adoption of IPM among cocoa farmers in the study area;

METHODOLOGY

Area of Study

The study was conducted in Osun State, located in the southwestern region of Nigeria. Osun State was established on August 27th, 1991 and covers an approximate area of 14,875 square kilometers. Its geographic coordinates are between 07°30′N 4°30′E/7.500ºN 4.500ºE. The economy of Osun State predominantly relies on agriculture. Key crops cultivated in the region include yams, cassava, corn, beans, millet, plantains, cocoa, palm oil and kernels, as well as various fruits. Osun State is one of the main cocoa producers in Southwest, Nigeria, hence the choice of the study area.

Sampling Procedure and Data Collection

A multistage sampling procedure was used to select cocoa farmers in the area. The first stage was the purposive selection of two local government areas which are Ife South and Ife Central based on the predominance of cocoa farmers in the Local Government Areas. The second stage involved a random selection of three communities from each local government area and finally, a random selection of twenty (20) farmers in each community selected. A total of 120 cocoa farmers were sampled. Primary data was collected from sampled cocoa farmers through the use of a structured questionnaire that was administered to them. The questionnaire was designed to obtain specific information on the socio-economic characteristics of the cocoa farmers in the study area; types of IPM adopted by the farmers in the study area, inputs used for cocoa production etc.

Methods of Analysis

The objectives were analyzed using different analytical techniques. Descriptive statistics was used be used to analyze i and ii. Double hurdle model was used to analyze objective iii. Descriptive statistics such as frequency and percentage were used to describe the socio-economic characteristics of the study and to identify the types of IPM adopted by farmers in the study area. The purpose of using a descriptive statistic revealed mean differences in some socio-economic characteristics among cocoa farmers in the area and also the type of IPM adopted by the farmers.

Double hurdle model

This study used the double-hurdle regression model as proposed by Cragg (1971) where adoption and intensity were treated separately (Awotide, et al., 2014). The two error terms in the equations are functionally independent. The model has an adoption equation written below as:

$$di=Zia+ui. \quad (1)$$

$$y^{*}= Xi'a +vi. \quad (2)$$

Where di' is a latent variable that takes the value 1 if the farmer adopts integrated pest management practices 0, if otherwise. Zi is a vector of household characteristics and a is a vector of parameters. Similarly, y represents the area of land allocated to the use of Integrated pest management by the respondents, while Xi' is a vector of household or individual characteristics and β is a vector of parameters. The u and v are independent error terms.

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

The socioeconomic distribution of the smallholder farmers showed that the majority (78%) of the respondents were male (Table 1). This implied that the male gender was more involved in cocoa farming than their female counterparts. The male domination in farming might be attributed to their access to resources such as credit and land. The average age of the farmers was 43.46 (±12.43) years. This implied that farmers were still in their active and productive age and are thus expected to be efficient in carrying out their farm operations related to the implementation of IPM since they possess the required energy. The majority (77.9%) of the respondents were married. Therefore, the high percentage of married respondents suggested that the farmers were stable and able to make good farming decisions. The mean household size of the respondents was 6.3(±2.4) people. This implies that farmers had a small to medium household size, they are thus expected to make use of hired labor to complement family labor in farming activities. The average years of experience for the respondents was 17.81(±11.85) years. This implies that farmers have been farming for a considerable number of years. It is expected that as farming experience increases, the chances of farmers implementing new innovative farming methods like IPM might also increase. The results also revealed that the mean years of formal education was 11.29(±6.43). Thus, they were expected to be able to interpret, understand, and use available resources to boost their level of production and improve their managerial abilities.

Table 1: Socio-economic characteristics of respondents

Variables	Participant
Age (years)	43.46 (±12.43)
Male (%)	78.00
Years of formal education	11.29(±6.43)
Years of farming experience	17.81(±11.85)
Association membership (%)	89.4
Extension contact (%)	73.3
Household size (#)	6.3(±2.4)
Marital status (%)	77.9
Farm size (ha)	2.9(±1.4)

Figures in parenthesis are standard deviation

Types of IPM used by cocoa farmers

The distribution of the correspondents as shown in Table 2 shows that 93.16% of farmers use chemicals and 6.84% percent of the respondents do not use chemical methods under IPM. All the respondents do not use biological means of IPM. The majority of the respondents have not heard about the biological means of pest reduction nor do they know how to go about it. The majority (95.73%) of farmers do not use mechanical methods under IPM and 4.27% of farmers use the mechanical method of controlling pests. About 16.67 do not use cultural methods under IPM and 83.33% of respondents use cultural methods under IPM.

Table 2: Distribution of farmers that use chemical methods under IPM

Chemical	Frequency	Percentage
No	5	4.17
Yes	115	95.83
Biological		
No	120	100
Yes	0	0
Mechanical		
No	112	93.33
Yes	8	6.67
Cultural method		
No	20	16.67
Yes	100	83.33
Total	120	100

Source: Field survey, 2023

Double estimates on adoption and IPM use intensity

The double hurdle regression results of IPM usage are presented in Table 3. The first hurdle showed the factors that influence the decision to adopt IPM using probit regression model while the second hurdle showed factors that influence intensity using truncated regression model. The goodness-of-fit shows that the estimates were statistically significant at 1% probability level which implies that the estimated model fit the data reasonably well. The first hurdle (Probit regression), showed that age, household size, and farm size significantly influence the probability of farmers adopting IPM techniques. The negative significance of age showed that as the farmer increases in age, they are less likely to implement IPM. Application of IPM might be labor intensive which of course could be provided by young energetic farmers. The positive significance of household size implies that medium to large household size are more likely to implement IPM because they have the required family labor to carry out these activities on their farm. In addition, the positive significance of farm size indicates that relatively medium to large farms are more likely to implement IPM. Having a large farm affords the farmers to experiment with new innovative methods.

The second hurdle revealed that education, farming experience, and farm size significantly influence the intensity of IPM usage among cocoa farmers. This implies that farmers who have large, educated with many years of farming experience are more likely to allocate larger plots of land to the implementation of IPM. Cocoa farmers who have received education in the form of training and seminars and are also experienced in cocoa production will most likely implement IPM on their cocoa farms.

Table 3: The Double hurdle regression results

	First hurdle (probit regression)			Second hurdle (truncated regression)		
	Coeff	Std. err	Z	Coeff.	Std. Err.	Z
Age	-.0612**	-.0296	-2.07	-.0136	.0097	-- 1.40
Marital status	-.5341	-.5117	-1.04	-.3603	.2520	-1.43
Level of Education	.2745	-.3176	0.86	.2020**	.0983	2.05
Farm experience	.0394	.0240	1.64	.0250***	.0090	2.76
Farm size	.0882**	.0382	2.31	.7411***	.1123	6.60
Household size	.2159***	.8603	-2.51	.2745	-.3176	0.86
Farm Association	.7706	.5793	0.97	.0905	.3065	-0.30
Constant	0.044	0.054	0.82	0.197	0.139	1.42
LR $chi^2(7)$	45.58					
Prob > chi^2	0.000					
Loglikelihood	-737.5849					

*******,****** represent 1% and 5% significance level respectively

CONCLUSION

The study revealed that most farmers use chemical and cultural methods under integrated pest management and don't use biological and mechanical methods under integrated pest management. The study also revealed that in the first hurdle, age, household size and farm size significantly influence the adoption of integrated pest management techniques while in the second hurdle, education farming experience, and farm size significantly influence the intensity of adoption of integrated pest management and are negative. To increase the adoption of IPM, this study suggests that younger farmers should be first targeted since they are more likely to implement these techniques. In addition, efforts should be made to improve the level of education of the cocoa farmers which could be in the form of training and seminars. This will help improve the skills of the farmers.

REFERENCES

Adeogun, S. O., Olawoye, J. E., & Akinbile, L. A. (2010). Information sources to cocoa farmers on cocoa rehabilitation techniques (CRTs) in selected states of Nigeria. *Journal of Media and Communication Studies*, *2*(1), 9–15.

Aneani, F., Anchirinah, V. M., Owusu-Ansah, F., & Asamoah, M. (2012). Adoption of some cocoa production technologies by cocoa farmers in Ghana. *Sustainable Agriculture Research*, *1*(1), 103–117.

Bateman, R. (2010). *Pesticide use in cocoa: A guide for training administrative and research staff* (2nd ed.). International Cocoa Organization (ICCO).

Famuyiwa, B. S., Torimiro, D. O., Obatolu, B. O., & Uwagboe, E. O. (2014). Preventive measures adopted by Nigerian farmers for the environmental hazards in cocoa plantations. *Journal of Agricultural Extension*, *18*(2), 99–111.

International Cocoa Organization. (2012). *Introduction to cocoa market: Supply, production*. http://www.bloomberg.com/news/2012-01-17/

Uwagboe, E. O. (2011). *Effect of integrated pest management (IPM) utilization on cocoa farmers' yield in selected states of Nigeria* (Unpublished M.Phil. thesis). University of Ibadan, Faculty of Agriculture and Forestry.

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21-25 OCT. 2024
PROCEEDINGS

Analysis of Food Insecurity Status among Wheat Farmers in the Northeast and Northwest Nigeria

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Abstract
Food insecurity is a global menace with Nigeria bearing more of its burden due to level of corruption, persistence insurgency and banditry operations in the favourable wheat producing zones of the country. This study describes socio economic characteristic and reveal food insecurity status quo of wheat farmers in the study area. Primary data were sourced through structured questionnaire and equal number (30) of respondents were selected each from four selected wheat selected states (Kano, Jigawa, Bauchi and Yobe) totaling 120 respondents for the study sampled frame. Descriptive statistics and Household Food Insecurity Access Scale (HFIAS) methodology was used to analyze the data. Result from the study showed that all respondents were male, most were adult aged, high prevalence of married individual, low level of formal education and were small-scale holder. Moreover, most (73.33%) of the wheat farmers were food insecure while only 26.67% were food secure. Under the food insecurity categories, 45%, 15% and 13.33% of the respondents fell under moderately food insecure access, mildly food insecure access and food insecure access respectively. Hence this study concluded that most of the wheat farmers were food insecure. The study thereby recommended implementation of better inceptives and ending long existing insurgency peculiar to that region by Government and stakeholders as a matter of urgency.

Introduction
Food insecurity, defined as the lack of consistent access to safe, nutritious, and culturally appropriate food, remains a global issue, especially pronounced in Nigeria (WFP, 2023). The situation worsened after the COVID-19 pandemic, compounded by the removal of fuel subsidies, high exchange rates, rising food inflation, and insurgencies (Thomas & Turk, 2023). Currently, 40% of Nigeria's population faces food insecurity despite the country's agricultural potential, as the focus remains on crude oil over agriculture. Conflict, especially in the northeast and northwest, has exacerbated the problem, displacing farming communities and exposing them to hunger in Internally Displaced Persons camps (Abdulyakeen, 2021).

Wheat is a vital crop in Nigeria and the highest imported food item after petroleum products, with a significant consumption gap that local production as been unable to meet. In 2020, Nigerian government spent over $2.15 billion on wheat importation, a 40% increase from previous year, making it the fourth-largest wheat importer globally after Egypt, China and Turkey (AfDB, 2020). Despite government efforts, Nigeria produces only 2% of its wheat needs (FMARD, 2022). According to Umar & Muhammad (2021), the challenges facing wheat production in Nigeria include overreliance on imported wheat, climate change, limited access to improved seeds, inadequate irrigation, insufficient funding, and the lack of a unified national strategy. However, analyzing wheat farmers' food insecurity is essential to developing targeted interventions that enhance their food access and livelihoods, which is the central aim of this study.

Specific Objectives

i. Examine socio economic characteristics of respondents in the study area;
ii. Estimates food insecurity status of the respondents in the study area.

METHODOLOGY

Study Area

This study was conducted in the Northwest (Kano and Jigawa) and Northeast (Bauchi and Yobe) regions of Nigeria.

Sampling Procedure

Multi-stage sampling procedure was employed to select sample. Firstly, equal sample sizes were purposely drawn from Bauchi and Yobe in the Northeast, and Kano and Jigawa in the Northwest due to their importance in wheat production and relative safety for data collection amidst regional insecurity. Moreover, two Local Government Areas from each of the four states were randomly selected, and one prominent wheat-producing village from each LGA was chosen for the study.

Analytical framework

This study employed descriptive statistics and the Household Food Insecurity Access Scale (HFIAS) to describe socioeconomic characteristics and food insecurity status of respondents in the study area respectively. The study adapted HFIAS indicator guide by Coates et al 2007. Using the Household Food Insecurity Access Prevalence (HFIAP) method it involved nine stepwise questions capturing the frequency of food insecurity experiences over the past 30 days. Households were categorized into four levels of food insecurity: food secure, mildly, moderately, and severely food insecure. A food secure household experiences little to no insecurity, while mildly food insecure households may worry about food or eat less preferred foods without cutting back on quantity. Moderately food insecure households sacrifice food quality and reduce meal sizes occasionally. Severely food insecure households often reduce meal sizes or experience severe conditions like going without food.

RESULTS AND DISCUSSION

Socioeconomic Characteristics

Age: The study shows that 40% of respondents are 40 years old or younger, suggesting a largely young to middle-aged workforce. However, the presence of older age groups (24.17% aged 51-60 and 8.33% over 60) raises concerns about future workforce sustainability and calls for broader socioeconomic research beyond the demands of the work.

Gender and Marital Status: All respondents are male, indicating a gender disparity in wheat farming. The high percentage of married individuals (95%) with an average household size of 11 highlights significant family responsibilities, emphasizing the need for support systems and further research into barriers to female.

Education: Over 60% of respondents have only primary education or less, underscoring a need for targeted educational programs and extension services to improve agricultural practices and decision-making skills among wheat farmers.

Wheat Farm size: Majority of the respondents cultivate less or equal to two hectares of land suggesting that majority of wheat farmers in the study area are small-scale holders in terms of land size and if wheat food security will be ensuring, commercialization should be encouraged across study area.

Table 1: Socioeconomic characteristics

Variable		Frequency	Percentage	Mean
	<=40	48	40.00	
Age(years)	41-50	33	27.50	45
	51-60	29	24.17	
	>60	10	8.33	
Gender	Male	120	100.00	
	Female	0	0	
Marital Status	Married/living with spouses	114	95.00	
	Married but living alone	2	1.67	
	Single	4	3.33	
	<=5	25	20.83	
Household size	6-10	43	35.83	11
	11-15	29	24.17	
	>15	23	19.17	
	No formal education	36	30.00	
Highest level of education	Primary education	40	33.33	
	Secondary education	29	24.17	
	Tertiary education	15	12.50	
Wheat farm size (hectare)	<=2	98	81.67	
	2-4	16	13.33	2
	>5	6	5	

Source: Field survey, 2023

Table 2 revealed the food insecurity/security status of respondents in the study area. It was obvious from table 3 that only 26.67% of the wheat farmers were food secure while food insecure respondents were estimated as 73.33%. This implies that most of the respondents are food insecure compared with those that are food secure. Table x under food insecurity category further revealed that 45%, 15% and 13.33% of the respondents fell under moderately insecure access, severely insecure access and mildly food insecure access category respectively. This suggests that a substantial portion of the surveyed population faces challenges in accessing an adequate and secure food supply. Several factors might have contributed to food insecurity situation among respondents in the study area. The removal of fuel subsidies in May 2023 by the Nigerian government, coupled with insurgency in wheat-producing states, has created economic hardships for many Nigerian citizens. Alli et al (2024) reiterated removal of fuel subsidies has significantly raised transportation costs, leading to increased food prices and worsening food insecurity, as both producers and consumers struggle with the rising costs of agricultural production. Moreover, wheat farming is capital and input-intensive, and the soaring prices of farming inputs have negatively affected farm production, particularly among subsistence farmers. This aligns with findings from Sanchi *et al.* (2022) that highlighted rising agrochemical prices, making it challenging for farmers to sustain their production. Furthermore, as noted by Ashby (2019), price increases in agro inputs introduce risks and income volatility for farmers. The data suggests that income shocks and uncertainties have been severe enough to affect consumption patterns, resulting in inadequate food crop production and, consequently, an increase in food insecurity among the respondents in the study area.

Table 2: Food security/insecurity status

Food secure **(26.67%)**	Food insecure **(73.33%)**		
	Mildly food insecure access **(13.33%)**	Moderately food insecure access **(45%)**	Severely insecure access **(15%)**

Source: Data Analysis, 2023

CONCLUSION AND RECOMMENDATIONS

The study concluded that most of the wheat farmers are food insecure and majority fell under Moderate food insecure access scale category. The study recommended that Government and stakeholders should intensify efforts to implement impactful incentives to wheat farmers and create an enabling, insurgent-free environment for all.

REFERENCES

Abdulyakeen, A. (2021). *Introduction to African politics: Deconstructing the constructed African history*. Lambert Academic Publishing.

Africa Development Bank (AfDB). (n.d.). *Nigeria country food and agriculture delivery compact*. https://www.afdb.org/sites/default/file/documents/publication/nigeria_country_food_and_agriculture_delivery_compact.pdf *(Accessed September 12, 2024)*

Alli, N. G., Jubril, T. S., & Bello, L. T. (2024). Impact of fuel subsidy removal on Nigeria's supply chain: A case study analysis. *International Journal of Studies in Business Management, Economic and Strategies*, *3*(4), 125–143.

Ashby, J. A. (2019). Integrating research on food and the environment: An exit strategy from the rational fool syndrome in agricultural science. *Ecology and Society*, *5*.

Coates, J., Swindale, A., & Bilinsky, P. (2007). *Household Food Insecurity Access Scale (HFIAS) for measurement of food access: Indicator guide version 3*. Food and Nutrition Technical Assistance Project, Academy for Educational Development.

Federal Ministry of Agriculture and Rural Development (FMARD). (2022). *National wheat strategy policy to rejig production of the wheat value chain*. https://fmard.gov.ng/fg-validates-national-wheat-strategy-policy-document/

Sanchi, I. D., Alhassan, Y. J., & Sabo, A. Y. (2022). Rising costs of farm inputs and its implication on 2022 wet season farming in Northwest subregion of Nigeria. *Direct Research Journal of Agriculture and Food Science*, *10*(5), 144–150. https://doi.org/10.26765/DRJAFS013726489

Thomas, A., & Turk, R. (2023). Food insecurity in Nigeria: Supply matters. *IMF Selected Issue Paper*, Washington, DC, USA.

Umar, U. A., & Muhammad, M. B. (2021). Challenges and strategies of wheat production in Nigeria amidst growing demands for wheat and wheat products. *Journal of Agriculture and Environment*, *17*(2), 1–6.

World Food Programme (WFP). (2023a). *Global report on food crises 2023: Mid-year update*. https://www.wfp.org/publications/global-report-food-crises-2023-mid-year-update

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Determinants Analysis of Stunting Conditions Relative to Normal Height for AGE Among Less Than 5years Old Farming Households in the North East Nigeria

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Abstract

Stunting among children under five remains a major health concern in Northern Nigeria, affecting their health, cognitive development, and future socioeconomic outcomes. This study focused on determining the causes of stunting in children under five from farming households in Northeast Nigeria. Data from the General Household Survey (wave 4) conducted by the National Bureau of Statistics was used to assess key variables, including weight, height, access to healthcare, household size, and asset ownership. Multinomial logistic regression was used to analyze the data. The results showed that Male-headed households, better access to health centers, and increased asset ownership significantly reduced the likelihood of severe stunting, while larger household size and being male increased the probability of severe stunting. The study concluded that household leadership, healthcare access, and economic stability are crucial in mitigating stunting among children in the region.

Keywords: Determinant, Stunting, Farming household children

INTRODUCTION

Food and nutrition security are critical global concerns, especially in developing nations where malnutrition and food insecurity are widespread. Nigeria, in particular, faces an alarming situation, with the number of undernourished individuals skyrocketing from 9.9 million in 2006 to 26.2 million in 2021 (FAO et al., 2022). The issue is especially severe among children, as 36.8% of those under five were stunted in 2018, with 17.1% severely affected (National Population Commission, Nigeria, ICF, 2019). In 2020, it was estimated that 12 million Nigerian children under five were stunted (FAO et al., 2022). Malnutrition continues to be a leading cause of illness and mortality among children globally.

The Nigerian government implemented programs to reduce malnutrition in alignment with Vision 20:2020 and the National Strategic Health Development Plan (2009–2015). Despite these efforts, Nigeria still has the highest rates of stunted and wasted children in sub-Saharan Africa, particularly in the Northeast regions (SPRING, 2018). Corruption, insecurity, and poor governance are major factors contributing to the failure of these programs to address the increasing incidence of malnutrition.

Addressing malnutrition in children is vital as they are the future. This study examines the Northeast region of Nigeria, where stunting rates are high, and seeks to identify the determinants of stunting conditions among under five farming households' children. The objective of this study is to examine the determinants of stunting conditions outcome among respondents in the study area.

METHODOLOGY

Study Area

The Northeast geopolitical zone of Nigeria is made up of Borno, Bauchi, Adamawa, Gombe, Taraba and Yobe states and falls within longitude 9.0820^0N and 8.6753^0E. The region occupies slightly less than one third of Nigeria's total area and had 13.5% of the country population (IOM, 2020).

Sources of Data

Secondary data were used for this study. The data were sourced from General Household Survey (GHS), panel 2018-2019, wave 4 conducted by National Bureau of Statistic

Analytical Framework

The study used multinomial Regression Model to analyze the determinants of respondents. This model is specified thus as follow:

$$\Pr(Y_i = j) = \frac{e^{(Xij\lambda + \text{r}VEPijt-1)}}{\sum^3 \; k=1 \; e^{(Xij\lambda + \text{r}VEPijt-1)}} \quad (1)$$

J= 0,1,2,3

The Multinomial model is explicitly expressed as:

$$Y_0 = \propto_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_7 X_7 + \mathcal{E}_i \quad (2)$$
$$Y_1 = \propto_1 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_7 X_7 + \mathcal{E}_i \quad (3)$$
$$Y_2 = \propto_2 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_7 X_7 + \mathcal{E}_i \quad (4)$$
$$Y_3 = \propto_3 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_7 X_7 + \mathcal{E}_i \quad (5)$$

Where Y_i represents 4 unordered categories of food and nutrition insecurity conditions; $Y_0 - Y_3$ = severe stunting (Y_0), moderately stunting (Y_1), normal condition (Y_2), extreme tallness condition (Y_3). Note that normal condition (Y_2) form the base outcome.
$X_1 - X_7$ = Household head age (years) (X_1), Household head sex (Male=1, Female=0)(X_2), Household size (Head count)(X_3), Child age (years)(X_4), Child sex (Male=1, Female=0)(X_5), Household asset (₦)(X_6), Access to health (if access=1, otherwise=0)(X_7)
$\beta_1 \ldots \beta_7$ = Parameters of the coefficients, $\alpha_0 \ldots \alpha_3$ = Intercept or the constant terms and $\mathcal{E}_i$= Error terms.

RESULTS AND DISCUSSION

Determinants of stunting conditions outcome among respondents in North East region (Nigeria)

The result in Table 1 reveals that male headed households in the North East Nigeria reduces the probability of severe stunting and moderate stunting of farming household children relative to normal height for age by 1.1758 and 1.1534 respectively. The result for severe stunting and moderate stunting for male headed households were both statistically significant at 5% and 10% respectively in the North East Nigeria. This implies that the possibility of a nourished child being in a male headed household is much more assured than being in a female headed household, which is in line with the findings of Jone's (2017). The study conducted by Chindime and Ubomba-Jaswa (2013) further justifies that there was probably likelihood of increase in severe stunting in children that live under female headed households than male headed households.

Increase in household size increases the probability of severe stunting among farming households' children in the North East Nigeria relative to normal height for age by 0.0630, and it was statistically significant at 5%. This suggested that if household increases its household size by a child birth, there is likelihood that severe stunting relative to normal height for age will increase. This finding is consistent with Olack *et al.* (2011), Quamme and Iversen (2022) that reiterated larger population size positively influences child stunting. It is important to note that increase in household population reduces quality food intake among poor households, increases competitiveness for food and nutrition among household members.

In the North East zone of the country, child age increases the probability of severe stunting among farming household children relative to normal height for age by 0.1122 and was statistically significant at 10%. This implies that as the farming household children age increases by 1year, there is likely chances that severe stunting will increase. This result is in conformity with the study of Mckenna *et al.* (2019) who found that there is higher risk of stunting among children who are no longer infants.

Furthermore, it should be noted that child age decreases probability of extreme tallness among farming household children relative to normal height for age by 1.1302 and was statistically significant at 1%. Nutrition plays a vital role in growth. Children without good nutrition may not be as tall as children with adequate nutrition. As nutritional insecurity increases with child age, there is likelihood possibility for extreme tallness to reduce. Although it should be noted that extreme tallness indicates more of endocrine disorder than food and nutritional issue.

Being a male child increases the probability of severe stunting among farming household children relative to normal height for age by 0.5024 and was statistically significant at 1%. In order words, giving birth to male children in the North East zone understudy suggested that severe stunting is likely to increase than when the child is a female. The study conducted by Berhane *et al.* (2020) also affirmed that boys were at greater risk for stunting than girls and this result was also the same with the findings of Nshunyiryo *et al.* (2019).

An increase in the assets value by a thousand naira reduces the probability of severe stunting relative to normal height for age by 0.0011in the North East zone of the country and it was statistically significant at 5%. In order words, increase in household asset (wealth) decreases the likelihood risk of severe stunting among children. This is consistent with the findings of Eshete *et al.* (2017).

In the North East zone, having access to Health center by respondents reduces the probability of severe stunting, moderate stunting and extreme tallness relative to normal height for age by 0.6873, 1.0376 and 2.6329 respectively. Access to health center coefficient under moderate stunting and extreme tallness categories were statistically significant at 1% while it was 5% statistically significant under severe stunting category. This implies that access to health center by the respondents reduce severe to moderate stunting and extreme tallness conditions among farming households in the study area. It is worthy to note that getting closer or having access to health center and its facilities will reduce malnutrition conditions among farming households in the study area, which is consistent with the findings of Shahid *et al.* (2022) and Adeyemi *et al.* (2022)**.**

Table 1: Determinants of stunting conditions outcome among respondents in North East region (Nigeria)

North East region (Nigeria) Height for Age						
Variables	**Severe stunting**		**Moderate stunting**		**Extreme tallness**	
Household head age	-0.0146	(0.157)	-0.0010	(0.384)	-0.0082	(0.852)
Househould head sex	-1.1758**	(0.017)	-1.1534*	(0.055)	9.2942	(0.195)
Household size	0.0630**	(0.037)	0.0106	(0.732)	0.1333	(1.979)
Child age	0.1122*	(0.099)	0.0831	(0.275)	-1.1302***	(0.007)
Child sex	0.5024***	(0.009)	0.2976	(0.165)	-1.1502	(0.184)
Assets own	-0.0011**	(0.038)	-0.0009	(0.130)	-0.0020	(0.406)
Health Centre Access	-0.6873**	(0.045)	-1.0377***	(0.003)	-2.6329***	(0.008)
Number of obs = 645	LR chi2(21) = 62.17		Prob chi2= 0.0000			
Pseudo R2 = 0.0455	Log pseudo-likelihood = 651.80259					

Source: Data Analysis 2022

CONCLUSION AND RECOMMENDATIONS

The study concluded that household head age/sex, valued assets and access to health center negatively influence severe stunting conditions while household size, children age/sex positively influence severe stunting conditions among farming households in the study area. The study therefore recommends that the government should intensify effort to improve accessibility to healthcare services in the study area by expanding healthcare facilities, increasing healthcare personnel, and implementation of National Health Insurance Services (NHIS) to farming household that will ensure adequate access to healthcare resources and information. It is also recommended that educating and discouraging farming household on dangers and bearing children they cannot cater for should be encouraged in the study area.

REFERENCES

Adeyemi, O., Toure, M., Covic, N., Bold, M., Nisbett, N. and Headey, D. (2022). Understanding drivers of stunting reduction in Nigeria from 2003 to 2018: a regression analysis. *Food Security*, 2022. Pp1-17, DOI:10.1007/s12571-022-01279-8

Berhane, H.Y., Jirstro, M., Abdelmenan, S., Berhane, Y. Alsanius, B. and Trenholm, J. (2020). Social stratification, diet diversity and malnutrition among preschoolers: a survey of Addis Ababa, Ethopia 12(3): 712.

Chindime, C. C and Ubomba-Jaswa, S. (2013). Household headship and nutrition status of toddlers: an examination of Malawian data. African population studies, 21 (2): 45-73.

Eshete, H., Abebe, Y., Loha, E., Gebru, T. and Tesheme, T. (2017) Nutritional status and effect of maternal employment among children aged 6-59 months in Wolayta

Sodo town, southern Ethoipia: A cross-sectional study, *Ethopia Journal Health Science*, 27, 155-162

FAO, IFAD, UNICEF, WFP and WHO. 2022. The State of Food Security and Nutrition in the World 2022. Repurposing food and agricultural policies to make healthy diets more affordable. Rome, FAO. https://doi.org/10.4060/cc0639en

Jone's (2017). Food insecurity and mental health status: a global analysis of 149 countries. *Am. J. Prev. Me*., 53(2): 264-273

Kristen, C. and Lesley. O. (2018). Guide to anthropometry: a practical tool for program Planners, Managers and implementers. Introduction to the Guide.31-54

Mckenna, C. G., Bartels, S. A., Pablo, L. A. and Walker, M. (2019): Women's decision-making pow.er and under nutrition in their Children under age five in the Democratic Republic of Congo: A cross-sectional study. PLoSone, 14(2019), article e 0226041

National Population Commission (NPC) [Nigeria] and ICF. 2018. 2019 Nigeria DHS Key Findings. Abuja, Nigeria and Rockville, Maryland, USA: NPC and ICF.

Nshunyiryo, A. Hedt-Gauthier, B. Mutaganzwa, C. Kirk, C. M. Beck, K. and Ndayisaba, A. (2019). Risk factors for stunting among children under five years: a cross-sectional population-based study in Rwanda using the 2015 Demographic and health survey BMC. Public Health, 19 P. 175

Olack, B.H., Cosmas L., Bamrah S., Dooling K. and Feikin (2011). Nutrition status of underfive Children living in an informal urban settlement in Nairobi, Kenya. *Journal Health population Nutrition*, 29(2): 357-363.

Quamme, S.H and Iversen, P.O. (2022). Prevenlence of child in Sub-Sahara Africa and its risk factors. *Clinical nutrition open science Journal*, 42, 49-61

Shahid, M., Ameer, W., Malik, N.I., Alam, M.B., Ahmed, F., Qureshi, M.G., Zhao, H., Yang, J. and Zia, S. (2022). Distance to Healthcare facilities and Lady Health Workers' Visits Reduce Malnutrition in under Five Children: A case Study of a Disadvantaged Rural District in Pakistan. *International Journal Environmental Research and Public Health* 19,8200. https://doi.org/10.3390/ijerph19138200

SPRING. Assessing Drivers of Malnutrition in Nigeria. SPRING. 2018 [cited 2020 Apr 20]. Available from:https://www.spring-nutrition.org/publications/reports/assessing-drivers-malnutrition-nigeria.

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The Role of Cassava Production in Advancing Food Security and Economic Prosperity in Nigeria: A Review of State-Level Analyses

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Abstract
Agriculture is important to Nigeria's economy, supporting a significant proportion of the population and serving as a key driver of food security and poverty alleviation. Despite Nigeria's vast agricultural potential, various challenges, including inconsistent and non-adoption of good agronomic practices, inadequate infrastructure, and climatic variability impede optimal productivity. This paper investigates regional disparities in cassava production across Nigeria's six geopolitical zones using secondary data from the National Agricultural Extension and Research Liaison Services and the Federal Ministry of Agriculture and Rural Development. By analyzing metrics such as total production, land area, and yield, the study aims to identify and highlight regions' agricultural strengths and weaknesses. Results reveal notable disparities in productivity; regions like the North-Central and South-West exhibits higher yields and production levels, suggesting effective farming practices, while areas such as the North-East face significant challenges. The findings emphasize the urgent need for targeted policy interventions to enhance agricultural productivity, improve food security and stimulate economic growth. Ultimately, promoting best practices across states can lead to sustainable agricultural development, alleviating poverty and enhancing rural livelihoods in the process.
Keywords: Cassava Productivity, Food Security, Regional Disparities, Economic Prosperity and Policy Interventions

INTRODUCTION

Agriculture is important to Nigeria's economy, employing a significant portion of the population, while serving as a primary source of food security and a means of poverty alleviation. With a land area of approximately 923,768 square kilometers (Mayong *et al*., 2005), Nigeria possesses vast agricultural potential, particularly in the cultivation of root and tuber crops, such as cassava, yam, and potatoes. However, the sector faces numerous challenges, including inconsistent agricultural practices, inadequate infrastructure, and varying climate conditions that hinder optimal productivity (Saginga, 2015).

One of the institutions driving agricultural research and development in Nigeria is the National Root Crops Research Institute (NRCRI) located in Umudike. The National Mandate of NRCRI is to research into genetic improvement, production, processing, storage and socio-economics of root and tuber crops of economic importance (Yam, Cassava, Potato, Sweetpotato, Cocoyam, Ginger, Hausa Potato (*Solenostemon rotindifolinus*), Sugerbeet, Radish, Rizga, and Amora (Arrow Root). NRCRI with IITA and other partners over the years has developed and released more than 50 improved cassava varieties, which has significantly contributed to making Nigeria the highest producer of cassava in the world (Egesi, 2023) with 60.8mt (FAOSTAT, 2022). Through extensive research activities, including the development of improved cassava varieties, the establishment of better agronomic practices, and the promotion of post-harvest technologies, and has played a crucial role in enhancing cassava yield and production efficiency. The institute conducts regular training programs for farmers and collaborates with various stakeholders in the agricultural sector to disseminate knowledge and innovations, thereby fostering greater productivity and food security (https://nrcri.gov.ng/who-we-are/).

Nigeria is divided into six geopolitical zones, each exhibiting distinct agricultural characteristics influenced by climate, soil types, and agricultural practices. Understanding these regional disparities in crop production, land usage, and yields is essential for crafting targeted policies that address food insecurity and enhance economic prosperity.

This paper aims to investigate the role of cassava production in advancing food security and economic prosperity in Nigeria through a state-level analysis. The methodology employed in this study involves the analysis of secondary data sourced from NAERLS/FMARD (2022). The results will provide insights into cassava performance across states, shed light on the implications for national food security, poverty reduction, and economic advancement. By highlighting the successes and challenges in various regions, this research seeks to inform policy interventions that can further strengthen Nigeria's agricultural sector, ensuring it becomes a robust engine for economic growth and sustainable development.

METHODOLOGY

This study utilized secondary data obtained from NAERLS/FMARD (2022). The data collected cover various states across Nigeria, focusing on three primary variables: total production (in metric tons), land area (in hectares), and yield (in tons per hectare) for the most recent available year. The first part of the analysis involves the calculation of basic statistics to summarize the production and yield data across the states. The study also compares the agricultural productivity of different states within each geopolitical zone. This analysis helps identify best practices and effective agricultural policies implemented in higher-performing states, which can be adopted by lower-performing ones. The analysis will focus on identifying regions with significant agricultural strengths and weaknesses, and examining how these factors contribute to broader economic outcomes. The findings will inform recommendations for policy enhancements aimed at optimizing agricultural output and improving living conditions in rural communities.

RESULTS AND DISCUSSION

Figure 1 presents a comprehensive overview of the trends in production, farm size, and yield cassava in Nigeria over two-decades span from 2003 to 2022. This period is particularly significant given the evolving agricultural landscape in the country, largely shaped by the efforts of the National Root Crops Research Institute (NRCRI) and other stakeholders focused on enhancing the performance of crops such as cassava, yam, potato, sweet potato, cocoyam, ginger, and others.

Production

The production of cassava in Nigeria has exhibited a generally increasing trend during this period, which can be attributed to several factors, including improved agricultural practices, introduction of high-yielding crop varieties developed through genetic research, and enhanced access to extension services. The emphasis on cassava production is particularly noteworthy, reflecting Nigeria's status as the world's largest producer of cassava. The concerted efforts by NRCRI in providing research-based strategies to farmers are likely reflected in the significant production increases.

Farm Size

Average farm sizes have shown variations influenced by several factors, including land availability, population pressure, and agricultural policy shifts. Despite an overall increase in cassava production, farm sizes may not have enjoyed proportional expansions. This indicates a trend towards more intensive farming practices, where farmers maximize outputs from smaller plots of land. NRCRI's focus on promoting efficient land use practices and crop diversification has likely contributed to optimizing production per hectare, which aligns with global sustainability goals.

Yield

Yield is a critical measure of agricultural success, and the trends observed in Nigeria highlight significant advancements in this area. Improvements in yield per hectare of cassava crop can be linked to research and development initiatives by NRCRI, which have concentrated on genetic improvement and the dissemination of agronomic best practices. The increasing yields suggest that farmers are adopting more innovative practices and technologies, contributing to enhanced food security and economic viability in rural communities.

State-Level Analysis

The data presented in Table 1 highlights the production, land area utilized, and yield per hectare across various states in Nigeria. This review focuses on analyzing these metrics to understand the regional disparities in agricultural output and their implications for food security and economic prosperity.

North-Central Region

The North-Central region, with a total cassava production of 16,548.29 metric tons and a land area of 2,771.91 hectares, demonstrates a relatively high average yield of 5.97 tons per hectare. Notably, **Benue State** is the leading producer in this region with 3,732.88 tons, benefiting from fertile land and favorable climatic conditions. Kogi also showcases a commendable average yield of 9.28 tons per hectare, indicating effective farming practices which could be modeled in other states.

North-East Region

The North-East region, with a production total of 1,746.93 tons and a land area of 426.08 hectares, exhibits an average yield of 4.1 tons per hectare. While Jigawa presents a promising yield of 8.5 tons per hectare, the overall productivity remains low, particularly in states like Yobe, which only achieves a yield of 2.67 tons per hectare. This highlights the ongoing food security challenges exacerbated by insecurity and environmental degradation (FAO, 2022).

North-West Region

This region produces a total of 4,572.99 tons, with an average yield of 5.18 tons per hectare. Kaduna State stands out with a yield of 9.91 tons per hectare, suggesting effective agricultural practices. Yet, the disparities within this region raise concerns about equitable food distribution and access, which are essential for alleviating poverty (World Bank, 2020).

South-East Region
The South-East, with an aggregate production of 9,701.54 tons and a land area of 1,401.96 hectares, shows a robust average yield of 6.92 tons per hectare. Imo State leads with a yield of 10.39 tons per hectare, indicative of potential best practices that can be disseminated to other states to improve overall agricultural productivity.

South-West Region
The South-West region has a total production of 12,129.15 tons and an average yield of 9.58 tons per hectare, reflecting optimal land use and farming technology adoption. Ogun State's 10.26 tons yield per hectare exemplifies successful agricultural practices. This region's better performance is vital for job creation in agriculture and ancillary sectors.

South-South Region
With a total production of 12,579.37 tons and a land area of 2,306.47 hectares, the South-South region has an average yield of 5.62 tons per hectare. Interestingly, Ebonyi State's yield of just 0.03 tons per hectare warrants further investigation into agricultural practices and resource allocation.

Implications for Food Security and Poverty Alleviation
High agricultural yields are directly related to food security and economic stability. Regions such as the North-Central and South-West, with higher yields, are better positioned to contribute to national food reserves and market supply, subsequently reducing food prices and enhancing access for lower-income. Conversely, regions with lower yields reflect the need for targeted interventions, including investment in agricultural technology, training for farmers, and improved access to financing. Furthermore, enhancing agricultural productivity can alleviate poverty by creating jobs, particularly in rural areas where major employment is derived from farming and related activities. Immanuel *et al*. (2024), indicated importance of cassava for Food Security, Poverty Reduction and Climate Resilience.

CONCLUSION AND RECOMMENDATIONS
Production, farm size, and yield trends highlights significant regional disparities, with the North-Central and South-West zones demonstrating superior performance due to effective agricultural practices, while the North-East faces discernible challenges largely due to insecurity and environmental degradation. To minimize these disparities and optimize the agricultural potential of Nigeria, targeted policy interventions are essential. There results therefore call for policies aimed at increased funds allocation to research institutions, to continue developing high-yield and resilient crop varieties. Expanded research into sustainable farming practices and climate-smart agriculture is critical to adapting to the changing climate and improving productivity. Investing in rural infrastructure, including roads, storage facilities, and irrigation systems, will help reduce post-harvest losses, improve market access, and facilitate efficient distribution of agricultural produce. Enhanced infrastructure can significantly contribute to the agricultural sector's resilience and overall efficiency. Expanding access to agricultural extension services will provide farmers with essential knowledge and skills, enabling them to adopt best practices and innovative technologies. Regular training programs focusing on modern farming techniques, pest management, and sustainable practices

should be emphasized. Implementing policies that facilitate access to credit and financial support for smallholder farmers can empower them to invest in better seeds, fertilizers, and equipment. Additionally, creating insurance mechanisms can protect farmers from the impacts of climate variability and market fluctuating prices. Encouraging the formation of cooperatives can provide farmers with collective bargaining power, access to shared resources, and a platform for knowledge exchange. This approach can enhance productivity and strengthen market presence. Government and non-governmental organizations should prioritize targeted interventions in regions with lower productivity, such as the North-East. Focused investments, capacity-building programs, and infrastructure improvements tailored to the unique challenges of these areas can significantly enhance productivity and food security. Engaging the private sector in agricultural development through public-private partnerships can lead to innovative solutions and investments in the agricultural value chain. Collaborations can facilitate technology transfer, enhance supply chain efficiency, and stimulate rural economies.

REFERENCES

FAOSTAT (2022). Food and Agriculture Organization Statistics. *Crop and Livestock Products*. Available at. https://www.fao.org/faostat/en/#data/QCL.

Egesi, C.N. (2023) (Ed). NRCRI at 100. NRCRI Publications: National Root Crops Research Institute, Umudike, Abia State Nigeria. 165pp. Available at https://www.researchgate.net/publication/375085801_NRCRI_at_100

Immanuel, S., Jaganathan, D., Prakash, P. and Sivakumar, S. (2024). Cassava for Food Security, Poverty Reduction and Climate Resilience: A Review. *Indian Journal of Ecology*, 51(1): 21-31.

Manyong, V.M., Ikpi, A., Olayemi, J.K., Yusuf, S.A., Omonoma, B.T., Okoruwa, V. and Idachaba, F.S. (2005). Agriculture in Nigeria: Identifying Opportunities for Increased Commercialization and Investment in USAID/IITA/UI Project Report Ibadan, Nigeria.

NAERLS/FMARD (2022). National Report of the *Wet season Agricultural Performance Survey in Nigeria*. National Agricultural Extension and Research Liaison Services, Ahmadu Bello University, Zaria and the Federal Ministry of Agriculture and Rural Development, Abuja: NAERLS Press. Pp. 171-172.

Saginga, N. (2015). Root and Tuber Crops (Cassava, Yam, Potato and Sweet Potato). Background paper *Feeding Africa* 21-23 Oct. 2015 Abdou Diouf International Conference Centre, Senegal. 29pp.

https://nrcri.gov.ng/who-we-are/

Table 1: State/Regional Production Statistics; Cassava (2022)

States/Regions	Production (mt)	Land area (ha)	Yield (t/ha)
Benue	3732.88	431.05	8.66
Fct	1818.23	367.32	4.95
Kogi	3528.94	380.27	9.28
Kwara	1481.94	402.70	3.68
Nasarawa	1788.06	302.55	5.91
Niger	1678.78	361.03	4.65
Plateau	1071.27	319.78	3.35
Taraba	1448.2	198.93	7.28
North-Central	**16548.29**	**2771.91**	**5.97**
Bauchi	495.55	137.65	3.6
Gombe	757.15	125.56	6.03
Yobe	494.23	185.10	2.67
North-East	**1746.93**	**426.08**	**4.1**
Jigawa	1046.07	123.07	8.5

States/Regions	Production (mt)	Land area (ha)	Yield (t/ha)
Kaduna	1969.49	198.74	9.91
Katsina	387.43	163.47	2.37
Kebbi	623.78	135.31	4.61
Sokoto	323.09	86.62	3.73
Zamfara	223.12	114.42	1.95
North-West	**4572.99**	**882.82**	**5.18**
Abia	1866.57	265.89	7.02
Anambra	2197.31	266.66	8.24
Ebonyi	26.63	887.67	0.03
Enugu	2185.39	244.45	8.94
Imo	3425.63	329.70	10.39
South-East	**9701.54**	**1401.96**	**6.92**
Akwaibom	1993.2	304.77	6.54
Bayelsa	1462.53	376.94	3.88
Crossriver	2545.07	433.57	5.87
Delta	1829.59	242.65	7.54
Edo	1490.13	310.44	4.8
Rivers	3258.86	637.74	5.11
South-South	**12579.37**	**2306.47**	**5.62**
Ekiti	1843.98	328.11	5.62
Lagos	1436.75	258.41	5.56
Ogun	1749.18	170.49	10.26
Ondo	3393.39	226.23	15
Osun	1888.09	190.72	9.9
Oyo	1817.77	195.46	9.3
South-West	**12129.15**	**1266.09**	**9.58**
National	**57278.27**	**9193.94**	**6.23**

Source: NAERLS/FMARD (2022)

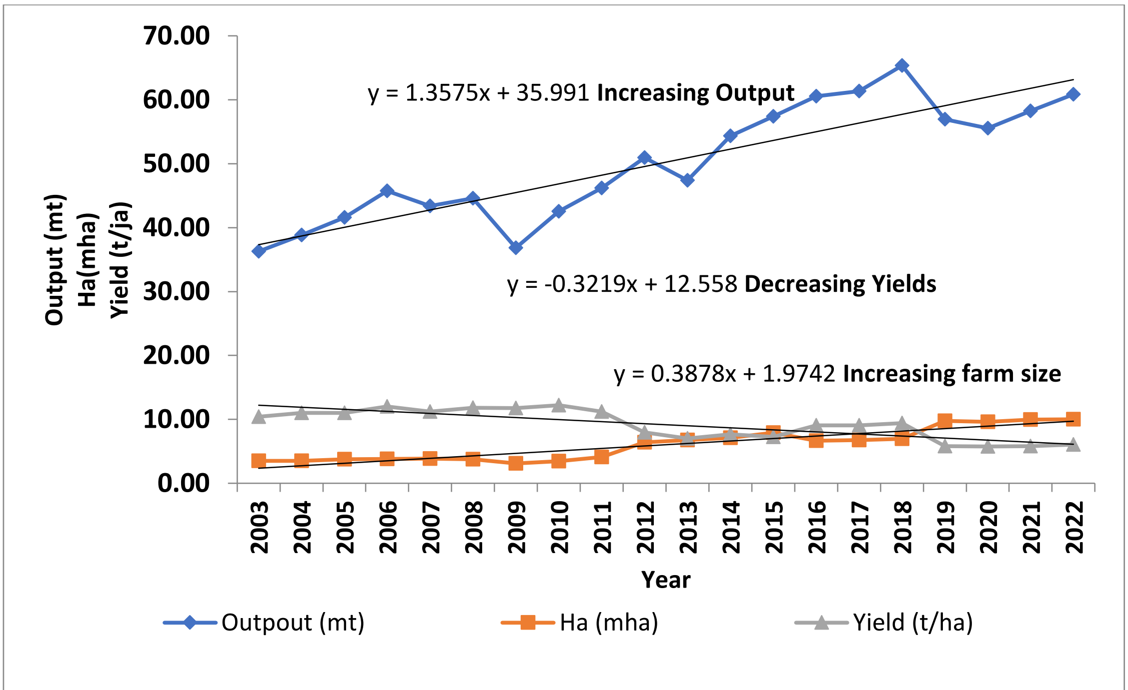

Fig. 1: Production, Farm size and Yield Trends in Nigeria: 2003-2022

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Biofertilizer Combined with Inorganic Fertilizer Improved the Growth and Yield of Maize in Minjibir, Sudan Savanna of Nigeria

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Abstract
Biofertilizers are gaining attention for promoting sustainable agriculture by enhancing nutrient and water uptake and suppressing soil-borne pathogens. However, poor soil fertility can limit their effectiveness. This study evaluated two biofertilizer formulations (A and B) and NPK fertilizer on maize productivity in Minjibir, Sudan savanna, Nigeria, during the 2023 rainy season using a randomized complete block design with four replicates. Treatments included three levels each of biofertilizer-A (0, 10, 20 L/ha), biofertilizer-B (0, 5, 10 L/ha), and NPK fertilizer (0%, 50%, 100% recommended rate). Biofertilizer-A contained Azotobacter sp., Azospirillum sp., and Bacillus licheniformis, while biofertilizer-B contained Azotobacter sp., Azospirillum sp., Bacillus subtilis, and Bacillus megaterium. Results showed biofertilizer-A significantly increased stem girth, while biofertilizer-B and NPK significantly improved the number of stands, cobs, plant height, and grain yield. Significant interactions were observed: biofertilizer-A with NPK improved plant height, biofertilizer-B with NPK improved stem girth, and both with NPK improved grain yield. The highest grain yield (6.14 t/ha) was with 10 L/ha biofertilizer-A, 10 L/ha biofertilizer-B, and 100% NPK. Combining 50% NPK with 20 L/ha biofertilizer-A and 5 L/ha biofertilizer-B yielded 5.28 t/ha, 88% higher than the control. These findings suggest biofertilizers can enhance maize performance in low-fertility soils when combined with NPK, promoting soil health and sustainable crop productivity.

Keywords: Biofertilizer; NPK fertilizer; Maize; Nigeria; Sustainable agriculture; Bacillus spp

INTRODUCTION
Biofertilizers are gaining worldwide attention for their potential to promote sustainable agriculture. They improve crop yield by enhancing nutrient and water uptake and suppressing soil-borne pathogens. Biological formulations have been demonstrated to promote crop yield by promoting growth and protecting plants from pathogens and are safer than chemical fertilizers and pesticides. The effectiveness of biological formulations can be improved by using multiple organisms or strains (Price-Price-Christenson and Yannarel, 2023). Plant growth-promoting rhizobacteria (PGPR) including *Azotobacter* sp., *Azospirillum* sp., *Bacillus subtilis*, *Bacillus licheniformis*, and *Bacillus megaterium* can promote plant growth by producing phytohormones and siderophores that stimulate plant growth and prevent pathogen infection. In addition, *Azotobacter* spp. is capable of nitrogen fixation (Sethi and Adhikary, 2012). *Azospirillum* spp. can improve root development which enhances water and nutrient use efficiency and converts nutrients to forms easily utilized by plants (Fukami *et al*., 2018). *Bacillus*

spp. can form long-lived stress-tolerant spores that persist for a long period (Tsotetsi *et al*., 2022). A biofertilizer mixed with biochar has been reported to enhance nitrogen availability and uptake and consequently, plant growth when used in combination with mineral fertilizer (Mikajlo et al., 2023). Large quantities of NPK fertilizers are usually applied to crops via soil application to improve crop growth and yield. However, long-term application of sole inorganic fertilizer may have deleterious effects on humans and the environment, hence, the need for alternative and sustainable nutrient management strategy. Therefore, this study was carried out to test the individual effect of two biofertilizer formulations and their combination with NPK fertilizer on the growth and yield of maize in Minjibir, Sudan savanna of Nigeria.

MATERIALS AND METHODS

Site Description, Soil Sampling and Analysis

Field experiments were established at the Institute for Agricultural Research (IAR) Farm at Minjibir, Kano during the 2023 wet season. The wet season trials started in June 2023 and ended in November 2023. In the Sudan savanna, the mean annual temperature and precipitation is 26.51 ± 0.41 °C and 571.31 ± 144.94 mm, respectively (Onyeneke et al., 2020). Soil auger was used to collect soil samples from the experimental fields at a depth of 0-20 cm prior to land preparation. Twenty soil samples were collected systematically in a zig-zag manner and bulked to form a composite sample. A subsample of the composite sample was air-dried, crushed, and sieved using 2 mm. Routine soil analysis was carried out in the Department of Soil Science laboratories at IAR Samaru using standard procedures.

Land Preparation, Sowing and Treatment Application

The fields were harrowed and ridged at 75 cm apart and maize was sown at an intra-row spacing of 25 cm. The maize variety sown was SAMMAZ 55, an early maturing variety (90 to 95 days) obtained from IAR, Samaru, Kaduna State, Nigeria. Biofertilizer-A is a formulation containing *Azotobacter* sp., *Azospirillum* sp., and *Bacillus licheniformis*, and biofertilizer-B contains *Azotobacter* sp., *Azospirillum* sp., *Bacillus subtilis* and *Bacillus megaterium*. A total of 27 treatments were evaluated comprising a factorial combination of three concentrations (0, 10, and 20 L/ha) of biofertilizer-A, three concentrations (0, 5, 10 L/ha) of biofertilizer-B and three levels of mineral fertilizer (zero, half and full recommended rates). In northern Nigeria, the full and half recommended rates of NPK fertilizer for maize are 120:60:60 and 60:30:30, respectively. The treatments were arranged in a randomized complete block design (RCBD) with four replications. Each treatment was allocated on 4 ridges (75 cm) of 3 m length. Biofertilizer-A was applied as a foliar spray at seedling, vegetative, and fruiting/tasseling stages and biofertilizer-B was applied at planting.

Data Collection and Statistical Analysis

Crop agronomic data such as plant height, stem girth, and number of cobs and stands per plot were measured during the growth period and grain yield was obtained at harvest. Data collected were subjected to analysis of variance (ANOVA) using the R program, version 4.1.2. Significantly different treatment means were separated using Duncan's Multiple Range Test (DMRT) at a 5 % level of significance.

RESULTS AND DISCUSSION

Physical and chemical properties of the experimental soil

Interpretation of the soil results was based on the critical values for nutrients as given by the Nigeria Federal Ministry of Agriculture and Natural Resources, FMANR (1990). The analytical values show that the soil texture was Loamy Sand and the pH in water was rated slightly alkaline (pH 7.23), organic carbon (1.88 g/kg), and total N (0.25 g/kg) contents were interpreted to be very low while available P level was high (34.30 mg/kg). Exchangeable bases including Ca^{2+} (4.80 cmol/kg), Mg^{2+} (1.35 cmol/kg), and Na^{+} (0.42 cmol/kg) were all classified as low while K^{+} (0.52 cmol/kg) was moderate. Although the fertility indices of the soil were generally low, the high soil P level may have variable effects on the response of the soil to fertilizer application and microbial inoculation.

Effect of treatments on growth components and yield of maize

Stem girth was significantly ($P \leq 0.05$) improved by biofertilizer-A and -B while biofertilizer-B and NPK fertilizer significantly improved the number of stands, number of cobs, plant height, and grain yield (Table 1). Biofertilizer-B at 5 l/ha improved the number of cobs, plant height, and grain yield by 8.16%, 5.68%, and 11.84%, respectively, compared to the control. Similarly, NPK fertilization at the full recommended rate improved the number of cobs, plant height, and grain yield by 19.92%, 5.68%, and 67.14%, respectively, compared to the control. The interaction of 20 l/ha of biofertilizer-A with the full rate of NPK improved plant height by 8.61%, 9.25%, and 7.39%, respectively, compared to the control, combination of 10 l/ha biofertilizer-A with 0 kg/ha NPK, and the combination of 10 l/ha biofertilizer-A with half rate of NPK (Figure 1). This result further emphasizes the importance of NPK fertilizer in improving maize growth in low-fertile soil and enhancing microbial activities in the rhizosphere.

The significant interaction effect of biofertilizer-B with NPK on maize stem girth is presented in Figure 2. A significant ($P \leq 0.05$) increment of 20.51% in stem girth was observed in the plots that received the combination of 5 l/ha biofertilizer-B with the full recommended rate of NPK compared to the control (0 l/ha biofertilizer-B with 0 kg/ha NPK). Other combinations that also significantly improved stem girth compared to the control include 10 l/ha biofertilizer-B with full recommended rate of NPK, 10 l/ha biofertilizer-B with half recommended rate of NPK, and 5 l/ha biofertilizer-B with half recommended rate of NPK. The lowest values of stem girth were found in plots that received only biofertilizer-B application with 0 kg/ha NPK to further demonstrate that the performance of the biofertilizer is contingent on the application of mineral fertilizers in low fertile soils. Since most soils in Nigeria are inherently low in fertility, soils with adequate levels of P are expected to enhance crop growth as P is the second most limiting plant nutrient (Bello et al., 2018). However, to sustain crop production in the low-fertile soils where this study was conducted, it was imperative to apply NPK fertilizer for optimal crop performance. In addition, the application of NPK fertilizer can also enhance the performance of the inoculated microbes which also rely on soil nutrients for survival in the rhizosphere.

Table 1 Effect of biofertilizers and NPK fertilizer on growth components and yield of maize

Treatments	No. of stands/plot	No. of cobs/plot	Plant height (cm)	Stem girth (cm)	Grain yield (t/ha)
Biofertilizer-A (0 l/ha)	40.36a	56.89a	179a	5.36b	4.39a
Biofertilizer-A (10 l/ha)	38.64a	54.25a	179a	5.56ab	4.40a
Biofertilizer-A (20 l/ha)	40.22a	57.86a	184a	5.62a	4.71a
Biofertilizer-B (0 l/ha)	37.86b	54.19b	176b	5.48a	4.22b
Biofertilizer-B (5 l/ha)	41.14a	58.61a	186a	5.61a	4.72a
Biofertilizer-B (10 l/ha)	40.22a	56.19ab	180ab	5.44a	4.57ab
NPK (0-0-0 kg/ha)	38.31b	51.75b	176b	5.43a	3.50c
NPK (60-30-30 kg/ha)	40.42a	55.19b	179ab	5.52a	4.51b
NPK (120-60-60 kg/ha)	40.50a	62.06a	186a	5.58a	5.50a

Means within the same column and having similar letter(s) are not significantly (P > 0.05) different from each other. NS and * stand for not significant and significant at P ≤ 0.05, respectively.

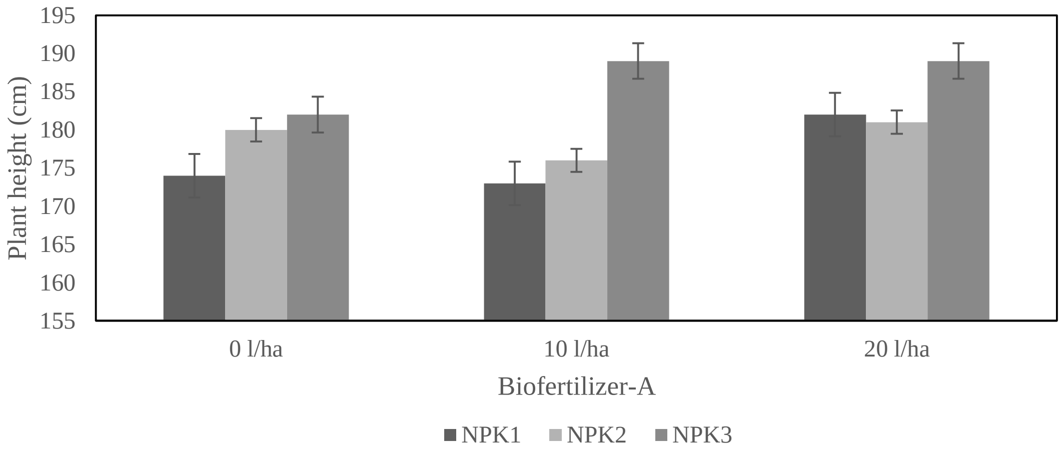

Figure 1 Interaction effect of Biofertilizer-A and NPK fertilizer on plant height
Note: NPK1, NPK2, and NPK3 stand for zero, half and full recommended rate of NPK fertilizer, respectively.

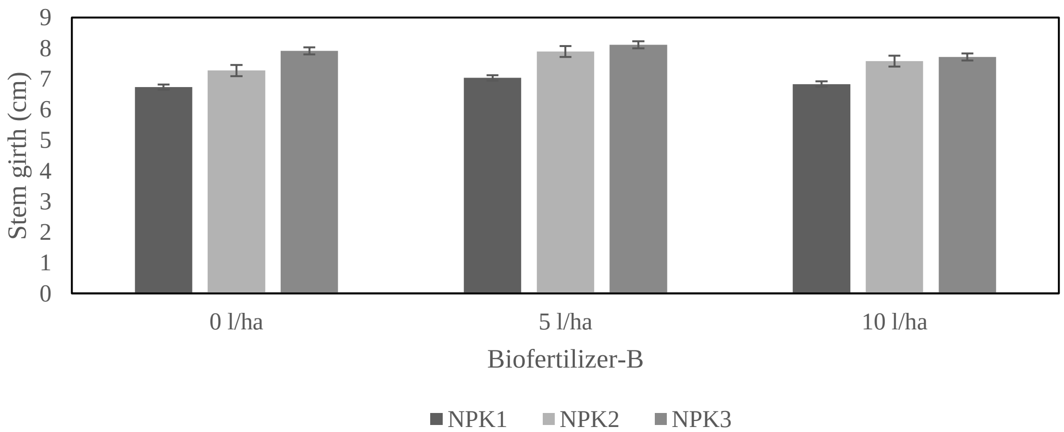

Figure 2 Interaction effect of Biofertilizer-B and NPK fertilizer on maize stem girth
Note: NPK1, NPK2, and NPK3 stand for zero, half and full recommended rate of NPK fertilizer, respectively.

In the three-way interaction of the treatments, the highest grain yield of 6.14 t/ha was obtained from plots that received the combination of 10 l/ha of biofertilizer-A, 10 l/ha biofertilizer-B and NPK full recommended rate (Figure 3). Maize grain yield was significantly increased by the interactions of 10 l/ha biofertilizer-A * 10 l/ha biofertilizer-B * full rate of NPK, 0 l/ha of Biofertilizer-A * 5 l/ha Biofertilizer-B * full rate of NPK, 10 l/ha Biofertilizer-A * 5 l/ha Biofertilizer-B * full rate of NPK, 0 l/ha Biofertilizer-A * 10 l/ha Biofertilizer-B * full rate of NPK, 20 l/ha Biofertilizer-A * 0 l/ha Biofertilizer-B * full rate of NPK, and 20 l/ha Biofertilizer-A * 5 l/ha Biofertilizer-B * full rate of NPK by 118.51%, 113.52%, 112.46%, 103.56%, 96.80%, and 90.75%, respectively, compared to the control (combination of 0 l/ha of biofertilizer-A, 0 l/ha biofertilizer-B and 0 kg/ha NPK). The outcome of this three-way interaction also shows the importance of NPK fertilizer in promoting the performance of biofertilizers on maize grain yield. NPK fertilizer was observed to be missing in all plots with low grain yields. This observation buttresses the importance of mineral fertilizer in supporting plant performance under the low fertility level of the experimental soil. Given the low fertility level of the experimental soil, a high response to NPK fertilizer application is expected as observed from the obtained results and this low soil fertility will affect the optimal performance of biofertilizers.

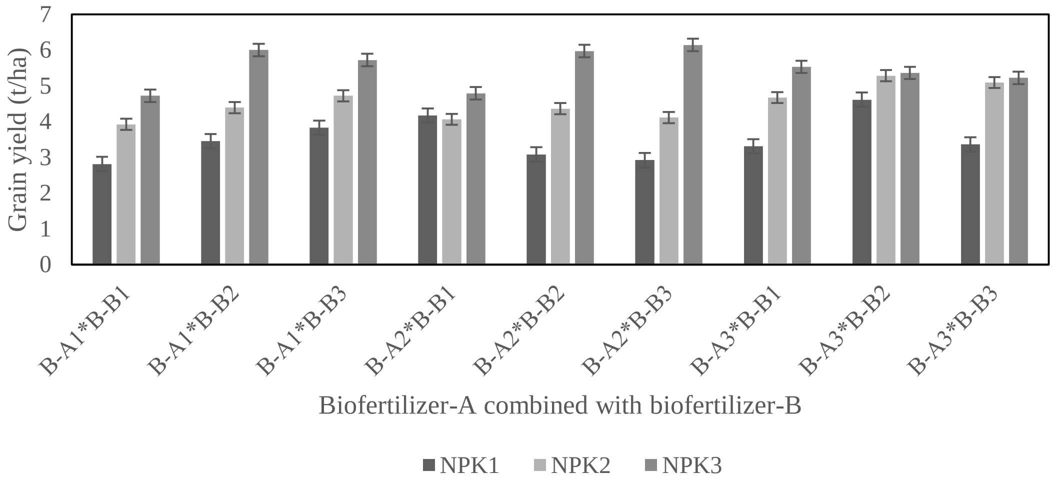

Figure 3 Interaction effect of Biofertilizer-A, Biofertilizer-B and NPK fertilizer on maize grain yield
Note: B-A1, B-A2 and B-A3 stand for biofertilizer-A at 0, 10, and 20 l/ha, respectively; B-B1, B-B2, B-B3, stand for biofertilizer-B at 0, 5, and 10 l/ha, respectively; NPK1, NPK2, and NPK3 stand for zero, half and full recommended rate of NPK fertilizer, respectively.

CONCLUSION AND RECOMMENDATIONS

This study showed the potential efficacy of biofertilizer formulations in improving maize growth and yield parameters under field conditions in the Sudan Savanna of Nigeria. Biofertilizer-B had a greater impact on maize growth and yield than Biofertilizer-A. The efficacy of these biofertilizers can be greatly enhanced with the inclusion of NPK fertilizer application. Despite the low fertility level of the soil, the biofertilizers combined with NPK fertilizer enhanced maize performance suggesting that they may play important roles in improving soil health. Therefore, it is recommended that future studies should also include the assessment of soil health due to the application of these biofertilizers and the study should also be repeated over time to validate the impact of these treatments on crop and soil productivity in different agroecological zones in Nigeria.

REFERENCES

Bello, S. K., Yusuf, A. A., & Cargele, M. (2018). Performance of cowpea as influenced by native strain of rhizobia, lime and phosphorus in Samaru. *Symbiosis*, *75*(3), 167–176.

Federal Ministry of Agriculture and Natural Resources (FMANR). (1990). *FMANR*.

Fukami, J., Cerezini, P., & Hungria, M. (2018). Azospirillum: Benefits that go far beyond biological nitrogen fixation. *AMB Express*, *8*(1), 73. https://doi.org/10.1186/s13568-018-0608-1

Mikajlo, I., Pourrut, B., Louvel, B., Hynšt, J., & Záhora, J. (2023). Plant-soil nitrogen, carbon and phosphorus content after the addition of biochar, bacterial inoculums and nitrogen fertilizer. *Journal of Plant Nutrition*, *46*(4), 541–555. https://doi.org/10.1080/01904167.2022.204336

Onyeneke, R. U., Emenekwe, C. C., Munonye, J. O., Nwajiuba, C. A., Uwazie, U. I., Amadi, M. U., Izuogu, C. U., Njoku, C. L., & Onyeneke, L. U. (2020). Climate progress–agricultural vulnerability assessment in Nigeria. *Atmosphere*, *11*(2), 190. https://doi.org/10.3390/atmos11020190

Price-Christenson, G., & Yannarel, A. (2023). Use of ecological theory to understand the efficacy and mechanisms of multistrain biological control. *Phytopathology*. Advance online publication. https://doi.org/10.1094/PHYTO-04-22-0115-RVW

Sethi, S. K., & Adhikary, S. P. (2012). Azotobacter: A plant growth-promoting rhizobacteria used as a biofertilizer. *Dynamic Biochemistry, Process Biotechnology and Molecular Biology*, *6*(1), 68–74.

Tsotetsi, T., Nephali, L., Malebe, M., & Tugizimana, F. (2022). Bacillus for plant growth promotion and stress resilience: What have we learned? *Plants (Basel)*, *11*(19), 2482. https://doi.org/10.3390/plants11192482

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Assessment of Yield Components of Selected Sweet Potato Genotypes at Clonal Stage Trial at Umudike, Nigeria

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ABSTRACT

This study assessed the yield components of 24 selected sweet potato (Ipomoea batatas) genotypes at the clonal stage during the 2021 planting season at the National Root Crops Research Institute (NRCRI), Umudike, Nigeria. The experiment was conducted using a randomized complete block design (RCBD) with three replications, 24 plots per replication, and a plot size of 5m x 3m. Sweet potato vines were planted at a spacing of 0.3m x 0.3m with a population of 50 plants per plot. Growth parameters such as vine length, leaf area, and number of roots were recorded at 8, 10, 12, and 14 weeks after planting (WAP). Data were analyzed using the general linear model in Genstat software (12th Edition), and significant differences were compared using the least significant difference (LSD) test. Results indicated that vine length, leaf area, and the number of roots increased significantly with time (WAP), but no significant differences were observed among genotypes for most traits. The longest vine length at 14 WAP was 387 cm for genotype NWA/OP/287, while the highest leaf area (125.2 cm²) and root number (7 roots) were recorded for genotypes 87/OP/208 and NWA/OP/247, respectively. The study concludes that genotype and environmental factors have a significant impact on yield components, and further evaluation in multi-locational trials is recommended to identify stable, high-yielding genotypes.

Keywords: Evaluation, Yield components, genotype

INTRODUCTION

Sweet potato (Ipomoea batatas L.) is one of the most important root and tuber crops globally, contributing significantly to food security, nutrition, and income generation, especially in sub-Saharan Africa. Nigeria is one of the leading producers of sweet potato in Africa, where it is grown for its edible storage roots, which are rich in carbohydrates, vitamins (notably vitamin A), and minerals (FAO, 2017). The crop's adaptability to diverse agro-ecological conditions, short growth cycle, and ability to withstand drought make it a vital component of sustainable agriculture (Laurie et al., 2015). To improve the productivity of sweetpotato, breeding programs focus on identifying high-yielding, disease-resistant genotypes with desirable agronomic traits (Mwanga et al., 2007). The clonal evaluation stage is a critical phase in the breeding process, where multiple genotypes are tested under uniform conditions to assess their performance and yield potential. Key parameters such as vine length, leaf area, and root number serve as indicators of overall plant vigor and potential yield, providing valuable insights into genotype performance (Odebode, 2008). This study was conducted to evaluate the yield components of selected sweet potato genotypes at the clonal stage in Umudike, Nigeria. By assessing the growth and yield performance of these genotypes, the research aims to identify potential candidates for further breeding and large-scale production.

MATERIALS AND METHODS

Study Area: The experiment was conducted at the National Root Crops Research Institute (NRCRI), Umudike, Nigeria, during the 2021 planting season. Umudike is located in the humid forest agro-ecological zone of southeastern Nigeria, characterized by a mean annual rainfall of 2,200 mm and an average temperature of 26°C. Experimental Design: Twenty-four sweet potato genotypes were selected from the NRCRI clonal evaluation trial. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Each plot measured 5m x 3m, and the vines were planted at a spacing of 0.3m x 0.3m, resulting in a plant population of 50 per plot. Data Collection: Data were collected on vine length, leaf area, and the number of roots at 8, 10, 12, and 14 weeks after planting (WAP) from 24 plants in the net plot. Standard agronomic practices, such as weeding and pest control, were employed to ensure optimal crop growth. Data Analysis: The data were subjected to analysis of variance (ANOVA) using the general linear model ($Y_{ijk} = \mu + A_i + B_j + AB_{ij}$ + random error) in Genstat software (12th Edition). Significant differences among genotypes, times, and their interactions were determined using the least significant difference (LSD) test at a 5% significance level.

RESULTS AND DISCUSSION

The analysis of variance showed no significant differences in vine length among the genotypes at 8, 10, 12, and 14 WAP. However, vine length increased significantly over time, with a mean length of 137.7 cm. At 8 WAP highest vine length was 243cm for genotype TIS/87/0087 and the lowest was 86.7 cm was recorded for NWA/OP/287 at 14 WAP (Table 1). The longest vine length at 14 WAP was recorded for genotype NWA/OP/287 (387 cm), followed by 87/OP/210 (356 cm). The check variety, TIS/87/0087, exhibited moderate vine lengths of 243 cm and 249 cm at 8 and 14 WAP, respectively.The increase in vine length over time reflects the vegetative growth of sweetpotato, which is crucial for the establishment of a strong canopy to support root development. However, the lack of significant genotype differences suggests that environmental factors may play a dominant role in vine elongation under the conditions of this trial. Leaf area is an important trait in determining the photosynthetic capacity and overall vigor of a plant. ANOVA results indicated no significant differences in leaf area among the genotypes, but a significant increase was observed over time. The highest leaf area at 8 WAP was 125.2 cm^2 for genotype 87/OP/208, while the lowest was 58.6 cm^2 for genotype PO3/82 (Table 2). At 14 WAP, the leaf area ranged from 65.2 cm^2 to 118.3 cm^2 across the genotypes. The observed increase in leaf area over time highlights the genotypes' capacity to expand their photosynthetic surface area, which is vital for biomass accumulation and root formation. However, like vine length, leaf area was largely influenced by environmental conditions rather than genotype. Root number is a critical yield component in sweetpotato, as it directly influences the number of marketable roots per plant. The number of roots increased significantly over time, There was no significant difference in the genotype, but a significant difference in time (weeks) and no significant difference in their interactions with the least significant difference for genotype being 1.076 time (in weeks) 0.439 and their interactions 2.153 ($P<0.05$). The highest number of roots at 8WAP for the genotypes was 5.66 genotypes was recorded for PO3/98. Whereas the lowest recorded was 3.66 respectively was recorded for 87/OP/145.respectively. At 14 WAP, the highest number of roots of 7 was recorded for NWA/OP/247. The lowest being 4.33 was recorded for 87/OP/208. The check variety TIS/87/0087 recorded 5.3 and 6 for both 8 and 14 WAP. The mean number of roots for the total weeks of 8, 10, 12, and 14 WAP were 4.5, 5.0, 5.0 and 5.7 respectively. The increase in root number over time suggests that the sweetpotato genotypes are well adapted to the agro-climatic conditions of Umudike. However, the lack of significant genotype differences indicates that root formation was primarily driven by time rather than inherent genetic factors.

Table 1 and 21.ANOVA table for Vine Length and leaf Area

	Weeks after planting							
	Vine Length				Leaf Area			
Genotypes	**8**	**10**	**12**	**14**	**8**	**10**	**12**	**14**
87/OP/132	89.7	105	204.7	230.3	112.4	96	10.8	112.3
87/OP/145	96.7	119.7	223.3	238	84.2	102.7	102.1	116.7
87/OP/161	114.7	207.7	250	212.3	87.9	111.9	164.1	116.7
87/OP/194	112	140.7	209	310.3	76.7	74.4	115.4	69.2
87/OP/208	105.3	125.7	232.3	328.3	125.2	97.2	103.8	118.3
87/OP/210	134	183.3	271	356	94.3	87.1	78.4	79.5
MAX	108.3	170	302	341.3	72	87.5	82.1	84.8
NWA/OP/231	74.3	162.7	295.7	346	98.3	88.8	104.9	95.3
NWA/OP/242	144.7	152.7	228.3	280.7	167	101.3	111.9	100.7
NWA/OP/247	267.7	212	269.7	288	81.4	113.5	111.3	83.8
NWA/OP/28	188.3	210.7	196	330.7	72.8	69.2	108	88
NWA/OP/287	86.7	122.3	334.3	278.7	112.3	88.1	103.5	105.4
NWA/OP/290	160	288	223.7	387	105.3	112.9	102.1	98
PO3/14	117.3	162.3	245	298.3	91.8	81.6	87.6	91.5
PO3/16	168.7	211.3	236	291.3	85	98.1	98	97.8
PO3/11	111.3	158.3	263		77.3	90.7	100.1	100.8
PO3/19	121.3	220.3	183.7	339	73.5	107.1	100	98.4
PO3/38	119.3	204	156.7	227.7	79.9	79.7	86.5	82
PO3/40	145.3	180.7	185.3	133.3	97.1	92	140.1	107.5
PO3/82	185.7	180.7	185.3	173	58.6	84.5	105.8	98.3
PO3/92	162.3	272	220.7	172.3	93.6	77.2	105.8	98.3
PO3/93	131	157.7	163	261.3	62.9	113.2	125.9	76.5
PO3/195	117.7	197	195.3	135	77.2	110.8	94.9	85
TIS/87/0087	243.3	223	115.3	249.3	89.3	94.7	105.8	93.1
Mean	**138**	**178**	**225**	**270.1**	**108**	**94**	**104.6**	**65.2**
Lsd $_{(0.05)}$ genotype	**27.53 (ns)**				**1.076 (ns)**			
Lsd $_{(0.05)}$ Time_wks	**11.24**				**0.43**			
Lsd $_{(0.05)}$ interaction	**55.06 (ns)**				**2.15 (ns)**			

Table 3. ANOVA table for number of roots

Genotypes	**8**	**10**	**12**	**14**
87/OP/132	4.6	5.3	5	5.6
87/OP/145	3.6	5.3	4	5
87/OP/161	4.6	3.3	5	7
87/OP/194	4.6	4.3	4.6	5.3
87/OP/208	3.6	4	5.3	4.3
87/OP/210	4.6	6	6	5.6
MAX	5	5.6	4.6	5
NWA/OP/231	3.3	4.6	5.3	7
NWA/OP/242	3.3	6	3.6	4.3
NWA/OP/247	4	5	5.3	7
NWA/OP/28	5.3	4	4.6	6.3
NWA/OP/287	4	6	5.3	6.3
NWA/OP/290	6.3	5	4.6	5.3
PO3/14	5.3	5	3	6.6
PO3/16	3.3	6.3	5	6.6
PO3/11	5.6	5	5.6	4
PO3/19	5	4.6	5.3	6
PO3/38	3.6	5.6	5.6	4
PO3/40	5	5.3	5.3	5.6
PO3/82	5.3	5.6	5.6	5.6
PO3/92	4.3	4.6	5.3	4
PO3/93	4.3	5.3	5	5.6
PO3/195	5.3	6	5.6	6.3
TIS/87/0087	5.3	4	6.3	6
Mean	**4.5**	**5**	**5**	**5.6**
Lsd $_{(0.05)}$ genotype 27.53 (ns)	**1.07**			
Lsd $_{(0.05)}$ Time_wks 11.24	**0.43**			
Lsd $_{(0.05)}$ interaction 55.06	**2.1**			

CONCLUSION AND RECOMMENDATIONS

This study assessed the yield components of 24 sweet potato genotypes at the clonal stage in Umudike, Nigeria, with a focus on vine length, leaf area, and the number of roots measured at 8, 10, 12, and 14 weeks after planting. The results indicate that time plays a significant role in the expression of these growth parameters, with vine length, leaf area, and root number increasing consistently across the different time points. However, genotype-specific effects were less pronounced, suggesting that while some genotypes showed potential for higher performance, environmental factors and the stage of growth had a greater influence on yield components. Genotype NWA/OP/287 showed the longest vine length, while 87/OP/208 and NWA/OP/247 exhibited superior leaf area and root numbers, respectively. These genotypes hold promise for further evaluation and potential use in breeding programs aimed at improving sweet potato productivity in Nigeria. However, given the lack of significant genotype-by-time interaction, the selection of genotypes for widespread cultivation should consider the stability of performance over time and in different environments.

Based on the findings of this study, the following recommendations are made:

i. Multi-Locational Trials: Since environmental factors significantly influenced vine length, leaf area, and root number, it is recommended that these genotypes be tested across multiple agro-ecological zones to identify stable, high-yielding varieties.

ii. Selection of Promising Genotypes: Genotypes such as NWA/OP/287 and 87/OP/208, which exhibited superior vine length and leaf area, respectively, should be considered for further evaluation in advanced yield trials.

REFERENCES

Laurie, S. M., Faber, M., & Claasen, N. (2015). Nutritional value of sweet potato. *African Journal of Food Science*, 9(8), 435-445.

Mwanga, R. O. M., Yencho, G. C., & Stevenson, P. C. (2007). Genotype × environment interactions for storage root yield in sweetpotato. *African Crop Science Journal*, 15(1), 63-72.

Odebode, S. O. (2008). Promotion of sweet potato for the food industry in Nigeria. *Bulgarian Journal of Agricultural Science*, 14(3), 300-308.

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Assessment of Postharvest Losses along Cowpea Value Chain in Madobi Local Government Area, Kano State, Nigeria

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Abstract
This study evaluates postharvest losses (PHLs) in the cowpea value chain in Madobi, Kano State, Nigeria, using cross-sectional data. A sample of 149 value chain actors was selected through probability proportional to size (PPS) sampling from three communities. Data were collected using questionnaires and a food loss calculator and analyzed with descriptive statistics, weight loss techniques, and multiple linear regression. Results indicated that 56.6% of actors were male, with an average age of 40.81 years. Respondents had average household size of 10 and varying levels of formal education (41.2%) while average years of experience in cowpea value chain was10.97 years. Value chain participation and losses incurred was primarily at the Farmers (32.9%), marketers (19.9%), and transporters (17.5%) nodes. Prime factors contributing to PHLs included pests and diseases (WMS = 3.56), inadequate storage facilities (WMS = 3.06), and poor handling (WMS = 3.40). Common management strategies involved cultural methods (WMS = 2.23), solar treatment (WMS = 1.94), and agrochemicals (WMS = 1.93). Statistical analysis revealed that PHLs were significantly influenced by marital status (β = 0.063, p<0.076), income (β = -0.108, p<0.055), quantity harvested (β = 1.013, p<0.000), and access to extension services (β = -0.091, p<0.085). The study concludes that significant losses (32.94%) occur primarily due to pest infestation. To mitigate these losses, it recommends the adoption of integrated pest and disease management technologies.

Keywords: Cowpea, Postharvest losses, Value chain, Food loss management, Kano State

INTRODUCTION
Postharvest losses (PHLs) remain a huge challenge in both developed and developing countries. Empirical evidence suggests that about one-third of all food produced globally, is either lost, wasted or discarded along the food value chain and that these losses occur mostly during postharvest operations (Kumar & Kaita, 2016). Available statistics affirmed that most of the food and crop loss occurs in less developed nations where poor business practices, technical and financial constraints, workforce shortages, and lack of adequate infrastructure for transportation and storage are apparent (Gustavsson *et al.*, 2011).

Nigeria is the largest producer and consumer of cowpea globally (Kamara et al., 2018) and the economic importance of cowpea to the Nigerian economy cannot be overemphasized. However, Cowpea (*Vigna unguiculata* (L.) Walp.), locally known as “wake” or “bean” in Nigeria has is not exempted from the challenges of postharvest losses that marred the success story of Nigeria’s exploit in the cowpea value chain.

PHLs are encountered along the cowpea value chain in handling, storage, transportation, processing and marketing thus, resulting in the degradation of both quantity and quality. Such losses can have great impact on nutrition, quality or quantity of the crop yield, health, the economic capacity of farmers, and food availability. The case of cowpea is peculiar. For instance, it is reported that insects, called Bruchids (*Callosobruchus maculatus*) can destroyed within several weeks if cowpea are left unprotected (Kalpna et al. 2022). The insect problems of cowpea are not limited to the field. Postharvest infestation with weevils is often identified as the key challenge for small scale cowpea producers, traders and consumers. This menace is exacerbated as a result of the dearth of adequate information on PHL management strategies. Therefore, the need for appropriate assessment and evaluation of the extent and possible factors responsible for postharvest losses incurred along the cowpea value chain, and to advance possible ways to reduce such losses is imperative.

METHODOLOGY

The study was conducted in Madobi local government area, Kano State. Located between latitudes 11^0 42' to 11^0 54'N and longitudes $8^0$15' to 8^0 33' E. Cross-sectional data was sought and collected with the aid of questionnaire and food loss calculator from 149 cowpea value chain actors in three communities using the probability proportional to size (PPS) sampling technique. Descriptive statistics, weight loss (WL) and regression analyses were used to achieved the research objectives.
Weight loss: Weight loss (WL) is a mathematical expression for the loss of both quantity and quality as:

$$WL = \frac{\mathrm{FW} - \mathrm{IW}}{IW} \times 100$$

Where;
WL = Weight loss, FW = Final weight, and IW = Initial weight
Multiple linear regression: Information on the determinants of PHls of cowpea was determined using a multiple linear regression model:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 U_i$$

Where; Y = post-harvest loss of cowpea (kg/value chain actor), X_1 = Age (years), X_2 = Gender, X_3 = Marital status, X_4 = Household size, X_5 = Level of education, X_6 = Farm size (hectare), X_7= Membership of cooperatives dummy (1 = yes, 0 = no), X_8= Extension contact dummy (1 = yes, 0 = no), X_9 = total quantity of cowpea harvested/bought (kg), X_{10} = packaging dummy (1 = improved, 0 = traditional), β_0 = y-intercept (constant term), $b_1 - b_8$ = Regression coefficients X_1-X_{10}= Variables, e = Error term

RESULTS AND DISCUSSION

Results of socioeconomic characteristics (Table 1) showed that more than half (56.6%) of the respondents were males while 43.4% were females, implying that both genders play active roles in cowpea value chain and PHL management. This result is in consonance with the findings of Sugri et al. (2021) who depicted similar distribution among respondents in Upper east region of Ghana. The mean age of respondents was 41±12 years, indicating the active and productive ages of respondents. The distribution of respondents according to household size revealed the mean household size of 10±7 persons, implying that respondents in the study area had relatively large household size, with further implication that there would be relative abundance of farm labour to tackle the menace of PHLs in cowpea.

Respondents educational status showed that, 41.2% of respondents had formal and conventional education. Contrary to the finding of Sugri et al. (2021) who averred that majority of actors in cowpea value chain were without formal education, result of this study revealed that that the actors in cowpea value were substantially educated, an indication that they could be informed about postharvest management scenarios, including mitigation measures. Likewise, respondents mean years of involvement in cowpea value chain was 11±8.1 years. This distribution of years of experience could be seen as an asset because, long years of experience tends to increase the chances of respondents' better use of cowpea postharvest management technologies. This assertion aligns with the finding of Bolaji (2014) who observed that years of farming experience increased statistically, the probability of reusing Purdue Improved Cowpea Storage (PICS) in the North Central region of Nigeria.

Result of access to extension services showed that 64.3% of respondents had no access to agricultural extension services. This implies that the near absence of such critical service could limited the knowledge of PHLs in cowpea. This view is in consonance with the submission of Ariong et al. (2023) that, supplying farmers with beneficial postharvest handling information is necessary, to ensure they meet the required grain standards. Result of the distribution of annual income showed that respondents in the study area had an average annual income of ₦376,839±211,312.

Table 1: Socioeconomic Characteristics of Respondents

Variables	Items	Freq	%	Min	Max	$\bar{X}$±SD
Sex	Male	81	56.6			
	Female	62	43.4			
Age	<=20	8	5.6	18	75	40.81± 12.09
	21-30	27	18.9			
	31-40	37	24.9			
	41-50	41	28.7			
	51-60	25	17.5			
	>=61	5	3.5			
Household size	<=5	42	29.4	2	45	10.48± 7.36
	6-10	56	39.2			
	11-15	19	13.3			
	16-20	15	10.5			
	20-25	5	3.5			
	>=26	6	4.2			
Educational status	Adult	33	23.1			
	Primary	20	14.0			
	Qur'anic	51	35.7			
	Secondary	22	15.4			
	Tertiary	17	11.9			
Years of involvement in cowpea VC	<=5	47	32.9	1	35	10.97± 8.09
	6-10	42	29.4			
	11-15	24	16.8			
	16-20	14	9.8			
	20-25	5	3.5			
	>=26	11	7.7			
Extension Contact	No	92	64.3			
	Yes	48	33.6			
Annual Income	<=200000	43	30.1	100,000	990,000	376,839±211,312
	200001-400000	49	34.3			
	400001-600000	35	24.5			
	600001-800000	11	7.7			
	800001-1000000	5	3.5			

Source: Field survey 2023

Postharvest operations along cowpea value chain

Results in Table 2 showed that PHLs occur more at the farmers (32.9%), then marketers (19.9%) and threshing (17.5%) nodes of cowpea value chain. This result show semblance with the findings of Kumar & Kaita (2016) that, PHLs are encountered along the value chain in handling, storage, transportation, processing and marketing. Detail analysis revealed that out of an average of 1015.75kg of cowpea harvested at the farm level, 344.27kg was lost, while transporters experienced average loss of 158.82kg out of 1050.73kg, representing 17.47% losses. Losses incurred at farm-level and marketing nodes were high because of storage activities that occur at these stages. This result is in line with the finding of Ariong et al. (2023) that poor storage contributes significantly to postharvest losses in food losses.

Table 2: Post-harvest Losses at Different nodes of Cowpea Value Chain

Value chain actors	Items	Initial quantity (Kg)	Quantity lost (Kg)	% loss
Farmers	Min	150	28.5	32.94
	Max	8000	2960	
	Mean	1015.75	344.27	
	Std. Dev.	926.88	354.67	
Transporters	Min	150	11.1	17.47
	Max	18000	1400	
	Mean	1050.73	158.82	
	Std. Dev.	1626.91	177.27	
Processors	Min	150	4.23	9.37
	Max	3000	625	
	Mean	921.15	81.10	
	Std. Dev.	616.47	99.88	
Marketers	Min	150	22.70	19.93
	Max	7233.33	1463.53	
	Mean	995.88	194.73	
	Std. Dev.	891.27	172.82	

Source: Field survey 2023

Cause of Postharvest Losses in Cowpea: Table 3 showed that the prime causes of PHLs in cowpea were pests and diseases (WMS = 3.56), inadequate storage facilities (WMS = 3.06) and poor handling techniques (WMS = 3.40). this result agrees with the submission of Lipinski et al. (2013) that postharvest infestation with weevils is the key challenge for small scale cowpea producers, traders and consumers of cowpea.

Table 3: Causes of Post-harvest losses in Cowpea

Cause	Response					WM	WMS
	NS (1)	MS (2)	Neutral (3)	S (4)	HS (5)		
Pests and diseases	26(26)	22(44)	14(42)	9(34)	72(360)	506	3.56
Inadequate storage facilities	19(19)	51(102)	21(63)	6(24)	46(230)	438	3.06
Poor handling during transportation	13(13)	28(56)	40(120)	10(40)	52(260)	489	3.40
Adverse weather effect on cowpea	17(17)	49(98)	28(84)	24(72)	25(125)	396	2.76
Insufficient access to markets	17(17)	47(94)	35(105)	12(48)	32(160)	424	2.96
Rodents	26(26)	38(76)	32(96)	20(80)	27(135)	413	2.88
Theft	28(28)	34(68)	36(108)	25(100)	20(100)	404	2.82
Delayed harvesting	31(31)	33(66)	26(78)	23(92)	30(150)	417	2.91

Cut-point = 3.0. <3.0 = Not severe, >=3.0 = severe. Source: Field survey, 2023.

Determinants of PHLs of Cowpea at the Farm Level

The summary of the determinants of PHLs of cowpea (Table 4) showed that marital status (β = 0.063, p<0.076), income (β = -0.108, p<0.055), quantity of cowpea harvested (β = 1.013, p<0.000), and access to extension services (β = -0.091, p<0.085) influenced, significantly PHL outcome in the study area. This implies that the probability of respondents' been married, and the quantity of cowpea harvested increased PHL management by 6.3 and 101.3%, respectively. Conversely, income and access to extension services relate negatively to PHLs management. This negation could be attributed to the fact that expensive equipment is sometimes needed for PHL prevention, which often times form exclusionary barrier to poor farmers (Lipinski *et al.* (2013), implying that the income of small-scale farmers could not impacted positively on PHL management in the study area.

Table 4: Determinants of PHLs of Cowpea at the Farm Level

Variables	B	Std. Error	t-statistics	Sig.
(Constant)	1.160	1.143	1.015	.312
Age	.013	.011	1.152	.251
Marital status	.063	.035	1.786	.076*
Access to financial services	.046	.051	.892	.374
Main Occupation	-.013	.014	-.921	.359
Income	-.108	.056	-1.938	.055*
Education	5.45e04	.017	-.026	.979
Training	-.019	.049	-.394	.694
Quantity harvested	1.013	.043	23.754	.000***
Access to Extension services	-.091	.052	-1.737	.085*
R^2	.884			
Adjusted R^2	.875			
F-Statistics	100.521 (0.000)***			

Source: Field Survey, 2023.

CONCLUSION AND RECOMMENDATIONS

Based on the findings, it can be concluded that PHLs occur at all nodes of cowpea value chain, but particularly at the production and storage nodes. The prime causes of these losses were the incidence of pests and diseases, inadequate storage facilities and poor handling practices, and PHLs is consistently and positively enhanced by marital status and the quantity of cowpea harvested. To mitigate these losses, it is recommended that the adoption of integrated pest and disease management and improved storage technologies are needed.

REFERENCES

Ariong, R. M., Daniel, M., Okello, D. M., Otim, M. H., & Paparu, P. (2023). The cost of inadequate postharvest

management of pulse grain: Farmer losses due to handling and storage practices in Uganda. *Agriculture & Food Security, 12*:20. https://doi.org/10.1186/s40066-023-00423-7

Bolaji, A. M. (2014). *Potential impact analysis of Purdue improved cowpea storage technology on income of users in North Central Nigeria*. A thesis submitted to the school of postgraduate studies, Ahmadu Bello University, Zaria

Gustavsson, J., Cederberg, C., Sonesson, U., van Otterdijk, R., & Meybeck, A. (2011). Global food losses and food waste 2011. Rome: FAO. http://www.fao.org/docrep/014/mb060e/mb060e00.pdf.

Kamara, A., Omoigui, L., Kamai, N., Ewansiha, S., & Ajeigbe, H. (2018). *Improving cultivation of cowpea in West Africa, in achieving sustainable cultivation of grain legumes*; Burleigh Dodds Science Publishing Limited: Cambridge, UK, 2018, Volume 2, pp. 235–252.

Kalpna, Hajam, Y. A., & Kumar, R. (2022). Management of stored grain pest with special reference to *Callosobruchus maculatus*, a major pest of cowpea: A review. *Heliyon*, *8*(1), e08703. https://doi.org/10.1016/j.heliyon.2021.e08703

Kumar, D., & Kalita, P. (2016). Reducing postharvest losses during storage of grain crops to strengthen food security in developing countries. *Foods*, *6*(1), 8. https://doi.org/10.3390/foods6010008

Lipinski, B., Hanson, C., Lomax, J., Kitinoj, L., Waite R., & Searchinger, T. (2013). Reducing food loss and waste, working paper. Washington: World Resources Institute; 2013.

Sugri, I., Abubakari, M., Owusu, R. K., & Bidzakin, J. K. (2021). Postharvest losses and mitigating technologies: evidence from Upper East Region of Ghana. *Sustainable Futures, 3*, 1-13. https://doi.org/10.1016/j.sftr.2021.100048.

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Assessment of Farmers Knowledge on Post-Harvest Management of Beans in Niger State, Nigeria

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Abstract
This study assessed farmers' knowledge on post-harvest management of beans in Niger State, Nigeria. A four-stage sampling technique was used to select one hundred and eighty (180) bean farmers in the study area. A structured questionnaire, complemented by the interview scheduled, was used for data collection. Data collected were described through frequency, percentages, and mean and analyzed using knowledge tests. The result showed that all the respondents were aware of post-harvest management practices for beans. Other farmers and farm forums were the most common sources of awareness among bean farmers. About 83.3% of bean farmers had high knowledge of the use of clay pots for storing beans, while 82.2% had high knowledge of the winnowing method of grading. The most significant constraints to post-harvest management of beans were shortage of funds ($\bar{X}$ =3.76) and inadequate training on post-harvest ($\bar{X}$ =3.48). It is recommended that the cost of post-harvest materials and tools be subsidized by the government and stakeholders for farmers' access at an affordable price. Also, funds should be made available by governments and non-governmental organizations so that farmers' could purchase post-harvest tools that are needed to enhance the longevity of agricultural produce.
Keywords: Farmers' knowledge, Post-harvest, Management, Beans

INTRODUCTION
Beans (Vigna unguiculata) are a nutritious and versatile legume that is mostly cultivated worldwide as a source of protein, fiber, vitamins, and minerals. Beans have low fat and cholesterol, which makes them healthy for consumption (Akintobi *et al.,* 2021). Post-harvest management of beans is essential to maintaining the quality of the produce and preventing spoilage. The essence of post-harvest management is to maintain the safety of beans, minimize losses, and maximize profits for farmers. Each step is crucial in ensuring that beans reach consumers in good condition. Post-harvest management is a proactive step taken to reduce the incidence of losses immediately after harvesting (Pelemo *et al.,* 2022). Post-harvest management in beans includes cleaning, drying, sorting, grading, packaging, storage, and transportation. The role of post-harvest management in beans is overemphasized. Post-harvest management promotes agricultural production by reducing post-harvest losses to the bearest minimum, enhancing nutrition, adding value to agricultural products by opening new marketing

opportunities, generating new jobs, and enhancing other related economic sectors for viable growth. Close to 5% of beans produced in Nigeria are lost to pests, disease, and poor management practices (Akintobi *et al.,* 2021). It is believed that post-harvest management will reduce post-harvest losses in beans. Specifically, this study tends to address these objectives: determine the level of awareness of post-harvest management in beans, identify sources of awareness of post-harvest management in beans, determine the farmers' knowledge of post-harvest management, and identify constraints associated with post-harvest management in beans.

METHODOLOGY

The research was done in the Niger State of Nigeria. The state is located within longitudes 3° 30' and 7° 20' East and Latitudes 8° 20' and 11° 30' North. The state has a population of about 6,220.617 (National Bureau of Statistics (NBS)) (2019). However, with a growth rate of 3.2%, the state will have an estimated population of 6,625,106.376 in 2021 (NBS, 2019). Some of the crops grown in the area are yam, cotton, shea butter, maize, sorghum millet, cowpea, soybean, beans, rice, and groundnut. Some of the tree crops are mango, citrus, coconut, cashew, banana, and pawpaw. The inhabitants of the state also rear some livestock, like goats, sheep, cattle, and chickens, among others. A multi-stage sampling technique was employed for this study. The first stage involved the random selection of three (3) agricultural zones in the state. The second stage involved the random selection of one (1) local government area from each of the zones, making a total of three (3) LGAs. The third stage involved the random selection of four (4) communities each from the selected LGAs, making a total of twelve (12) villages. The fourth stage involved the use of proportional sampling to select 10% of the farmers from the sampling frame to give a total of one hundred and eighty (180) respondents. Primary data was used for this study area. Data was collected by the researcher, assisted by trained enumerators, using a structured questionnaire complimented with interview schedules. The objectives of the study were achieved using frequency, percentage, and mean. Objective iii was achieved by carrying out knowledge tests for the farmers. The knowledge test was based on the post-harvest management used for beans by the farmers. A total of twenty-one (21) knowledge questions in beans were subjected to a knowledge test. Knowledge scores were recorded for each farmer. Each of the statements carried a full weight of one (1). Farmers were asked to choose one response against alternative responses as right, wrong, or I don't know. For each right response, a farmer received a full weight of 1, for each wrong, or, I don't know, a farmer received 0. Thus, the knowledge score ranged from 0 to 100, where < 50 = low knowledge level, 51–69 = average knowledge level, and >70 = high knowledge level.

RESULTS AND DISCUSSION

Level of Awareness of Post-harvest Management Practices in Beans

Table 1 revealed that all the farmers (100%) were aware of all post-harvest management practices for beans. This result showed that there was a high level of awareness about post-harvest management of beans in both states. This might be due to the fact that beans are produced extensively in the study area. This finding agreed with Elemosho *et al.* (2017), who reported high levels of awareness of post-harvest management among farmers in River State, Nigeria.

Table 1: Distribution of the farmers according to level of awareness on post-harvest managementin beans (n=180)

Post-harvest management practices	Freq (%) Aware	Freq (%) Not Aware
Sorting methods	180 (100.0)	0
Packaging materials	180 (100.0)	0
Storage materials	180 (100.0)	0
Transportation methods	180 (100.0)	0
Preservation methods	180 (100.0)	0
Processing	180 (100.0)	0
Pest controls	180 (100.0)	0
Diseases controls	180 (100.0)	0

Sources: Field survey, 2018

Information Sources of Awarenesson Post-harvest Management

Results in Table 2 indicated that other farmers ranked 1st as the major sources of awareness on post-harvest management in the study area, which was followed farmers forum which ranked 2nd andcommunity meetings ranked 3rd. The findings showed that other farmers, farmers forum and friends were the major sources of awareness on post-harvest management in the study area. This finding agreed with Tsado *et al.* (2018), who stressed that other farmers and friends were the major sources of information on the improved rice varieties in Niger State, Also, Elemosho *et al.* (2017) reported that other farmers were the major sources of awareness on post-harvest management in River State, Nigeria.

Table 2: Information sources of awareness on post-harvest management (n=180)

Sources of awareness*	Frequency	Percentage	Rank
Others farmers	138	76.7	1th
Farm forum	130	72.2	2nd
Community meeting	68	37.8	3rd
Extension officers	64	35.6	4th
Friends	64	35.6	4th
Mass media	55	30.6	6th
ADP	30	16.7	7th
Ministry of agriculture	29	16.1	8th
Parents	22	12.2	9th
Field days	20	11.1	10th
Exhibition	20	11.1	10th
Written information	14	7.8	12th

Sources: Field survey, 2018. *Multiple responses

Knowledge Level of Farmers on Post-harvest Managementin Beans

Table 3 indicated 67.2% of the beans producers had high and average knowledge on sorting of beans by hand picking and use of tray. Also, 82.2% had high knowledge on winnowing grading method in beans. Proper winnowing of beans is mostly used to remove chaff and other particles in other to increase the market value of beans, it is expected that chaff free beans attract more market value and will probably improve farmers' income and livelihood. About 53.3% of farmers had average knowledge on use of basket for packing beans. Moreover, 83.3% of the farmers had high knowledge on the use of clay pot for storing beans. Furthermore, 62.8% and 49.4% of the farmers had average and low knowledge on the use of aluminum phosphate and trap in controlling storage pest in beans. Moreover, 65.0% had high and average knowledge on the use of sun drying for beans. Proper sun drying of beans becomes imperative to reduce the menace of weevil attacks that is accounted to more that 50% loss in beans (Center for Food Technology and Research, 2017).

Table 3: Knowledge level of farmers on post-harvest managementin beans (n=180)

Knowledge	Frequency	Percentage	KL
Sorting methods			
Hand pickingand use of tray	121	67.2	Average
Grading methods			
Manual sieving	125	69.4	Average
Winnowing	148	82.2	High
Selective picking	82	45.6	Low
Packing methods			
Use of basket	96	53.3	Average
Use of heapan	1	0.6	Low
Storage materials			
Use of metal tank/silo	12	6.7	Low
Use of concrete tank/silo	8	4.4	Low
Use of warehouse	71	39.4	Low
Use of clay pot	150	83.3	High
Use of hermatic storage	5	2.7	Low
Use of sack bag	52	28.9	Low
Transportation methods			
Use of open pickup/lorry/trucks	76	42.2	Low
Use of motorcycle	106	58.9	Average
Control of storage pest			
Use of trap	89	49.4	Low
Use of aluminum phosphate	113	62.8	Average
Diseases control			
Cleaning of storage material	92	51.1	Average
Preservation methods			
Use of open air drying	46	25.6	Low
Sun drying	117	65.0	Average
Processing products			
Processed to beans flour	102	56.7	Average
Processed to beans cake	138	76.7	High

Sources: Field survey, 2018. Note: $\leq$ 50=Low Knowledge, 51-69=Average Knowledge, $\geq$70=High Knowledge, KL = Knowledge Level

Constraints Associated with Post-harvest Management in Beans

Table 4 revealed that shortage of funds ($\bar{X}$ =3.76), high cost of post-harvest materials ($\bar{X}$ =3.61), inadequate training ($\bar{X}$ =3.48) and lack of technical knowledge ($\bar{X}$ =3.27) were the severe constraints associated with post-harvest management in beans. This finding is in tandem with that of Agada and Ijih (2019) that inadequate training is a serious menace to post-harvest management practices in Benue State, Nigeria. However, lack of farmers' participation ($\bar{X}$ =2.98) was not a severe constraint associated with post-harvest management in beans.

Table 4: Constraints associated with post-harvest management in beans (n=180)

Constraints	Mean
Inadequate training on post-harvest	3.48
Shortage of fund	3.76
High cost of post-harvest materials	3.61
Lack of farmers participation	2.98
Lack of technical knowledge	3.27
Knowledge and skills limitation	3.33
Insect attack	2.84

Sources Field survey, 2018

CONCLUSION AND RECOMMENDATIONS

It can be concluded that all the respondents were aware of post-harvest management in beans. Other farmers, farm forum and community meeting were the major sources of awareness on post-harvest management. Also, beans farmers had high knowledge on winnowing method of grading and processing method of beans to cake. The most sere constraints associated with post-harvest management in beans were shortage of funds and high cost of post-harvest materials. It is recommended that the cost of post-harvest materials and tools be subsidized by the government and stakeholders for farmers' access at an affordable price. Also, funds should be made available by governments and non-governmental organizations so that farmers' could purchase post-harvest tools that are needed to enhance the longevity of agricultural produce.

REFERENCES

Agada. O. & Ijih, B. E "Analysis of post harvest management practices among Farmers in Oju, Benue State, Nigeria". *Journal of Agriculture and Environmental Sciences*, 8 (1), 191-198.

Akintobi, O. S., Evinemi, C. A, and Achagwa, S. M (2021). Analysis of the Problems Associated with Cowpea Storage Among Farmers in Kuje Area Council, Federal Capital Territory Abuja, Nigeria. *FUDMA Journal of Agriculture and Agricultural Technology* 4 (1), 91-98.

Elemasho, M. K., Alfred, S. D.Y., Aneke, C. C., Chgali, A. J.C. & Ajiboye, O. (2017). Farmers' perception of adoption of post-harvest management of selected food crops in River State, Nigeria, *International Journal of Agricultural Respiration, Innovation and Technology,* 7 (1), 22-26.

Pelemo, J. J., Ajibola, B. O., Yakubu, S., Akubo, D., Eyiobami, B. H., Enemosah, A. P.O. and Beida, A. S. (2022). Assessment of Farmers Knowledge on Post-harvest Management of Maize in Niger State, Nigeria. *Fuoye Journal of Agriculture and Human Ecology,* 6 (2), 41-48.

National Bureau of Statistics (NBS) (2019). Federal Republic of Nigeria 2006 Census official Gazzette, Retrieved 26/08/2022 from www.nigeriastate.gov.ng.

Tsado, J. H., Ajayi, O.J., Tyabo, I.S., Pelemo, J. J,.& Adebayo, E. (2018).Socio economic analysis of rice farmers uptake of improved seeds for enhanced well-being in Wushishi community In Niger State, Nigeria. Paper presented at 27th Annual Conference of Rural Sociology Society of Nigeria RUSAN held at Ahmadu Bello University Zaria, 7th-11th October.

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UNIVERSITY OF ABUJA, NIGERIA
21-25 OCT. 2024
PROCEEDINGS

Assessment of the Preference of Arable Crop Farmers for Modes of Training on Climate-Smart Agricultural Practices in Ekiti State, Nigeria

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Abstract
This study assessed the preferences of arable crop farmers regarding modes of training on climate-smart agricultural practices (CSAP) in Ekiti State. A three-stage sampling procedure was used to select one hundred and thirty-five arable crop farmers, from whom data were collected through questionnaires and interviews. The data were analyzed using frequency counts, percentages, means, and analysis of variance (ANOVA). The study revealed that the majority (72.6%) of the respondents were male, with a mean age of 46.41 years. Most were married (87.4%) and educated (93.3%). The mean household size and annual income were 9.47 persons and NGN 675,940.74, respectively. Among the various training modes presented, interactive workshops in the form of direct training ranked highest ($\bar{x}$ = 2.44), followed by government extension integrated programmes ($\bar{x}$ = 2.39) and the use of demonstration farms ($\bar{x}$ = 2.36). There was no significant difference in the preference for training modes among arable crop farmers in the study area (F = 1.104, p = 0.335). The prominent modes of training preferred by the farmers were workshops/direct training, government extension integrated programmes, and demonstration farms. Therefore, training programmes on climate-smart agricultural practices for arable crop farmers in the study area should be conducted using the most preferred training modes to enhance understanding and utilization of acquired knowledge and skills.

***Keywords*: *Arable crop farmers, climate-smart agriculture, preference, training mode*.**

INTRODUCTION

The negative impact of climate change on various sectors of the global economy is profound and cannot be overstated. Climate change has emerged as one of the most pressing global challenges, hindering economic development in areas such as agriculture, water resources, fisheries, forestry, land use, wildlife, energy, and industrial processes (Madu & Nwankwo, 2021). The effects and damages caused by climate change are widespread and increasingly visible, particularly in regions where residents are more vulnerable due to limited awareness of climate change adaptation and mitigation (Ojo et al., 2023). Among the sectors affected, agriculture remains the most vulnerable to climate change, especially in sub-Saharan Africa, where small-scale farming systems are predominantly rain-fed and climate-dependent. This makes them highly susceptible to climate variability, with limited adaptive capacity (Cohn et al., 2017; Cudjoe et al., 2021). The negative effects of climate change on food production, food security, and the environment have garnered global attention, highlighting the need to collaborate with farmers to adopt innovative agricultural practices. This need has led to the development of Climate-Smart Agriculture (CSA) (Waaswa et al., 2021).

According to Kijima (2011), Climate-Smart Agriculture (CSA) is defined as agriculture that sustainably increases production and income, enhances resilience, and mitigates greenhouse gas emissions, thereby contributing to national food security, development objectives, and poverty reduction (FAO, 2010). Agriculture is considered climate-smart when it achieves three main objectives: (i) sustainably increasing agricultural productivity and income, (ii) adapting and building resilience to climate change, and (iii) reducing or eliminating greenhouse gas emissions (Fanen & Adekola, 2014).

Despite their importance in mitigating climate risks and enhancing food security (Kassie et al., 2013), the adoption of adaptation strategies remains low (Holden et al., 2003, as cited in Ekpa et al., 2021; Shiferaw & Holden, 2001, as cited in Ekpa et al., 2021). This low adoption is particularly evident among arable crop farmers in Nigeria, including those in Ekiti State, and is often attributed to inadequate knowledge of CSA. This underscores the need to train farmers on CSA to strengthen their adaptation strategies to climate events.

When considering training for arable crop farmers, it is important to identify the modes of training that are most acceptable to them. While various studies have explored climate-smart agricultural practices in Ekiti State, there is limited information on farmers' preferences regarding modes of training on CSA practices. Therefore, this study aims to assess the preferences of arable crop farmers in Ekiti State for training methods on CSA practices.

METHODOLOGY

The study was carried out in Ekiti State, Nigeria. The State is mostly an agrarian State. The population of the study comprised arable crop farmers in the study area. A Multi-stage random sampling procedure was used to select the respondents for the study. At the first stage, three (3) Local Government areas (LGAs) were randomly selected, while the second stage involved random selection of three (3) towns/communities in each of the selected LGAs to make a total of nine (9) towns/communities. At the third stage, fifteen (15) arable crops farmers were selected from each of the selected town/community to make a total of one hundred and thirty-five (135) respondents that constituted the sample size for the study. The identification and selection of the respondents were done through the assistance of the extension agents covering the areas. Questionnaires and interview schedule structured with both open and close ended questions in line with the objectives of the study were used for data collection.

The dependent variable; preference of arable crop farmers for modes of training on climate-smart agricultural practices was measured on a 4-point scale of Not preferred, preferred, more preferred, and most preferred which attracted the scores of 0, 1, 2 and 3 respectively. The mean score was obtained and used to determine the respondents' preference for the modes of training on CSAP. The data collected were analysed using frequency counts, percentage, mean and Analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Socio-economic Characteristics of the Arable Crop Farmers in the Study Area

The analysis of the socio-economic characteristics of the respondents, as presented in Table 1, indicates that the majority (72.2%) of the respondents were male arable crop farmers. This suggests a male dominance in agricultural production, likely due to the rigorous activities involved in crop farming, which tend to favour physical strength. This finding aligns with the result of Obabire *et al*. (2021b) which reported that 70% of their responds were male. The mean age of the arable crop farmers was 46.41 ± 12.42 years, indicating that the respondents were not too old and would likely be active and possess the necessary strength to engage in farming activities beyond subsistence levels. Furthermore, the findings revealed that the majority (87.4%) of the respondents were married, supporting the findings of Ige *et al*. (2021) and Obabire, *et al.* (2021), which reported that 87.5% and 90.3% of their respondents were also married. This suggests that marriage can provide benefits, such as support, useful advice, and assistance in farming operations.

Additionally, the results indicated that a significant majority (93.3%) of the farmers had some form of education, while only a small percentage (6.7%) had no formal education. This suggests that the farmers are generally educated, which may influence their preferences for certain training modes on climate-smart agricultural practices (CSAP).

The mean household size was 9.47± 8.30 persons, indicating that farmers have an average of 10 individuals who could offer useful advice regarding their preferred training modes for CSAP. These individuals could also serve as a valuable source of family labor in implementing CSAP. This supports the assertion of Opeyemi *et al.* (2021), who noted that a larger household increases a household's labour endowment. The analysis also revealed that more than half (53.3%) of the respondents were members of cooperative societies. Membership in such societies could influence the respondents' preferences for training modes on CSAP by providing access to credit facilities and information on climate-smart practices. Finally, the findings in reveal that the mean annual income of the respondents was NGN 675,940.74. This income is grossly inadequate, considering the household size of approximately 10 persons and the prevailing economic situation in the country.

Table 1: Distribution of the respondents based on their socio-economic characteristics n = 135

Socio-economic characteristics	Frequency	Percentage	Mean
Gender:			
Male	98	72.6	
Female	37	27.4	
Age (Years)			46.41±12.42
Marital Status:			
Single	11	8.1	
Married	118	87.4	
Widowed	4	3.0	
Separated	2	1.5	
Educational Qualification			
No formal education	9	6.7	
Primary education	25	18.5	
Secondary Education	60	44.4	
Tertiary Education	41	30.4	
Household size (persons)			9.47±8.30
Membership of cooperative society Association			
Member	72	53.3	
Not a member	63	46.7	
Yearly Income (₦)			675940.74

Preference for mode of training on CSAP

Table 2 shows that, Interactive Workshop/Direct Training, with the mean of 2.44, ranked highest among the modes of training on CSAP preferred by the respondents. This mode received the highest preference, indicating that farmers value hands-on, direct engagement with trainers for better understanding. This aligns with the report of Technoserve (2021) that Face-to-face, in-person training by experienced trainers - directly sharing their knowledge and passion - has the power to permanently transform lives for the better. In the same vein, Government Extension Integrated Programme (mean=2.39) ranked 2nd, suggesting trust and reliance of the respondents on government programmes for training. The Use of Demonstration Farms (mean=2.36) ranked 3rd and the implication is that practical demonstration remains an effective method for learning, emphasizing experiential learning. Collaboration with NGOs (mean=1.99) and Peer Learning (mean=1.97) were less favoured, which may indicate a preference for structured training formats over informal peer-based learning. However, Interactive Media (videos, animations, podcasts) ranked 7th with mean of 1.86. This implies that this mode received the lowest preference, suggesting that while digital methods are useful, they may not be as effective for the training on CSAP in the study area. The lower preference for interactive media may be as a result of limited access to technology and digital literacy among the farmers.

Table 2: Distribution of the respondents based on their preference for mode of training on CSAP

S/N	Mode of Training	NP	P	MP	MoP	Mean	SD	Rank
1	Interactive media-videos, animations and podcast	8.9	29.6	28.1	33.3	1.86	0.99	7th
2	Interactive workshop/Direct training	1.5	15.6	20.0	63.0	2.44	0.81	1st
3	Use of demonstration farms	2.2	15.6	26.7	55.6	2.36	0.82	3rd
4	Private extension services	5.2	25.9	31.1	37.8	2.01	0.92	4th
5	Collaboration with NGOs	2.2	32.6	28.9	36.3	1.99	0.89	5th
6	Peer-to-peer learning	5.9	28.9	27.4	37.8	1.97	0.95	6th
7	Government extension integrated programme	-	14.8	31.9	53.3	2.39	0.73	2nd

NP = Not preferred, P=preferred, MP=more preferred, MoP=most preferred

Analysis of variance of the difference in preference of arable crop farmers on mode of training of CSAP across the LGAs

Findings from the study (Table 3) show that there is no significant difference in the preferences of the arable crop farmers across the different the LGAs, given the F-value of 1.104 with a significance level of 0.335. The implication of this result is that the preferences for modes of training on CSA practices are the same. The Duncan post hoc tests also reveal no significant differences between the LGAs as indicated by a significance level of 0.189, suggesting that while there are variations in preference scores, they are not statistically significant.

Table 3: Analysis of variance of the difference in preference of arable crop farmers on mode of training of CSAP across the LGAs

Vriables	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	31.111	2	15.556	1.104	0.335
Within Groups	1859.822	132	14.090		
Total	1890.933	134			

Duncan Post Hoc Tests: Ijero Local Government = 14.3556, Oye LGA = 15.2444, Irepodun/Ifelodun LGA= 15.4667, sig = 0.189

CONCLUSION AND RECOMMENDATIONS

The findings indicate a strong preference among arable crop farmers for direct training/interactive workshop, government integrated programme and use of demonstration farm over digital or peer-based approaches. Continued emphasis on government and direct training programes will likely facilitate more effective knowledge transfer and adoption of sustainable climate-smart agricultural practices in Ekiti State.

ACKNOWLEDGEMENTS

We acknowledge the Tertiary Education Trust Fund (TETFund) for providing the fund to carry out this research work, as part of the Institution Based Research (IBR) of the Federal Polytechnic, Ado-Ekiti, Nigeria.

REFERENCES

Cohn, A.S., Newton, P., Gil, J. D. B., Kuhl, L., Samberg, L., Ricciardi V., Manly, J. R., Northrop, S. (2017). Smallholder agriculture and climate change. *Annu Rev Environ Resour*. 42(1):347–75. https://doi.org/10.1146/annurev-environ-102016-060946.

Cudjoe, G.P.; Antwi-Agyei, P.; Gyampoh, B. A. (2021).The Effect of Climate Variability on Maize Production in the Ejura-Sekyedumase Municipality, Ghana. *Climate* 9, 145. https://doi.org/10.3390/ cli9100145.

Fanen, T. and Adekola, O. (2014). Assessing the role of climate-smart agriculture in combating climate change, desertification and improving rural livelihood in Northern Nigeria. African Journal of Agricultural Research, 2014. 12(3) 42-56.

FAO (2010). The State of Food and Agriculture 2010: Food Aid for Food Security? Policy brief. Rome.

Holden, N.M., Brereton, A.J., Fealy, R. and Sweeney, J. (2003). Possible change in Irish climate and its impact on barley and potato yields, In Ekpa. D. Tiri, G. D. and Ekpa, M.O. (2021). Analysis of the challenges of climate-smart agricultural practices among crop farmers in North-West, Nigeria. *Journal of Agriculture and Environment* Vol. 17 (2):7-24.

Ige, G. O., Akinnagbe, O.M., Odefadehan, O.O., Ogunbusuyi, O.P. (2021). *Constraints to Farmers' Choice of Climate Change Adaptation Strategies in Ondo State of Nigeria*. In: Oguge, N., Ayal, D., Adeleke, L., da Silva, I. (eds) African Handbook of Climate Change Adaptation. Springer, Cham. https://doi.org/10.1007/978-3-030-45106-6_103.

Kassie, M., Jaleta, M., Shiferaw, B., Mmbando, F. and Mekuria, M. (2013). Adoption of interrelated sustainable agricultural practices in smallholder systems: evidence from rural Tanzania, *Technol. Forecast. Soc. Change,* 80 (3): 525–540.

Kijima, Y., K. Otsuka and D. Serunkuuma, (2011). An inquiry into constraints on a green revolution in Sub-Saharan Africa: The case of NERICA rice in Uganda. World Dev., 39: 77-86.

Madu, I. A. and Nwankwo, C. F. (2021) Spatial pattern of climate change and farmer–herder conflict vulnerabilities in Nigeria, *GeoJ*. 86 (6): 2691–2707.

Obabire, I. E., Jimoh, A. S., Oyewusi, I. K., Omotayo, F. S. and Koyenika, O. O.(2021). Adaptation Strategies to Mitigate the Effects of Climate Variability on the Production Practices of Maize Farmers in Ikole Local Government Area of Ekiti State, Nigeria. *Proceedings of 13th Engineering Forum, held at the School of Engineering, the Federal Polytechnic, Ado-Ekiti, Nigeria between* 11th – 14th October, 2021. Pp 366-373.

Obabire, I. E., Obabire, I.R., Oke, D.M., Babadiji, A.O. and Koyenikan, O.O. (2021). Determinants of Rural-Urban Migration among the Household Members of Arable Crop Farmers in Ikole Local Government Area of Ekiti State, Nigeria. *Proceedings of 13th Engineering Forum, School of Engineering,* The Federal Polytechnic, Ado-Ekiti, Nigeria, 11th – 14th October, 2021. Pp 359-365.

Ojo, T. O., Kassem, H.S., Ismail, H., Adebayo, D.S. (2023). Level of adoption of climate smart agriculture among smallholder rice farmers in Osun State: does financing matter? *Scientific African*, 21: 1 – 8, e01859

Opeyemi, G., Opaluwa, H.I., Adeleke, A.O., and Ugbaje, B. (2021). Effect of climate smart agricultural practices on farming households' food security status in Ika north east local government area, Delta State, Nigeria. *Journal of Agriculture and Food Sciences*, 19 (2):30-42.

Shiferaw, B. and Holden, S.T. (2001) Farm-level benefits to investments for mitigating land degradation: empirical evidence from Ethiopia, In Ekpa. D. Tiri, G. D. and Ekpa, M.O. (2021). Analysis of the challenges of climate-smart agricultural practices among crop farmers in North-West, Nigeria. *Journal of Agriculture and Environment* Vol. 17 (2):7-24.

Technoserve (2021). Using Digital Tools to Reach Smallholder Farmers with Limited Access to Communications Technology. Digitally Enabled Training for Unconnected Farmers. technoserve.org

Waaswa, A., Nkurumwa, A. O., Kibe, A.M., and Kipkemoi, N .J. (2021). Communicating climate change adaptation strategies: Climate-smart agriculture information dissemination pathways among smallholder potato farmers in Gilgil Sub-County, Kenya. *Heliyon*. 7(8):e07873. Doi:10.1016/j.heliyon.2021.e07873.

Disposition of Arable Crop Farmers to Climate-Smart Agricultural Practices in Gbonyin Local Government, Ekiti State, Nigeria

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Abstract
Climate change has adversely affected the agricultural sector, particularly arable crop production, in Sub-Saharan Africa. The adoption of recommended climate-smart agriculture (CSA) practices to mitigate the impacts of climate change has been reported to be low among farmers. This study investigated the disposition of arable crop farmers toward CSA. A two-stage sampling procedure was employed to select eighty (80) respondents, from whom data were collected using an interview schedule. The collected data were analyzed using frequency counts, percentages, means, and a regression model. The findings indicated that the majority (80.0%) of the respondents were male, with a mean age of 59.9 years. Additionally, 82.5% were married, and 61.3% had attained secondary education. The mean household size, annual income, and farming experience were 6 persons, NGN 974,000, and 24.4 years, respectively. The categorization of the arable crop farmers showed that the majority (63.8%) had a positive disposition toward CSA practices in the study area. The regression model revealed that education (β = 0.243, p = 0.038) and income (β = 0.271, p = 0.029) significantly contributed to the farmers' disposition toward CSA practices. In conclusion, the farmers predominantly exhibited a positive attitude toward climate-smart agricultural practices, with education and income identified as major predictors of their disposition toward CSA in the study area.
***Keywords**: Arable crop farmers, climate change, climate-smart agriculture, disposition*

INTRODUCTION

Climate change is a global reality that has been universally acknowledged. The over-reliance of Sub-Saharan Africa on rain-fed agriculture has made the effects of climate change particularly severe for some member countries, including Nigeria. The FAO (2014) noted that climate change is likely to cause significant crop yield losses, adversely affecting the livelihoods of smallholder farmers in Africa. Consequently, food security and income generation opportunities for farming households that depend heavily on agriculture may be jeopardized (FAO, 2014).

It is evident that climate change will have a profound impact on Nigeria, especially in areas such as agriculture, land use, energy, biodiversity, health, and water resources (Apata, 2011). The IPCC's Fourth Assessment Report predicts that climate change could reduce yields by as much as 50% in some highly vulnerable areas, including Sub-

Saharan Africa (Fanen and Adekola, 2014). According to this report, Ekpa et al. (2021) observed that warming in Sub-Saharan Africa, including Nigeria, is expected to exceed the global average, and rainfall will decline in certain regions. Arable crops are particularly affected by decreasing rainfall, especially among the small-scale farming population. The high susceptibility of small-scale farming systems to climate change and variability is largely due to their reliance on rain-fed agriculture (Cohn *et al.*, 2017). This is especially true for developing countries like Nigeria, which face persistent food insecurity while also experiencing significant population growth and heightened exposure to the adverse effects of global warming (Gabriel et al., 2023).

In response to the need for increased food security without compromising environmental quality and in support of the Paris Agreement on climate change, the FAO developed the concept of Climate-Smart Agriculture (CSA) (FAO, 2018; IPCC, 2019). CSA is an approach aimed at transforming farming practices to deliver positive outcomes across three impact pillars: intensification, adaptation, and mitigation, thereby supporting food security in the context of climate change (Lipper *et al.,* 2014; Taylor, 2018). CSA enhances adaptation to climate change and increases food security while ensuring productivity, even under unfavorable climatic conditions. This is achieved through various soil management practices that sequester carbon in the soil, reduce greenhouse gas emissions, and promote intensive production (FAO, 2013). Lipper *et al*. (2018) noted that while the CSA concept has gained considerable traction in recent years, empirical evidence to support implementation strategies at the country level is still lacking. Therefore, this study examined the disposition of arable crop farmers toward climate-smart agricultural practices in the Gboyin Local Government Area of Ekiti State, Nigeria.

METHODOLOGY

The study was conducted in Gbonyin Local Government Area (LGA) of Ekiti State, which comprises eight towns: Ode, Ijan, Aisegba, Agbado, Imesi, Egbe, Iluomoba, and Iro. Gbonyin LGA was established on October 1, 1996, with Ode Ekiti as its headquarters. A two-stage random sampling procedure was employed to select respondents for the study.

In the first stage, four towns were randomly selected from the eight in the LGA, resulting in the selection of Ode, Aisegba, Imesi, and Ijan. In the second stage, arable crop farmers in these selected towns were identified, and 20 arable crop farmers were randomly chosen from each town, yielding a total sample size of 80 respondents. Data were collected using a questionnaire that included both open-ended and closed-ended questions to gather information on the socio-economic characteristics of the arable crop farmers and their disposition toward climate-smart agricultural practices. The dependent variable—disposition of the respondents—was measured on a 5-point Likert scale: Strongly Agree, Agree, Undecided, Disagree, and Strongly Disagree, with corresponding scores of 5, 4, 3, 2, and 1, respectively, for positive statements, and reversed for negative statements. The mean score was calculated to categorize the farmers: those scoring below the mean were classified as having an unfavorable or negative disposition, while those scoring at the mean or above were classified as having a favorable or positive disposition toward climate-smart agricultural practices (CSAP) in the study area.

The collected data were analyzed using descriptive and inferential statistical tools, including frequency counts, percentages, means, and regression models, with a significance level set at $\alpha \leq 0.05$.

Regression model:

$$Y = A+BX_1+BX_2+BX_3+BX_4+BX_5+BX_6+ BX_7 + e \quad (1)$$

Where,
Y is the dependent variable, A is constant, B is a slope, X_1 to X_7 are independent variables, e is error term

Y = Disposition towards CSAP
X_1 = Gender (Male = 1, otherwise = 0)
X_2 = Age (Scale)
X_3 = Marital status (married=1 otherwise= 0)
X_4 = Education (Number of years spent in school)
X_5 = Farming experience (scale)
X_6 = Household size (scale)
X_7 = Income (scale)
e = error term

RESULTS AND DISCUSSION

Socioeconomic Characteristics of the Respondents

The results of the socio-economic characteristics of the respondents as presented in Table 1 indicate that the mean age of the arable crop farmers was 59.9 years. This implies that majority of the respondents were aged and may not have enough strength and vigor to carry out farming activities on a large scale. This is consistent with Ayinla *et al* (2024) who reported the average age of the farmers in their study as 55 years, indicating an aging farming population. Majority (80%) of the respondents were male while (20%) were female, the implication of this is that, male are likely stronger and have the strength to carry out agricultural practices, even at their old age. This agrees with the findings of Ibitoye *et al*. (2014) who reported dominance of male in agricultural production in a study on constraints to climate variability adaptation among arable crop farmers in Ekiti state, Nigeria. The result further revealed that the majority (82.8%) of the respondents were married. This corroborates the findings of Obabire and Adeleye (2024) which reported that 88.8% of the arable crop farmers in their study were married. Married people could easily get help, farming advice and support from their spouses. It was also revealed by the result of the analysis that the higher proportion (61.3%) of the farmers had secondary school education. This shows that the famers have some level of education which may influence their disposition towards CSAP, because education levels are linked to understanding climate information and adopting adaptation practices (Kibue, *et al.* 2016; Eneji, *et al*. 2020). The mean household size was revealed to be 6.0 persons. This implies that they have an average of 6 dependents that could also be of assistance in terms of family labour while carrying out CSAP on their farms. Conclusively, the result shows that mean annual income of the arable crop farmers was NGN974,000, which means that the mean monthly income could be about NGN 81,000. Considering the households size of the farmers and the prevailing economic situation in the country, their annual income could be seen as inadequate. This could in-turn affect their production.

Table 1: Distribution of the respondents based on their socio-economic characteristics

Socio-economic characteristics	Frequency	Percentage	Mean
Gender:			
Male	64	80.0	
Female	16	20	
Age (Years)			59.85
Marital Status:			
Single	3	3.8	
Married	66	82.5	
Divorced	3	3.8	
Widowed	6	7.5	
Separated	2	2.5	
Educational Qualification			
Primary education	12	15.0	
Secondary Education	49	61.3	
National Diploma/Tertiary	19	23.8	
Household size (persons)			6.0
Yearly Income (₦)			974,000

Categorization of the Arable Crop Farmers based on their Disposition towards CSAP

The mean categorization of the respondents as presented in Table 2 shows that majority (63.8%) of the respondents had positive disposition towards climate–smart agricultural practices in the study area. The disposition of the farmers could have a great impact on the level at which they practice CSAP. Positive disposition exhibited by the arable crop farmers would have positive influence on their continuous practice of CSA if provided with the enabling environment.

Table 2: Categorization of the arable crop farmers based on their disposition towards CSAP

Variable	Frequency	Percentage
Negative disposition towards CSAP	29	36.3
Positive disposition towards CSAP	51	63.8

Relationship between Socioeconomic Charactersitics of the Arable Crop Farmers and Their Disposition towards CSAP

Table 3 shows that gender (β=0.093, p=0.480), age (β=-0.120 p=0.438), marital status (β=-0.121, p=0.326), farming experience (β=0.161, p=0.365) and household size (β=-0.101, p=0.515) had no significant relationship with the disposition of arable crop farmers towards CSAP. However, education (β=0.243, p=0.038) and income (β=0.271, p=0.029) had significant relationships with the disposition of the arable crop farmers towards CSAP. The implication of these findings are that gender, age, marital status, farming experience and household size of the arable crop farmers had little or no influence on their disposition towards CSAP, while education and income were the major predictors of their dispositions towards CSAP. The R^2 value of 0.158 indicate that 15.8% variation in climate –smart agricultural practices could be explained by this model, while the remaining percentage could be accounted for by external factors. This agrees with the findings of Ayinla et al. (2024) who reported that farmers' attitude are weakly influenced by increase in how educated the farmer is, among other factors.

Table 3: Regression analysis of the relationship between the socio-economic of the arable crop farmers and their disposition towards CSAP

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	111.948	10.528		10.634	0.000
Gender	2.473	3.486	0.093	0.709	0.480
Age	-0.119	0.152	-0.120	-0.779	0.438
Marital status	-3.379	3.416	-0.121	-0.989	0.326
Education	0.872	0.413	0.243	2.109	0.038*
Farming experience	0.131	0.143	0.161	0.912	0.365
Household size	-0.454	0.694	-0.101	-0.654	0.515
Income	4.370E-6	0.000	0.271	2.223	0.029*

R=0.397, R-Square = 0.158, Adjusted R Square = 0.076, Std. Error of the Estimate = 10.25078

CONCLUSION

This study, having assessed the disposition of arable crop farmers towards climate-smart agricultural practices in Gbonyin Local Government area of Ekiti State, concluded that the disposition of the farmers towards climate-smart agricultural practices was positive. Education and income of the farmers were the major predictors of their disposition to climate-smart agricultural practices in the study area.

REFERENCES

Apata, T. G. (2011). Factors influencing the perception and choice of adaptation measures to climate change among farmers in Nigeria. Evidence from farm households in Southwest Nigeria. Environmental Economics, 2 (4): 74 – 83.

Ayinla, R. A., Alao, O. T., Adesoji, S. O., Ayinla, R. A. and Olawuyi, S. O. (2024). Assessment of Arable Crops Farmers' Knowledge, Attitudes and Perception on Climate Change Extreme Events in South-west, Nigeria. Journal of the Austrian Society of Agricultural Economics, Vol. 20(5): 2089 - 2104

Cohn, A. S., Newton P, Gil JDB, Kuhl L, Samberg L, Ricciardi V, Manly JR, Northrop S. Smallholder agriculture and climate change. Annu Rev Environ Resour. 2017; 42(1):347–75. https://doi.org/10.1146/annurev-environ-102016-060946.

Ekpa. D. Tiri, G. D. and Ekpa, M.O. (2021).Analysis of the challenges of climate-smart agricultural practices among crop farmers in North-West, Nigeria. *Journal of Agriculture and Environment* Vol. 17 (2):7-24.

Eneji, C.V.O., Onnoghen, N. U., Acha, J.O. and Diwa, J.B. (2020). Climate change awareness, environmental education and gender role burdens among rural farmers of Northern Cross River State, Nigeria. *International Journal of Climate Change Strategies and Management*, 13(4/5): 397-415.

Fanen, T. and Adekola, O. (2014). Assessing the role of climate-smart agriculture in combating climate change, desertification and improving rural livelihood in Northern Nigeria. *African Journal of Agricultural Research,* 2014. 12(3) 42-56.

FAO. (2018). *The future of food and agriculture – Alternative pathways to 2050*. p. 228.

FAO (2014). Adoption of Climate-Smart Agricultural Practices: Barriers, Incentives, Benefits and Lessons Learnt from the MICCA Pilot Site in Kenya. Final Report prepared by Morgan C. Mutoko for MICCA Programme in December, 2014.

FAO (2013): Climate Smart Agriculture Source Book. United Nations. Rome, Italy: Food and Agriculture

Gabriel, I., Olajuwon, F., Klauser, D., Michael, B. and Renn, M. (2023). State of climate smart agriculture (CSA) practices in the North Central and Northwest zones Nigeria. *CABI Agric Biosci* 4, 33 https://doi.org/10.1186/s43170-023-00156-4

Ibitoye O, Ogunyemi AI, Ajayi JO (2014) Constraints to climate variability adaption among arable crop farmers in Ekiti state, Nigeria. Paper presented at the annual national conference of Nigerian Association of Agricultural Economists (NAAE). Theme: climate change, agriculture and food security in Nigeria. The Federal University of Technology, Akure

IPCC. (2019). *Climate Change and Land:* An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. p. 906.

Kibue, G.W., Liu, X. and Zheng, J. (2016). Farmers' perceptions of climate variability and factors influencing adaptation: evidence from Anhui and Jiangsu, China. Environmental Management 57(5): 976- 986.

Lipper, L., McCarthy, N., Zilberman D., Asfaw S., Branca G. (2018). Climate smart agriculture: building resilience to climate change. Berlin: Springer.

Lipper, L., Thornton, P., Campbell BM., Baedeker, T., Braimoh, A., Bwalya, M., Caron, P., Cattaneo, A., Garrity, D., Henry, K., Hottle, R., Jackson, L., Jarvis, A., Kossam, F., Mann, W., McCarthy, N., Meybeck, A., Neufeldt, H., Remington, T., Torquebiau, E. F. (2014). Climate-smart agriculture for food security. *Nat Clim Change*. 2014; 4(12):1068–72. https://doi.org/10.1038/nclimate2437.

Obabire, I. E. and Adeleye, I. A. (2024). Training Needs of Arable Crop Farmers on ClimateSmart Agricultural Practices in Ekiti State, Nigeria. *International Journal of Innovative Science and Research Technology,* Vol. 9 (5): 3464 – 3470.

Taylor M. Climate-smart agriculture: what is it good for? J Peasant Stud. 2018; 45(1):89–107. https://doi.org/10.1080/03066150.2017.1312355.

Field Screening of New Taro Genotypes at Advance Trial for Yield and Taro Leaf Blight Disease in Umudike Rain-fed Agro-Ecology of Southeastern Nigeria

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Abstract

Field screening of 25 new hybrid Taro genotypes at Advance Trial for yield and immune/resistance to taro leaf blight disease. The trial was conducted at the Western experimental field of National Root Crops Research Institute, Umudike, Umuahia Abia State in the rain-fed forest agro-ecology of Southeastern Nigeria. The objectives were to selection of high yielding Taro genotypes of cocoyam, selection of resistant/immune genotypes to Taro Leaf Blight (TLB) diseases and for inclusion into future hybridization block for resistance progeny development. The trial was conducted on experimental plot size of 9m^2. Spacing of 1m x 0.5m between plant rows and within plant rows on 30cm high ridges spaced 1.0m apart in a Randomized Complete Block design with three replications. Data were collected on stand count, vigour, taro leaf blight rating and tuber yield. Results indicated that Taro genotypes with TLB rating of 1.0 (immune), fresh tuber yield of 5.7kg and above per plot and vigour rating of 4.6 and above respectively were selected for inclusion into the germplasm further progeny development.

Keywords: Taro, Taro-leaf-blight, yield, vigour and progeny development

INTRODUCTION

Yield losses in taro ranging from 5 to 95% have been attributed to Taro Leaf Blight (TLB) disease (Onyeka et al, 201). This variation in TLB disease attack has been at maximum on some varieties of Taro especially the Taro species of the cocoyam. This wide variation in disease impact on some varieties of *Colocassia species* is indicative of the genetic variability available in the cocoyam varieties of the Taro crop with some Taro varieties being susceptible and immune, while others are tolerant. The Taro species of the cocoyam is a food security crop for most states in Nigeria such as Cross River, Anambra, Enugu, Nasarawa, Plateau, Benue, Kwara and Ebonyi State where the crop is grown both as upland and wetland crop.

A disease that has the tremendous effect on yield need combating as observed by Mba and Dixon (1997). One of the measures for controlling the disease is the use of fungus-resistant varieties. According to Mba and Dixon (1997) clones are usually tested across space, location and time before reliable selection are made for traits that are being bred for. One of the measures Mba and Dixon (1097) mentioned for use in breeding for disease resistance was the use of heritability estimate (h^2) as an important parameter employed by the breeders in making selections (Allard (1960).

Resistance as stated by Mba and Dixon (1997) is polygenic and this type of genetic control in many other host-pathogen interactions gives durable resistance but this may be partial resistance subject to environmental conditions, plant age and inoculum pressure in the field. Although the aim is to select genotypes that are resistance in order to provide target genes for future transgenic lines but some Taro genotypes that showed field resistant may prove to be susceptible in later years. This is because field testing relies on uncontrollable incidence and levels of inoculum, also reaction may depend on the TLB isolates prevalent at the time in the field.

However, cocoyam in general is susceptible to several pathogens, but the most destructive diseases are cocoyam root rot, leaf blight disease of Taro, and bobone virus disease of *Xanthosoma Species*. For Taro species, the worst is Taro leaf blight. Breeding for disease resistance is the most economic and environment friendly way to confront the diseases. The steps for improving taro resistance to blight diseases include screening resistant germplasm within the cultivated species in the open field among the wild relatives. This will be followed by the transfer of desirable genes through recombination (Ajala *et al.,* 2023).

This study aims at (1) selection of high yielding Taro genotypes of cocoyam and (2) selection of Taro genotypes resistant/immune to Taro Leaf Blight (TLB) diseases in the rainforest agroecology of Southeastern Nigeria and 3, for inclusion into future hybridization block for resistance progeny development.

MATERIALS AND METHODS

The genotypes used for this study were new hybrid Taro genotypes at Advance Trial of the varietal selection. The trial was conducted at the Western experimental field of National Root Crops Research Institute, Umudike, Umuahia Abia State in the rain-fed forest agro-ecology of Southeastern Nigeria. The trial consisted of 25 Taro genotypes plus one check a total of 26 cultivars evaluated under exclusively rain-fed regimes in a randomized complete block design with three replications. No fertilizer or pesticides or fungicides were applied to the experimental plots conducted (from June/July to December) on plot size of $9m^2$ (3 x 3m). Spacing of 1m x 0.5m between plant rows and within plant rows on 30cm high ridges spaced 1.0m apart in a Randomized Complete Block design with three replications.

Data collection: Data collection included growth data of stand count at harvest. Other growth component data collected were: vigour scoring using the scale of 1 to 5. Where 1= very low vigour, 2= low vigour, 3= moderate vigour, 4= vigorously, 5= very vigorously. Scoring for TLB disease was taken on monthly bases based on incidences and severity on scale of 1 to 5.

1= No symptoms TLB disease observed,
2 = symptom of mild water soaked patches while the rest of leaf appearing green and healthy
3 = symptom of strong increasing water soaked lesion on one-third of the leaf
4 = symptom of severe water soaked distortion of two-thirds of the leaf
5 = symptom of very severe water soaked distortion of four-fifths or more of the leaf

Yield data included: Number of corms, number of cormels, number of corms+cormels,. Also, weight of corms, weight of cormels and weight of corms+cormels in t/ha.

Statistical analysis: The data collected were subjected to analysis of variance (ANOVA), using SAS software. Standard error of difference means was used to separate significant means at 5% level of probability.

RESULTS AND DISCUSSION

The result of the vigour and reactions of the hybrid Taro genotypes to the effect of Taro Leaf Blight disease are presented in Table 1. Crop vigour: The Vigour rating ranged from 3.0 to 5.0 with grand mean of 4.6. This indicated that many of the Taro genotypes were moderately to very vigorous at their growth stage. Vigour rating was taken at the peak of the Taro growth period (5 months after planting) when all the vegetative components of the plants were well exposed to assist the plant for food synthesis. This was at the period when the plants heights, the number of leaves, the turgidity of the petioles and the expanded leaves were at its peak. Vigour relates to the characteristics of the genotype that result in high field performances and eventually high good yield (Adebisi *et a.l,* 2013). At this stage also, pests and pathogens were poised to consume the luxuriant plant especially when the environmental factors are conducive. Crop vigour is an important component of a genotype quality and good health to obtain optimum plant stand and high production of the crops. Adeyemo and Fakorede (1995) have shown that hybrid vigour can also be a selection criterion when breeding for improved yield in crops. Vigour may cause the variations in the uniformity of the crop growth, and in some species differences in both vegetative and reproductive yield. High vigorous crop will perform better under environmentally stressed conditions than very low vigour crops.

Response of the Taro genotypes to the Taro Leaf Blight (TLB) disease

Of the total of 388 number of Taro plants in the field, 242 plants which represented 62.4% showed no symptoms of TLB disease (Score 1) which means that they were not attack by TLB disease caused by the pathogen *Phytophtora colocasiae* and were regarded as being immune. The seventeen (17) Taro stand which represented 4.4% with the score of 2.0 showed that presence of the pathogen. However, the pathogen could not develop more than the sign it showed. This means that the Taro genotype resisted the continuous spread of the pathogen and were regarded as resistant. Of the 31 Taro stands which represented 8.5% with the score of 3.0 had the disease spread to almost half of the leaves and certain plant parts. With that score of 3.0, the Taro plants were said to be tolerant. The Taro genotypes which were 16 stands with the disease score of 4.0 which represented 4.1% had almost all the plant parts severely damaged. This showed that the disease attack was severe. The plants at this category could be regarded as susceptible to TLB attack. This genotype especially NCe/005 was highly susceptible to this pathogen. For the fact that the Taro genotypes react differently to the attack of TLB disease indicated reasons for their genetic differences. Those Taro genotype that were immune and resistant to the attack, could be further evaluated in the field for field validation of the result. They could also be added as parents in the hybridization block for progeny development.

The result of the Number of stand, corm, cormels and number of corms+ cormels plus weights of corms, cormels, corms+cormels and yield per t/ha of the Taro AYT genotypes evaluated in 2023 are presented in Table 1.

Number of Taro plants at harvest

The Taro genotypes at the Advance Yield Trial (AYT) stage had high significant ($p<0.01$) variability in the number of plant stand at harvest. This varied from 11.0 to 16 stands at harvest per plot with mean of 14.9 stands per plot. According to Nwankwo and Ikoro (2021), number of plants per plot was also a yield component. This was because number of plants per plot contributed to the yield of that plot. Taro genotypes with high number of stands per plot was an evidence of genetic differences in the adaptability of the genotypes in that location.

Number of corms+cormels

There was high significant ($p<0.01$) differences in the number of corms+cormels produced by the Taro genotypes. The highest number of corms+cormels was produced by SM120/AYT/21/017 with 183.0 corms+cormels per plot of $9m^2$, followed by SM132/AYT/21/004 while the least was SM/AYT/21/NCe/03 with grand mean of 51.0 corms+cormels per plot. The Taro genotypes with mean number of corms+cormels above the grand mean were included among the high yielding Taro genotypes that were selected for further evaluation. According to Nwankwo, and Ikoro (2021), number of corms+cormels were a function of yield. It is the number of yield components such as number of corms plus number of cormels that the farmer uses to estimate the volume of the yield of the Taro crop. However, high number of corms+cormels but with low fresh weight of corms+cormels was an indication of low soil nutrients.

Fresh weight of the corms+cormels

Themean fresh weight of corms+cormels differed significantly ($p<0.01$) among the Taro genotypes evaluated. The Taro genotypes that produced the heaviest fresh matter accumulation was SM131/AYT/21/021 with 8.3kg per plot which was equivalent to 7.5t/ha of fresh corms+cormels. This was followed by SM120/AYT/21/007 with 8.1kg and/or 7.3t/ha of fresh weight of corms+cormels while the least of fresh corms+cormels was produced by SM120/AYT/21/002 with grand mean of 4.1kg or 4.0t/ha of fresh corms+cormels. The grand mean of fresh corms+cormels produced by all the genotypes was 5.7kg or 4.7t/ha of corms+cormels. The Taro genotypes that produced fresh matter of corms+cormels more than the grand mean of 5.7kg (or 4.7t/ha) were included among the genotypes selected for further evaluation. High fresh weight accumulation of corms+cormels was an indication of high photosynthetic efficiency of the high yielding Taro genotypes which resulted as a result of high vigour. Therefore those Taro genotypes selected for high vigour was an indirect way of selecting them for high yield. High yielding Taro genotypes of cocoyam will support smallholder farmers to sustainably improve taro cultivation, increase food security and household incomes. High yielding genotypes coupled with good agricultural practices will assist farmers with the skill to penetrate high value export market.

CONCLUSION

Taro genotypes that yielded highly in terms of fresh weight of corms+cormels of 5.7kg and above per plot, high vigour rating of 4.6 and above were selected, Sixty-two percent (62.4%) of the Taro genotypes scored 1.0 were immune while 4.4% with the score of 2.0 were resistant to the TLB disease which indicated that these Taro genotypes had varying resistances to the disease. These Taro genotypes were selected for further evaluation and inclusion in future Taro hybridization block for progeny development.

REFERENCES

Adebisi, M.A, Okelola, F.S, Alake, C.O, Vaughan –Ayo, M.A and Ajala, M.O. (2010). Interrelationship Between Seedling Vigour Traits and Field Performance In New Rice For Africa (NERICA) genotypes (Oryza sativa L.). Journal of Agricultural Science and Environment. 10(2): 15-24.

Adebisi, M.O, Kehide, T.O, Porbeni, J.B.O, Oduwaye, O.A, Biliaminu K., Akintunde, S.A. (2013).Seed and Seedling Vigour in Tropical Maize Inbred Lines. Plant Breeding and Seed Science. 67: 88-101.

Adeyemo M.O, and Fakorede M.A.B. (1995). Genetic Variation for Seedling Vigour and Its Correlated Responses from Selected For Grain Yield In A Tropical Maize (Zea mays L.) Population. Discovery and innovation. 7 (2): 111-119.

Ajala, M.O, Adebisi, M.A, Akingbogun, O.A. (2003). Variability for Seedling Vigour in Tropical Cowpea (Vigna unguiculata L.) Walp. Moor journal of Agricultural Research, Vol14: p54-59.

Mba, R .E .C and Dixon, A.G.O (1997). Heritability estimates for ACMD resistance for some newly developed cassava clones in Nigeria, African Journal of Root and Tuber crops. ISTRC-AB. Volume 2 Numbers 1 and 2 1-278 May ISSN 1118-2075. Cnotributions of Biotechnology to Cassava for Africa. Proceedings of the cassava biotechnology network. Third International Scientific meeting .Kampala, Uganda 26 – 31 August 1996 (eds) Anne Marie and Malachy O. Akoroda.

Onyeka T. J., Chukwu G. O., Nwadili C., Shaema K. and Barndyopadhyay (2010). Stemming the outbreak of taro leaf blight in Nigeria: Update on pathogen identification and effort by NRCRI and partners. NRCRI, Annual Report 2010.

Allard, R.W (1960). Principles of plant breeding. John Wiley and Sons London p440.

Nwankwo, I.I.M and Ikoro, A.I (2021). Storage Root and Vine Yield Evaluation of Exotic Sweetpotato Varieties in Umudike Rainforest Agro-ecology of Southeastern Nigeria. Ogunji, J.O., I.I. Osakwe, R.U. Onyeneke, S.C. Iheanacho & M.U. Amadi (2021). (eds) Climate Smart Agriculture and Agribusiness Development in Nigeria. Proceedings of the 54th Annual Conference of the Agricultural Society of Nigeria held at Alex Ekwueme Federal University Ndufu Alike, Ebonyi State, Nigeria 31st January – 4th February, 2021 PP1378 - 1382.

Table 1: Vigour and reactions of the hybrid Taro genotypes to the effect of Taro Leaf Blight disease at AYT stage.

S/no.	Genotype Name	Mean vigour Score (1 to 5	Mean number of plant /plot	Mean incidences	Severity Score (1 to 5)				
					No symptom (Score 1)	Symptom present (Score 2)	Symptom mild (Score 3)	Symptom severe (Score 4)	Symptom very severe, plant almost dead (Score 5)
1	SM132/AYT/21/001	5.0	16	16	*	0.0	0.0	0.0	0.0
2	SM120/AYT/21/002	4.6	16	16	*	0.0	0.0	0.0	0.0
3	SM132/AYT/21/003	5.0	16	2	0.0	*	0.0	0.0	0.0
4	SMNCe/AYT/21/001	4.1	16	4	0.0	*	0.0	0.0	0.0
5	SM132/AYT/21/004	4.8	16	16	*	0.0	0.0	0.0	0.0
6	SMNCe/AYT/21/05	4.5	16	16	*	0.0	0.0	0.0	0.0
7	SM120/AYT/21/007	4.4	16	16	*	0.0	0.0	0.0	0.0
8	SM151/AYT/21/008	3.0	15	6	0.0	*	0.0	0.0	0.0
9	SM/AYT/21/NCe/03	4.4	15	15	*	0.0	0.0	0.0	0.0
10	SM120/AYT/21/009	4.6	16	16	*	0.0	0.0	0.0	0.0
11	SM/NCe/002	5.0	13	13	*	0.0	0.0	0.0	0.0
12	SM120/AYT/21/010	5.0	16	16	*	0.0	0.0	0.0	0.0
13	SM132/AYT/21/011	4.8	16	16	*	0.0	0.0	0.0	0.0
14	SM132/AYT/21/012	4.7	15	15	*	0.0	0.0	0.0	0.0
15	SM158/AYT/21/013	5.0	14	5	0.0	*	0.0	0.0	0.0
16	SM132/AYT/21/014	4.3	16	4	0.0	0.0	*	0.0	0.0
17	SM158/AYT/21/015	5.0	14	14	0.0	0.0	*	0.0	0.0
18	SM136/AYT/21/016	4.5	12	12	*	0.0	0.0	0.0	0.0
19	SM120/AYT/21.017	4.2	13	6	0.0	0.0	*	0.0	0.0
20	SM138/AYT/21/018	5.0	15	15	*	0.0	0.0	0.0	0.0
21	SM120/AYT/21/019	3.8	12	12	*	0.0	0.0	0.0	0.0
22	SM136/AYT/21/020	5.0	16	16	*	0.0	0.0	0.0	0.0
23	SM131/PYT/20/021	4.1	11	3	0.0	0.0	*	0.0	0.0
24	SM132/AYT/21/022	4.2	16	16	*	0.0	0.0	0.0	0.0
25	SM120/PYT/20/023	5.0	15	6	0.0	0.0	*	0.0	0.0
26	NCe/005	5.0	16	16	0.0	0.0	0.0	*	0.0
	Mean	4.6	14.9						
	Range	3.0- 5.0	11-16						
	%	92.3%			62.4%	4.4%	8.5%	4.1%	0.0%

Note: Vigour rating:
Where;
1 = very low vigour,
2 = low vigour,
3 = moderate vigour,
4 = vigorously,
5 = very vigorously

Taro leaf blight Severity score:
1 = No symptoms TLB disease observed,
2 = symptom of mild water soaked patches while the rest of leaf appearing green and healthy
3 = symptom of strong increasing water soaked lesion on one-third of the leaf
4 = symptom of severe water soaked distortion of two-thirds of the leaf
5 = symptom of very severe water soaked distortion of four-fifths or more of the leaf

Table 2: Number of stand, corm, cormels and number of corms+ cormels plus weights of corms, cormels, corms+cormels and yield per t/ha of the Taro AYT genotypes evaluated in 2023

S/no.	Genotype name	Mean Stand count at harvest/plot	Mean number of corms/ plot	Mean number of cormels/plot	Mean number. of corms+cormels/plot	Mean weight of corms/plot	Mean weight of cormels per plot	Mean weight of corms+cormels per plot	Mean weight of corms+cormels per t/ha
1	SM132/AYT/21/001	16	18	44	62.0	2.7	2.8	5.5	5.0
2	SM120/AYT/21/002	16	16	36	52.0	1.9	2.2	4.1	4.0
3	SM132/AYT/21/003	16	19	101	120.0	2.8	2.3	5.1	4.6
4	SMNCe/AYT/21/001	16	17	56	83.0	2.5	1.9	4.4	4.0
5	SM132/AYT/21/004	16	20	122	142.0	2.5	2.9	5.4	4.9
6	SMNCe/AYT/21/05	16	18	66	80.0	2.8	1.8	4.6	4.1
7	SM120/AYT/21/007	16	17	102	86.0	5.3	2.8	8.1	7.3
8	SM151/AYT/21/008	15	16	112	128	3.6	2.8	6.4	5.8
9	SM/AYT/21/NCe/03	15	19	32	51.0	2.8	2.5	5.3	4.8
10	SM120/AYT/21/009	16	18	49	67.0	3.1	2.8	5.9	5.3
11	SM/NCe/002	13	16	98	114.0	2.6	3.1	5.7	5.1
12	SM120/AYT/21/010	16	19	106	125.0	2.7	3.6	6.3	5.7
13	SM132/AYT/21/011	16	22	92	113.0	2.1	2.7	4.8	4.3
14	SM132/AYT/21/012	15	16	122	138.0	3.5	3.1	6.6	5.9
15	SM158/AYT/21/013	14	15	114	129.0	2.9	3.5	6.4	5.8
16	SM132/AYT/21/014	16	18	142	160.0	2.6	3.9	6.5	5.9
17	SM158/AYT/21/015	14	16	112	128.0	2.8	2.7	5.5	5.0
18	SM136/AYT/21/016	12	18	123	141.0	2.2	3.9	6.1	5.5
19	SM120/AYT/21.017	13	15	168	183.0	2.3	2.8	5.1	4.6
20	SM138/AYT/21/018	15	19	95	114.0	1.9	3.5	5.4	4.9
21	SM120/AYT/21/019	12	21	79	100.0	1.8	2.5	4.4	4.0
22	SM136/AYT/21/020	16	16	113	129.0	2.8	2.8	5.6	5.0
23	SM131/PYT/21/021	11	15	95	110.0	2.8	5.5	8.3	7.5
24	SM132/AYT/21/022	13	14	88	102.0	2.8	3.6	6.4	5.8
25	SM120/PYT/20/023	15	17	92	109.0	2.5	2.8	5.3	4.8
26	NCe/005	16	16	78	94.0	2.8	2.6	5.4	4.9
	Mean	14.9	17.1	89.3	106.4	2.7	3.0	5.7	4.7
	Range	11-16	14-22	32-168	51-183	1.8-5.3	1.8-5.5	4.1-8.3	4.0-7.5
	SE	3.9**	4.2**	9.6**	10.5**	1.7**	1.8**	2.4**	2.2**

AGRICULTURAL SOCIETY OF NIGERIA
58TH ANNUAL CONFERENCE
UNIVERSITY OF ABUJA, NIGERIA
21-25 OCT. 2024
PROCEEDINGS

Multi-Location Trial of Taro Accessions for Adaptation across Diverse Environments for Official Registration and Release as "Variety" to Farmers in Nigeria

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Abstract
Some Taro accessions of the Araeceae family of cocoyam have superior agronomic characteristics which could qualify them for official recommendation and registration as varieties in Nigeria. As such, "Multi-location Trial of Taro Accessions for Adaptation across Diverse Environments for Official Registration and Release as "Variety" to Farmers in Nigeria" was carried out. Data were collected on fresh tuber yield and biotic stresses across locations and statistically analyzed using ANOVA. Results indicated that the following accessions have high fresh tuber yield across locations based on ranking and were immune/resistant to major biotic stresses disturbing Taro in the field:NCe/001 (Cocoindia) (27.0t/ha), NCe/002(Ede-Ofe green) (28.7t/ha), NCe/003 (Ede-Ofe purple) (30.6t/ha), NCe/005 (Ukpong) (30.9t/ha) and NCe/006 (Gana) (16.3t/ha). These accessions will be selected for on-farm farmers' participatory evaluation for final selection by farmers before official registration and release as "variety."
Keywords: Release, Registration, Variety, Taro, high yield and biotic stresses

INTRODUCTION

Taro accessions of *Areceae* family of Cocoyam can make significant contribution in the diet of the people or as varieties in the farming system of the people or as progenitors in breeding programme for the farmer preferred traits. In cocoyam growing States of Nigeria, Taro farmers depend on the accessions for survival. Taro is an important security food for poor resource farmers. When it is planted, some accessions are harvested in piece meal by milking for home consumption and as such regarded as security crop. The maturity period is almost the same when compared with cassava, and yam which take 7 to 12 months to mature depending on varieties. Cocoyam is broadly divided into two: *Xanthosomasagittifolium* (Tannia) and*Colocasiaesculenta* (Taro) species which in turn have subdivisions. Cocoyam (in its broad name) can be boiled and eaten in some cases without salt or even eaten with Sauce. It could be fried, boiled, roasted and pounded into fufu or ground into flour for other uses such as in commercial value addition (used for thickening soup, biscuits, processed into starch, and other food products). This makes the crop an important crop. In cocoyam growing states, the crop has been used for income generation and for home consumption. As a result, many indigenous landraces of cocoyam exists.Taro accessions are adapted to their local areas and have developed resistance to local pests and diseases. These Taro accessionsare recognized by farmers as result of their good qualities as such could be used for genetic recombination (Nwankwo, *et al*., 2012). Some Taro accessions have superior agronomic characteristics which could qualify them for official recommendation and registration as varieties. These Taro accessions also contain valuable sources of resistance to important diseases and pests, capable of adaptation to environments where Taro is grown, and other desirable characteristics such as high dry matter content which is associated with culinary qualities preferred by consumers. (Godden, 1999). Amadi *et al*., (2015) also pointed out that Taro accessions could be a source of resistance or immunity to cocoyam virus disease (CMV) which has been a hindrance to Taro cultivation. Registration and the protection of Taro accessions are of high priority. However, the objectives of this study were: to evaluate Taro Landraces for high fresh tuber yield for field cultivation in diverse Agro-Ecological Zones of Nigeria, to document Taro accessions for official registration and release as “variety” to farmers, to officially register top Taro accessions which are close to or equally better than hybrid varieties, to officially register the Taro accessions which farmers use for feeding the Nation, self-employment and income generation through commercialization, for industrial and export purposes.

MATERIALS AND METHODS

Procedures presented in this report were trials conducted between 2021 and 2023 include the following

1. Thetrial briefly outlined below followed the standard protocols used by the National Root Crops Research Institute Breeding Programme and 2 other trials conducted by collaborators. Nine taro accessions were planted at six locations namely Umudike (Abia State, Rain forest), Igbariam (Anambra State, Derived savannah), Otobi (Benue State, Southern Guinea savannah), Kuru (Jos Plateau, Cool mid altitude),), Nyanya (Nasarawa State, Southern Guinea Savanna) and Iresi (Osun State, Rain Forest). At each location, the experiment was laid out in randomized complete block design with 3 replications. Plot size was (4 x 5m) = 20m^2 containing 30 stands, planted at 50cm within row and 1.0m between ridges. The plots were 1m apart. This gave a total of 6 plots replicated 3 times. Each replication/block were 2 m apart.

Planting method and material

Cut-sett about 100g from symptomless tubers of cocoyam Taro accessions were the sources of planting material. Each Scientist was given a set of 9 clones to test in the area. Each of the 9 clones appeared on all the farms (reps) in the 6 locations across the country.

Weed control measures

Herbicides were sprayed at 3 days after planting and plots were subsequently hand weeded at 6 and 12 weeks after planting.

Soil nutrient amendment

Poultry manure was worked into the soil during land preparation and NPK 15:15:15 fertilizer was applied at the 4th week after planting. Harvesting took place when leaves became senescent.

The following growth data were collected: plant emergence per plot at 4 weeks after planting, Data on folia biotic reactions of the Taro cocoyam were collected. These included pests and diseases such as Taro leaf blight, and nematodes. Severity scale used was on 1 to 5. Where 1 = no damage/no pests present, 2 = very little damage/few present), 3 = moderate damage/moderate number present, 4 = considerable damage/considerable number present, 5 = severe damage/very high number present

Harvest data: Fresh weight of corms (t/ha), Fresh weight of cormels (t/ha) and Total fresh weight of corms+cormels (t/ha); Data on cocoyam root rot were also collected at harvest.

Data collection and Analysis: Data collected were statistically analyzed using ANOVA. The fresh tuber weights (corms, cormels and corms+cormels)converted in tons per hectare were statistically analyzed and mean tuber yield were separated using LSD at 5% probability level.

RESULTS AND DISCUSSION

Combined Fresh weight yield ofTaro corms + cormels for the two years 2022 and 2023

The result of the performance of the taro accessions for the two years combined and across the agro-ecologies of the country in terms of the fresh weight yield of corms + cormels in 2022 and 2023 combined is presented in Table 1.

Fresh yield of tubers within locations

The combined mean performance of the Taroaccessions indicated significant ($p<0.01$) variation in the tuber yield performance of corms + cormels within locations and across locations. Among the Taro accessions evaluated in both years 2022 and 2023, the combined analyses indicated that Ede-ofe green NCe/002 ranked 1st in two locations: Plateau and Nyanya locations. In Plateau, Ede-ofe green had mean corms + cormels fresh weight of 32.2t/ha more than the location mean of 16.6t/ha with corm + cormels yield range of 0.8 to 30t/ha in that location. In Nyanya location also the mean corms + cormels fresh weight of Ede-ofe green NCe/002 was 32.0t/ha far above the grand mean of that location which was 16.7t/ha of fresh weight of corms + cormels in location yield range of 0.5 to 32.0t/ha of fresh weight yield of corms + cormels.

Ede-ofe purple NCe/003 was ranked 1st in two out of 6 locations namely Abia and Oshun locations. The mean fresh weight of corms + cormels in Abia was 30.6t/ha far above the location mean of 17.6t/ha with location range of 0.5 to 30.6t/ha. In Oshun location, the corm + cormel fresh weight of Ede-ofe purple NCe/003 was 30.7t/ha also far above the location mean of 15.9t/ha in location yield range of 0.4 to 30.7t/ha fresh weight of corms + cormels. UkpongNCe/005 ranked 1st position in two out of six locations: Benue and Anambra. In Benue, the mean corms + comels fresh weight was 35.6t/ha above the location mean yield of 17.8t/ha of fresh weight of corms + cormels in location yield range of 0.5 to 35.6t/ha, while in Anambra the mean fresh weight of corms + cormels was 35.1t/ha above the location mean of 18.4t/ha in location yield range of 1.0 to 35.1t/ha of fresh weight of corms + cormels.

CocoindiaNCe/001 was ranked 2nd position in one out of six locations. In Plateau location, the mean corms + cormels fresh weight was 30.0t/ha above the location mean of 16.6t/ha with the location yield range of 0.8 to 30.0t/ha. Also Ede-ofe green NCe/002 was ranked 2nd position in Benue with mean fresh weight yield of 31.3t/ha above the location mean of 17.8t/ha in location yield range of 0.5 to 35.6t/ha fresh weight of corms + cormels. AkiriNCe /004 was ranked 2nd position in two out of six locations. In Abia location, the fresh mean yield of corms + cormels was 30.5t/ha above the location mean of 17.6t/ha in the location yield range of 0.5 to 30.5t/ha. In Oshun where it was also ranked 2nd position with mean corms + cormels fresh weight of 29.2t/ha above the location mean yield of 15.9t/ha with location yield range of 0.4 to 30.7t/ha of fresh weight corms + cormels.

CocoindiaNCe/003 was ranked 3rd position in two out of six locations. In Abia location, the mean fresh corms + cormels yield was 28.0t/ha above location mean yield of 17.6t/ha in location yield range of 0.5 to 30.5t/ha fresh weight of corms + cormels. In Anambra location, the mean fresh weight of corms + cormels was 30.3t/ha above location mean of 18.4t/ha in location yield range of 1.0 to 35.1t/ha of fresh weight of corms + cormels. Ede-ofe green NCe/002 was ranked 3rd position in Oshun with mean corms + cormels fresh weight of 25.1t/ha above the location mean yield of 15.9t/ha in location yield range of 0,4 to 30.7t/ha fresh weight of corms + cormels. Ede-ofe purple NCe/003 was ranked 3rd position in two out of six locations. In Plateau location, the mean fresh yield of corms + cormels was 29.4t/ha above the location mean of 16.6t/ha in location yield range of 0.8 to 30.0t/ha of fresh weight of corms + cormels. This accession in Benue location gave mean fresh weight of corms + cormels of 31.2t/ha above the location mean of 17.8t/ha in location yield range of 0.5 to 35.6t/ha fresh weight of corms + cormels. UkpongNCe/005 ranked 3rd position in one (Nyanya) out six locations with mean fresh weight yield of corms + cormels of 27.9t/ha above the location mean of 16.7t/ha in location yield range of 0.5 to 32.0t/ha fresh weight of corms + cormels.

CocoindiaNCe/001 ranked 4th position in 3 out of 6 locations. The mean corms + cormels yield at Oshun location was 22.3t/ha above the location mean of 15.9t/ha in location yield range of 0.4 to 30.7 t/ha of fresh weight of corms + cormels. In Benue location, the mean corms + cormels fresh weight was 26.7t/ha above the location mean of 17.8t/ha with location yield range of 0.5 to 35.6t/ha, while in Nyanya location, the mean fresh weight of corms + cormels was 24.7t/ha in location yield range of 0.5 to 32.0t/ha with location mean yield of 16.7t/ha.

AkiriNCe/004 ranked 5th position in two out of six locations. In Oshun location, the mean fresh weight of corms + cormels was 20.3t/ha above the location mean of 15.9t/ha in location yield range of 0.4 to 30.7t/ha of fresh corms + cormels. Also in Anambra location, the mean fresh weight of corms + cormels was 21.1t/ha above the location mean yield of 18.4t/ha in location yield range of 1.0 to 35.1t/ha of corms + cormels. UkpongNCe/005 was ranked 5th position in two out of six locations. The mean fresh weight of corms + cormels in Abia location was 18.3t/ha below the location mean of 17.6t/ha in location yield range of 0.5 to 30.5t/ha. Also in Oshun location, the mean corms + cormels fresh weight was 16.4t/ha above the location mean of 15,9t/ha in location yield range of 0.4 to 30.7t/ha of fresh weight of corms + cormels.

GanaNCe/006 was ranked 5th position in 4 out of 6 locations. In Abia location, fresh weight of corms + cormels yield was 18.5t/ha above the location mean of 17.6t/ha with location yield range of 0.5 to 30.5t/ha of corms + cormels fresh weight yield. In Oshun location, the mean fresh weight of corms + cormels was 16.4t/ha above the location mean yield of 15.9t/ha in location yield range of 0.4 to 30.7t/ha of fresh weight of corms + cormels. In Plateau location the mean corms + cormels fresh weight was 17.6t/ha above the location mean of 16.6t/ha in a location yield range of 08 to 30.0t/ha. In Benue location, mean fresh corms + cormels yield weight was 17.8t/ha equivalent to the location mean yield of 17.8 t/ha in the location yield range of 0.5 to 35.6t/ha of fresh weight of corms + cormels. AkiriNCe/004 was ranked 6th position in 2 out of 6 locations. In Plateau the mean fresh weight of corms + cormels yield was 13.0t/ha far below the location yield mean of 16.6t/ha with location yield range of 0.8 to 30.0t/ha of fresh weight of corms + cormels, and in Benue location mean fresh weight of corms + cormels was 15.9t/ha also quite below location mean of 17.8t/ha in location yield range of 0.5 to 35.6t/ha of fresh corms + cormels. GanaNCe/006 was also ranked 6th position in 2 out of 6 locations. Nyanya mean fresh weight of corms + cormels was 13.8t/ha below the location mean of 16.7t/ha in location yield range of 0.5 to 32.0t/ha of fresh weight ofcorms + cormels. Also in Anambra location, the corms + cormels fresh weight was 14.3t/ha, lower than the location mean yield of 18.4t/ha in the location yield range of 1.0 to 35.1t/ha of corms + cormels.

Fresh tuber yield across locations

The fresh weight of corms + cormels across locations indicated that UpongNCe/005 ranked 1st position with mean yield of 30.9 across locations and above the general mean of 17.0t/ha. This accession was stable in four locations where the mean yield ranked 1st in two locations (Benue and Anambra) and 5th in (Abia and Oshun) locations. This was followed by Ede-ofe purple NCe/003 which ranked 2nd across location with mean of 30.6t/ha above the general mean of 17.0t/ha of fresh weight of corms + cormels. It had yield stability in all the 6 locations. It ranked 1st position in Abia and Oshun locations, 2nd position in Nyanya and Anambra, and 3rd position in Plateau and Anambra locations. However, GanaNCe/006 was ranked 6th position with mean fresh weight of corms + cormels across locations of 16.3t/ha far below the general mean of 17.0t/ha of fresh corms + cormels. Based on ranking, it was stable in 6 locations where it ranked 5th (in Abia, Oshun, Plateau and Benue) and 6th position in Nyanya and Anambra locations. Although in these locations the mean fresh weight of corms + cormels were above the general mean across locations.

Other accessions such as Nsuka Dwarf with 0.9t/ha, Nsuka Short tail with 1.0t/ha and Nsuka Long tail with 0.8t/ha had fresh corms+cormels yield far below the various location mean and the general mean of 17.0t/ha and with range of 0.8 to 30.9t/ha.

Locations

The location that gave the best yield was Anambra with mean yield of fresh corms + cormels yield of 18.4t/ha followed by Benue location with mean yield of 17.8t/ha while the least location was Oshun with mean yield of 15.9t/ha of fresh weight of corms + cormels. Therefore accessions were nominated for registration based on the location with the highest corms + cormels production. However, the change in rank of most of the Taro accessions in each of the years indicated that they were affected by location effect whilesomewere consistent in their rank in some locations and may be regarded to be less affected by environmental factors (Amadi et al 2015). Since most of the accessions are location specific, they could be registered and documented as varieties that are location specific and release for commercial Taro production in those locations including using them for export markets.

Pests and Diseases reactions

The mean performance of the pests and diseases reactions indicated that there was very little to moderate reactions of pests and diseases attack on the Taro accessionshence the severity score of 1.0 for most of the pests and diseases to 1.6 severity rating for Taro leaf blight (Table 2). This indicated that the selected accessions for registration and documentation wereimmune/resistant to most of the major pests and diseases attacking cocoyam crops in the field. Hence Godden (1999) made a point when he said that landraces/accessions could be a source of resistance or immunity to disease such as TLB which has been a hindrance to cocoyam cultivation. However, not only to TLB disease but could be a source of resistance to leaf spot disease, virus disease and corm soft rot diseases of cocoyam.

CONCLUSION

The following accessions were nominated for on-farm farmer's participatory variety selection based on their yield superiority in terms of fresh yield weight. They were: NCe/001 (Cocoindia) (27.0t/ha), NCe/002(Ede-Ofe green) (28.7t/ha), NCe/003 (Ede-Ofe purple) (30.6t/ha), NCe/005 (Ukpong) (30.9t/ha) and NCe/006 (Gana) (16.3t/ha). These accessions were immune/resistant to major biotic stresses disturbing Taro in the field. Accessions with their mean fresh weight of corms + cormels below the general mean will not be nominated for varietal consideration as a variety. Such accessions include; Nsuka Dwarf with 0.9t/ha, Nsuka Short tail with 1.0t/ha and Nsuka Long tail with 0.8t/ha.

REFERENCES

Nwankwo, I.I.M (2012). Performance of Introduced and Locally Bred Orange Fleshed Sweetpotato Varieties in the Rainforest Ecology of Southeastern Nigeria**.** International Journal of Applied Research and Technology; Published by EsxonPublishers 2 (6): 48 - 54.

Amadi, C. O., Onyeka, J., Chukwu, G. O., Okoye, B. C., Ezeji, L. and Ezigbo, E.C. (2015) Evaluation of Exotic Genotypes of Taro (*Colocasia esculenta*) in Nigeria. The *Nigerian Agricultural Journal* 46 (1&2): 48-56

Godden D (1999). Economic rationale for cooperation in germplasm conservation. Paper presented at ACIAR/NARI Workshop on Regional Co-operation in Conservation and Management of Plant Genetic Resources in the Pacific. Lae. 1999.

Table 1: Combined Fresh weight yield performance of the Taro Landraces across the Agro-ecologies of the country in 2022 and 2023 in t/

Clone Name	Weight of corm and cormels	Abia	R	Oshun	R	Plateau	R	Benue	R	Nyanya (FCT)	R	Anambra	R	Mean	Gen. Rank
CocoindiaNCe/001	**Corms+cormels**	**28.0**	**3**	**22.3**	**4**	**30.0**	**2**	**26.7**	**4**	**24.7**	**4**	**30.3**	**3**	**27.0a**	**4**
	Corms	17.2		11.1		16.5		17.6		11.5		16.5		15.1	
	Cormels	10.9		11.2		13.5		9.1		13.2		13.8		11.9	
Ede-Ofe –Green NCe/002	**Corms+cormels**	**26.0**	**4**	**25.1**	**3**	**32.2**	**1**	**31.3**	**2**	**32.0**	**1**	**28.8**	**4**	**28.7a**	**3**
	Corms	15.2		16.6		15.6		21.7		16.7		17.9		17.0	
	Cormels	10.8		8.5		16.6		9.6		15.3		10.9		11.8	
Ede-Ofe Purple NCe/003	**Corms+cormels**	**30.6**	**1**	**30.7**	**1**	**29.4**	**3**	**31.2**	**3**	**30.3**	**2**	**31.2**	**2**	**30.6a**	**2**
	Corms	19.2		16.8		19.2		17.5		16.6		18.5		18.0	
	Cormels	11.4		13.9		10.2		13.7		13.7		12.7		12.6	
AkiriNCe/004	**Corms+cormels**	**30.5**	**2**	**29.2**	**2**	**13.0**	**6**	**15.9**	**6**	**20.3**	**5**	**21.1**	**5**	**18.2b**	**5**
	Corms	17.2		17.3		6.7		9.9		10.7		12.8		10.6	
	Cormels	13.3		11.9		6.3		6.0		9.6		8.3		7.6	
UkpongNCe/005	**Corms+cormels**	**18.3**	**5**	**16.4**	**5**	**26.4**	**4**	**35.6**	**1**	**27.9**	**3**	**35.1**	**1**	**30.9a**	**1**
	Corms	10.7		9.7		16.3		24.3		16.2		22.5		19.0	
	Cormels	7.6		6.7		10.1		11.3		11.7		12.6		11.9	
GanaNCe/006	**Corms+cormels**	**18.3**	**5**	**16.4**	**5**	**17.6**	**5**	**17.8**	**5**	**13.8**	**6**	**14.3**	**6**	**16.3b**	**6**
	Corms	10.7		9.7		10.0		12.6		6.1		8.0		9.5	
	Cormels	7.6		6.7		7.6		5.2		7.7		6.3		6.8	
Nsuka Dwarf	Corm + cormel	**1.2**	**7**	**0.4**		**1.3**	**6**	**0.7**	**8**	**0.6**	**8**	**1.4**	**7**	**0.9c**	8
	Corms	0.6		0.2		0.7		0.5		0.2		0.5		0.5	
	Cormels	0.6		0.2		0.9		0.2		0.4		0.9		0.4	
Nsukashorttail	Corm + cormel	**0.6**	**8**	**0.9**		**1.7**	**7**	**1.0**	**7**	**0.5**	**9**	**1.0**	**9**	**1.0c**	7
	Corms	0.2		0.3		1.0		0.5		0.1		0.4		0.4	
	Cormels	0.4		0.6		0.7		0.5		0.4		0.6		0.6	
Nsukalongtail	Corm + cormel	**0.5**	**9**	**1.3**		**0.8**	**9**	**0.5**	**9**	**0.7**	**7**	**1.1**	**8**	**0.8c**	9
	Corms	0.2		0.5		0.2		0.2		0.3		0.4		0.3	
	Cormels	0.3		0.8		0.6		0.3		0.4		0.7		0.5	
Mean	**Corms+cormels**	**17.6**		**15.9**		**16.6**		**17.8**		**16.7**		**18.4**		**17.0**	
	Corms	15.8		13.7		9.3		11.6		8.7		10.8		10.0	

	Cormels	1.8	2.2	7.3	6.2	8.0	7.6	7.0
Range	corms+cormels	0.5-30.6	0.4-30.7	0.8-32.2	0.5-35.6	0.5-32.0	1.0-35.1	0.8-30.9
	LOCATION	**3**	**6**	**5**	**2**	**4**	**1**	
$LSD_{(0.05)}$	**Corms+cormels**	4.4*	4.2*	5.39**	4.5*	4.3*	5.5**	4.4
	Corms	4.2*	3.2*	4.05**	3.6*	3.1*	3.5**	
								3.4
	Cormels	1.4*	1.6*	3.46**	2.6*	3.0*	2.9**	2.8

Table 2: Mean response of the Cocoyam *Colocasia species* accessions to biotic stress in 2022 and 2023 trials combined

	Cocoyam Diseases				**Cocoyam Pests**				
Clone Name	Bobone mosaic virus	Leafspot	Taro Leaf blight	Root rot	beetle	Crickets	Termites	Nematodes	Millipedes
Cocoindia-NCe/001	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Edeofe- Green NCe/002	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.5	1.0
Edeofe- purple NCe/003	1.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0
Akiri, NCe/004	1.0	1.0	1.7	1.0	1.0	1.0	1.0	1.0	1.0
Ukpong, NCe/005	1.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0
Gana, NCe/006	1.0	1.0	2.0	1.0	1.0	1.0	1.0	1.5	1.0
Nsuka Dwarf	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Nsukashorttail	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Nsukashorttail	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Mean	**1.0**	**1.0**	**1.6**	**1.0**	**1.0**	**1.0**	**1.0**	**1.2**	**1.0**

Note: 1=no damage/no pests present, 2=very little damage/few pests present, 3=moderate damage/moderate number of pests present , 4=considerable
damage/considerable number of pests present, 5 = severe damage/ very high number pests present

Effect of Fertilizer Use on the Vegetative Growth of Sweetpotato Planting Materials In Iresi, South-Western Nigeria

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Abstract
The experiment was carried out in the research farm of National Root Crops Research Institute (NRCRI), Iresi South Western Nigeria in 2023 cropping season to determine the effect of fertilizer use on the vegetative growth of sweetpotato planting material. The genotypes of the sweetpotato were Ex-Igbariam, King-J and Mothers Delight while the fertilize rates were 0kg/ha, 200kg/ha, 400kg/ha and 600kg/ha. The experimental design was a 4x3 factorial arranged in a randomized complete block design (RCBD) with three replicates. Vine length was significantly enhanced at 200kg/ha of Mothers Delight and Ex-Igbariam at 8WAP than King-J at 400kg/ha. At 10WAP, Ex-Igbariam gave the highest vine length at 400 kg/ha. At 8WAP, fertilizer rate of 200kg/ha gave the highest number of leaves in Ex-Igbariam. At 10WAP, fertilizer rate of 400kg/ha gave the highest number of leaves at treatment Ex-Igbariam. King J had the highest biomass at fertilizer rate 600kg/ha followed by Ex-Igbariam at the fertilizer rate of 400kg/ha. To produce more vine length and number of leaves, application of fertilizer at the rate of 200kg/ha is recommended for Mothers Delight and Ex-Igbariam.
Keywords: Fertilizer, vegetative, growth, sweetpotato, planting materials, southwestern Nigeria.

INTRODUCTION

According to (Odebode, 2004), sweetpotato (*Ipomoea batata* L.) is an important food security crop in Nigeria. It is a versatile and nutritious root crop cultivated in more than 100 countries. It is a short-term crop consumed by boiling and mashing. It is grown as a staple food in many parts of the tropics, subtropics and some developing countries where it accounts for about 107 million/tons in production per year. It is a mono-cropped or intercropped with some staple crops such as cassava, yam and maize. Nigeria is one of the largest producers in Sub Saharan Africa with the annual production of 3.46 million tons per year. It can be grown throughout Nigerian states especially Kaduna, Kano, Zaria, Sokoto, Benue, and Kebbi. It is an important staple food crop in Africa, and Nigeria in particular. It contains Vitamin A which has sufficient quantities of the precursor (beta-carotene). Children under five years of age, pregnant women and lactating women are prone to the deficiency of Vitamin A that can lead to blindness. Chronic deficiency will not allow the child's capacity to fight other diseases with sufficient negative long-term effect on the health of humans. Sweetpotato is cultivated easily and has the ability to thrive under harsh conditions. It is an attractive cash crop, because low input is required. This makes it a good security crop due to its high calorie return per unit land area. It can be purchased in affordable price and easily cultivated.

Sweet potatoes are tolerant to low fertilization and nutrient availability. However, most farmers apply fertilizers to boost their yields in commercial farming. In all cases, farmers are advised to invest in improving soil health and fertility by applying suitable practices like crop rotation, use of fertilizer green and animal manure. Infertility of the soil is one of the major problems of sweetpotato production which makes it difficult for the crop to attain higher yields. Sweetpotato, as a heavy feeder, requires greater volume of soil nutrients and water (Osundare, N. 2004). According to Okpara (2000), low soil fertility is one of the major constraints in sweetpotato production. Addition of macronutrients must be applied to the soil for higher yield (Asa, Adedoyin Ayobami *et al*., 2021). External nutrient inputs are essential to improve and sustain the growth and yield of sweet potato. The principal objective of the study was to determine the effect of fertilizer use on the vegetative growth of sweetpotato planting material.

MATERIALS AND METHODS

The field trial was located at the farm of National Root Crops Research Institute (NRCRI), Iresi South Western Nigeria in 2023. Iresi is located within latitude 7^0 56′ N and longitude 4^0 50′ SE. A composite soil test was taken from the site at a depth of 0-20cm for physical and chemical analysis before cropping. The field was prepared by slashing, ploughed and harrowed. The field was marked out into three replications and each replicate was divided into 12 plots measuring 2mx3m ($6m^2$). The spacing between each replicate was 1m and the spacing between each plot was 0.5m. The experiment was a Factorial in Randomized Complete Block Design (RCBD) factorial with three replications. The genotypes of the sweetpotato were EX-IGBARIAM, KING J and MOTHERS DELIGHT and the fertilize rates were 0kg/ha., 200kg/ha., 400kg/ha and 600kg/ha. The 12 plots were replicated three times which gave a total of 36 plots, each plot measured 2m x 3m and comprised 4 ridges. Five plants were tagged and data were collected on them. The sweetpotato vines were 25cm long and had at least 4 nodes. The seed vines were inserted in which two nodes were inside the soil and the remaining two nodes were above the soil. It was planted 1m between the ridges and 0.3m apart along the row on the ridges. Fertilizer application (NPK 15:15:15) was done at 4WAP at different rates. The seed vines were treated with Decis EC 12 by dipping and spread under shade for one hour before planting. It was treated so that pest will not attack it most especially termites and weevils. Weeding was done manually three times using Indian hoe. Cross bars were constructed to control erosion. Data were collected on the following growth parameters: vine length, number of leaves per plant at 4, 6, 8 and 10 WAP. Data were analyzed using Genstat Statistical package version 9. Comparison of treatment means for significance was done by the use of least significant difference (LSD) at the probability level of 0.05.

RESULTS AND DISCUSSION

The soil of the study area was texturally sandy clay loam (Table 1.0). The soil was high in Nitrogen (0.29%) but low in organic matter content. Vine length was significantly enhanced at 200kg/ha of Mothers Delight and EX-Igbariam at 8WAP than King-J at 400kg/ha (Table 2.0). On the other hand, at 10WAP, EX-Igbariam gave the highest vine length at 400 kg/ha. (Table 3.0). At 8WAP, fertilizer rate of 200kg/ha gave the highest number of leaves in EX-Igbariam (Table 4.0). At 10WAP, fertilizer rate of 400kg/ha gave the highest number of leaves at treatment EX-Igbariam (Table 5.0). King J had the highest biomass at fertilizer rate 600kg/ha followed by EX-Igbariam at the fertilizer rate of 400kg/ha (Table 6.0).

CONCLUSION

To produce more vine length and number of leaves, application of fertilizer at the rate of 200kg/ha is recommended for Mothers Delight and EX-Igbariam.

REFERENCES

Asa, Adedoyin, Ayobami; Ezelobe, Courage, Afegheze; Ajisola, Judge K. (2021).Growth and Yield Response of Sweet Potato (Ipomoea batatas) to Organic and Inorganic Fertilizer on Degraded Soil of Southern Guinea Savanna of Nigeria. *International Journal of Environment, Agriculture and Biotechnology* Vol-6, Issue-5; Sep-Oct, 2021.

Odebode, S. O., (2004). Acceptability of Sweetpotato "sparri" and its potentials for enhancing food security and economic empowerment of rural women in Southwestern Nigeria. The Nigerian Journal of 307 Promotion of Sweetpotato for the Food Industry in Nigeria Rural Sociology, No.s 1&2: 104-112.

Okpara, D.A., Njoku, J.C. and Asiegbu, J.E., (2000). Responses of two sweet potato varieties to four green manure sources and inorganic fertilizer in a humid tropical ultisol. Biological agriculture and horticulture, 22: 81-90.

Osundare, Niyi. (2004). Effect of fertilizer types and varying population on the performance of cocoyam. DOI: 10.4314/mjar.v5i2.31804

Table 1: Some physicochemical properties of soil for the experiment.

	Properties
	Physical properties
Sand (%)	76.0
Silt (%)	12.0
Clay (%)	12.0
Texture	Sandy Clay Loam
	Chemical properties
pH (in H_2O)	5.46
N (%)	0.29
OC (%)	0.65
OM (%)	1.12
pH ($CaCl_2$)	5.10
Acidity (Al^{3+})	1.97
Acidity (H^+)	0.90
P (ppm)	27.44

Sources: Soil Science Laboratory, Department of Soil Science and Land Resources Management, Obafemi Awolowo University, Ile Ife, Osun State.

Table 2: Effect of fertilizer rate on vine length (cm) of Sweetpotato planting material at 8WAP

Fertilizer rate (kg/ha)	Treatments	8 WAP		Mean
	Ex-Igbariam	King-J	Mothers Delight	
0	133.3	91.1	181.2	135.2
200	176.3	91.2	256.1	174.5
400	160.8	100.9	216.2	159.3
600	155.9	98.3	195.8	150.0
Mean	156.6	95.4	283.1	

LSD ($_{0.05}$) for fertilizer rate (F) means = 32.59

Table 3: Effect of fertilizer rate on vine length (cm) of Sweetpotato planting material at 10WAP

	10 WAP			
Fertilizer rate (kg/ha)	**Treatments**			**Mean**
	Ex- Igbariam	King-J	Mothers Delight	
0	181.5	105.5	251.0	179.33
200	234.9	107.4	322.8	221.7
400	263.5	123.9	324.5	237.3
600	259.4	140.0	308.1	235.8
Mean	234.8	119.2	301.6	

LSD ($_{0.05}$) for fertilizer rate (F) means = 82.79

Table 4: Effect of fertilizer rate on number of leaves of Sweetpotato planting material at 8 WAP

		8WAP		
Fertilizer rate (kg/ha)	**Treatments**			**Mean**
	Ex- Igbariam	**King-J**	**Mothers Delight**	
0	176.1	168.2	118.1	**154.1**
200	235.2	162.6	259.1	**218.9**
400	230.3	221.7	178.7	**210.2**
600	212.9	150.9	137.0	**166.9**
Mean	**213.6**	**175.9**	**173.2**	

LSD ($_{0.05}$) for fertilizer rate (F) means = 66.59

Table 5: Effect of fertilizer rate on number of leaves of Sweetpotato planting material at 10 WAP

		10 WAP		
Fertilizer rate (kg/ha)	**Treatments**			**Mean**
	Ex- Igbariam	**King-J**	**Mothers Delight**	
0	289.0	181.0	272.0	**247.0**
200	266.0	253.0	439.0	**319.0**
400	597.0	401.0	307.0	**435.0**
600	508.0	371.0	274.0	**384.0**
Mean	**415.0**	**301.5**	**323.0**	

LSD ($_{0.05}$) for fertilizer rate (F) means = 103.1

Table 6: Effect of fertilizer rate on the biomass (t/ha) of Sweetpotato planting material.

		Biomass		
Fertilizer rate (kg/ha)	**Treatments**			**Mean**
	Ex- Igbariam	**King-J**	**Mothers Delight**	
0	13.80	12.00	7.60	**11.13**
200	9.47	16.33	5.67	**10.49**
400	19.33	18.73	9.67	**15.91**
600	18.00	22.00	10.33	**16.78**
Mean	**15.15**	**17.27**	**8.32**	

LSD ($_{0.05}$) for fertilizer rate (F) means = 4.79

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Serum Chemistry of Weaned Rabbits Fed Graded Levels of Maggot Meal as a Replacement for Soybean Meal

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Abstract
This study investigated the effect of replacing soybean meal (SBM) with maggot meal (MM) in growing rabbit diets on the serum indices. Sixty unsexed mixed breeds (New Zealand White x California) rabbits were allotted on a weight equalization basis into five dietary treatments, where the control diet (soybean meal-based) has no MM (MM0) while other diets contain 25% (MM25), 50% (MM50), 75% (MM75) and 100% (MM100) MM as replacement for soybean meal. Each treatment comprises four replicates having three rabbits each (12 rabbits per treatment) and the feeding trial lasted for 56 days. Feed and water were offered to the rabbits' ad-libitum throughout the experimental period. Blood collection for the determination of serum was done on the 56th day. All data obtained were subjected to one-way analysis of variance SAS 2000 and significant means were separated using Duncan multiple range test. The feeding of MM100 diet to rabbits resulted in the highest (P<0.05) total protein. The albumin and creatinine were however not significantly (p>0.05) different. The cholesterol of MM0 and MM100 were significantly (p<0.05) similarly influenced by varying replacement levels of MM in the diet of rabbits. Urea value was least in MM0 which had the highest glucose value. In conclusion, the replacement of soybean meal with MM in the diet of rabbits up to 100% did not have any deleterious effect on the serum parameters as well as the health status of the rabbits.
Keywords: Serum, Maggot meal, California breed, Creatinine, Glucose

INTRODUCTION
The consumption of rabbit meat is continually gaining credence lately sequel to the health implication associated with the intake of chicken, pork, premium beef and other red meat (Ajani *et al*., 2020) The preference for it amongst other meat without a commensurate increase in its production has hiked its cost price. Rabbit feeding can be adjusted to suit the ever-advancing cost of feed ingredients globally. Rabbit tolerance too to many feed ingredients has made it to utilize agricultural and industrial waste especially those that are not of high competition for livestock and humans (Mafimidiwo *et al.,* 2022). The increased over dependence of monogastric animal on soybean meal as the most prominent protein source has not helped the situation at curtailing the market price. The resultant effect is the unbearable increase in the price of feed. It therefore become obvious that alternatives sources of protein such as maggot meal needed to be explored. Maggot meal produced from black fly (*Hermetia illucens*) have

been reported to have similar nutrient composition as soybean meal and it is easily digestible by livestock (Baker *et al*., 2021). No health hazard has been attributed to its incorporation in livestock feed (Dillak *et al*., 2019). The ease of production and it's readily availability has made its usage encouraging. Meanwhile, further proof of its suitability can be made through the serum indices. Therefore, this research work replaces soybean meal with maggot meal in the diet of growing rabbits to determine its effect on the serum parameters.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Teaching and Research Farm of the Department of Agricultural Technology, Yaba College of Technology, Epe along Lagos-Ijebu-ode road, Lagos State. The farm is located on latitude 3.58^o E and longitude 6.47^{o}N (Google Earth, 2023). It lies in the low land rain forest zone within the agro-ecological zones of Southern Nigeria.

Experimental diet formulation

The feed ingredients were sourced from a reputable feed milling industry at Ilara area of Epe Lagos and conveyed to the Teaching and Research Farm of Yaba College of Technology, Epe Campus. The diets were formulated for the grower rabbits (NRC 2012) where soybean meal was replaced at 0, 25, 50, 75 and 100% with maggot meal (Table 1).

Experimental animal management

A total of sixty unsexed (New Zealand white x California breed) grower rabbits of about 758-760.50g body weight was procured from a reputable farm in Ibadan. The rabbits were subjected to endo and ecto-parasites treatment using Ivomec ® at 1ml/50kg bodyweight and was allowed to be stabilized for seven days during which formulated diets were provided to the animals daily and water were offered liberally. The fifteen hutches were all washed and disinfected before the arrival of the experimental animals. The hutches raised at 90cm above the floor were arranged in an open sided house to allow good ventilation. The rabbits were housed three per hutch with a concrete feeder and a drinker per hutch.

Experimental animals and design

The rabbits were allotted randomly on weight equalization basis after stabilization into five dietary treatments. Twelve rabbits were allotted per treatments having four replicates with three rabbits per replicate in a completely randomized design. They were fed for eight weeks. At the end of the 8th week of the trial, four rabbits per treatment were selected and bled from the external ear vein using a 2ml sterilized disposable syringe into labeled plain sample bottles (without anti-coagulant). Prior to bleeding, a cotton swab soaked in 70% ethanol was used to dilate the vein and to prevent infection. The samples were taken to the laboratory and was used to determine the serum biochemical components. (Table 2).

Table 1: Showing Nutrients and composition of Experimental diets. (100g/Kg DM)

Ingredients (Kg)	Diet 1 (MM0)	Diet 2 (MM25)	Diet 3 (MM50)	Diet 4 (MM75)	Diet 5 (MM100)
Maize	44.00	44.00	44.00	44.00	44.00
Maggot meal	0.00	6.75	13.50	20.25	27.00
Soybean meal	27.00	20.25	13.50	6.75	0.00
Wheat offal	20.00	20.00	20.00	20.00	20.00
Fish (72%)	1.33	1.33	1.33	1.33	1.33
Bone meal	2.50	2.50	2.50	2.50	2.50
Limestone	2.50	2.50	2.50	2.50	2.50
Premix*	0.05	0.05	0.05	0.05	0.05
Salt (Nacl)	0.50	0.50	0.50	0. 50	0.50
Lysine	0.05	0.05	0.05	0.05	0.05
Methionine	0.07	0.07	0.07	0.07	0.07
Molasses	2.00	2.00	2.00	2.00	2.00
Total	**100**	**100**	**100**	**100**	**100**
Calculated analysis					
Metabolizable Energy (kg/kcal)	2538	2553	2570	2584	2596
Crude protein (%)	20.92	20.83	20.74	20.66	20.57
Crude fibre (%)	4.66	4.54	4.47	4.39	4.31
Ether extract	2.83	2.85	2.97	3.21	3.32
Ash	5.21	5.10	4.90	4.89	4.78

*Each 1 kg vitamin and mineral premix provides the following per kg diet: Vit. A 12000000 IU, Vit. D3 750000 IU, Vit. E 10000 mg, Vit. K 2000 mg, Vit B1 1000 mg, vit B2 4000 mg, Vit. B6 1500 mg, Vit B1210 mg, Pantothenic acid 10000 mg, Niacin 20000 mg, Biotine 50 mg, Folic acid 1000 mg, Choline chloride 500mg, selenium 100mg, Manganese 55 gm, Zinc 50 gm, Fe 60 gm, CU 2.5 gm, CO 6 mg and Iodine 1gm. MM0= without maggot meal (Control), MM25= 25% maggot meal, MM50= 50% maggot meal, MM75= 75% maggot meal, MM100= 100% maggot meal, [a] = calculated using the Pauzenga equation: ME= (37 × CP % + 81.8 × CF % + 35.5 × NFE %) (24)

Table 3: Serum chemistry of Grower rabbits fed with diets containing graded levels of maggot meal as replacement for soybean meal.

Parameters	MM0	MM25	MM50	MM75	MM100	SEM	P-value	Normal range¶
Total Protein (g/dl)	6.55^{c}	8.15^{b}	8.80^{b}	8.05^{b}	11.60^{a}	0.49	0.001	5.40-7.50
Albumin (g/dl)	4.95	4.70	5.05	4.85	4.90	0.05	0.321	2.70-5.00
Globulin (g/dl)	2.60^{8}	3.45^{b}	3.75^{b}	3.20^{b}	6.70^{a}	0.48	0.000	1.50-2.70
Creatinine (mmol/l)	1.68	2.01	0.99	1.67	1.39	0.14	0.206	0.56-4.44
Glucose (mg/dl)	131.65^{a}	101.80^{bc}	115.75^{ab}	102.25^{bc}	88.20^{c}	4.49	0.003	75.00 - 155.00
Cholesterol (mg/dl)	94.85^{a}	73.65^{b}	74.25^{b}	80.85^{ab}	78.80^{b}	6.59	0.004	10.00 - 80.00
Urea (mg/dl)	22.85^{b}	32.35^{ab}	33.40^{ab}	43.75^{a}	33.90^{ab}	3.46	0.038	20.00 - 45.00

[ab]Means within a row with different superscripts differ (P<0.05)
MM0= without maggot meal (Control), MM25= 25% maggot meal, MM50= 50% maggot meal, MM75= 75% maggot meal, MM100= 100% maggot meal. SEM = Standard error of mean ¶=Melillo (2007)

RESULT AND DISCUSSION

The result of serum parameters of grower rabbits fed diets with varying replacement level of MM for soybean meal shows that rabbits fed MM100 diet had the highest total protein while those fed MM0 (control) diet had the lowest total protein. The increased total protein observed could be due partly to the high protein content of MM and partly due to level of inclusion. This may also imply that there was increased nutrient utilization especially protein that promote growth and development. Report of Awosanya *et a*l. (1999) reveal that the quantity and quality of dietary protein has direct influence on the blood protein. The report of this study is contrary to the report of Hong *et al.* (2020) who observed no influence of MM (*Musa domestica*) inclusion at 5% level of replacement for white fish meal on total protein of growing beagles. Shah (2020) also reported no significant effect of MM (*Musa domestica*) inclusion up to 100% as replacement for soybean meal in the diet of leghorn layers on serum total protein. Mat *et al*. (2022) reported a reduced total protein for broilers fed diet containing 12% defatted black soldier fly larvae meal (BSFLM). The difference in these reports could be attributed to differences in the source of MM used and processing techniques. The highest serum globulin was observed with incorporation of MM100 while those fed diet without MM had the lowest globulin content. The total serum protein and globulin of rabbits fed MM100 diet was higher than the upper limit of the normal range reported by Melillo (2007) which is an indication of high amount of protein in the blood stream of the rabbits and invariably increase the nitrogen excretion. The serum glucose content was highest for rabbits fed MM0 diet and those fed MM100 diet had lowest serum glucose. The increased glucose observed implies higher energy content of the diet. The values obtained for other treatments were within the normal range. Increased cholesterol was observed in rabbits fed MM0 diet while those fed MM25, MM50 and MM100 diets had reduced serum cholesterol.

The reduced cholesterol observed for the groups of rabbits fed diet containing MM suggests that despite the high ether extract content of MM, it did not result into increased blood cholesterol and were within the normal range reported by Melillo (2007). The glucose and cholesterol levels which were within the normal range with the inclusion of MM is an indication that abnormal conditions like diabetes, liver malfunction and under or over absorption of fat that are symptoms of abnormal glucose and cholesterol levels in the blood did not occur (Bush, 1991). Urea content increased for rabbits fed MM75 diet when compared to those on MM0 diet. The reduction in urea of rabbits on MM0 could be attributed to the increased nitrogen content of the diet. Blood urea reduction has been implicated in diseased liver or poor protein intake (Bush, 1991). The increased urea with the use of MM could be linked to the MM inclusion that has higher crude protein. Although, the values across treatments were within the normal values and this clarifies that there is no existence of ill-health status of the rabbits. The albumin content was not significantly influenced by inclusion of MM in the diet of rabbits, but the values observed were within the reference values even with 100% dietary replacement of soybean meal with MM. This observation suggests nutrient adequacy of the diets and specifically the dietary protein. Onifade and Tewe (1993) stated that when normal protein utilization is altered, it results in abnormal serum albumin. The serum creatinine was also similar across treatments and the values were within the normal range which suggests absence of muscle wasting and this implies that the rabbits were not surviving at the expense of their body reserves (Njidda and Isidahomen, 2010).

REFERENCES

Ajani, J.O., Oyekan, O.O., Udagbe, O.M., Ogundimu, O.A and Oyewole, O.O. 2020. Prolificacy and fecundity studies among selected breeds of rabbits (Oryctolagus cunniculus) Linnaeus. International *Journal of Animal Health and Livestock Production Research.* 4(1):55-70.

Awosanya, B., Joseph, J. R., Apata, D. F. and Agboola, M. A. (1999). Performance, blood chemistry and carcass quality attributes of rabbits fed raw and processed *Puerari*a seed meal. *Tropical Journal of Animal Science*, 2 (2): 89–96.

Baker, K. M., Utterback, P. L., Parsons, C. M. and Stein, H. H. (2011). Nutritional value of soybean meal produced from conventional, high-protein, or low-oligosaccharide varieties of soybeans and fed to broiler chicks. *Poultry Science*, 90:390-395.

Bush, B. M. (1991). Interpretation of Laboratory Results for Small Animal Clinicians. Blackwell Scientific Publications. London, UK, pp: 32–67.

Dillak, S. Y. F. G., Suryatni, N. P. F., Handayani, H. T., Temu, S. T., Nastiti, H. P., Osa, D. B., Ginting, R. Y. and Henuk, Y. I. (2019). The effect of fed maggot meal as a supplement in the commercial diets on the performance of finisher broiler chickens. *IOP conference series. Earth and Environmental Science,* 260: 012056.

Duncan, D. B. (1955). Multiple Range and Multiple F-Test. Biometrics, 11: 1-5

Hong, Y., Zhou, J., Yuan, M., Dong, H., Cheng, G., Wang, Y., Xia, J. and Zhang, L. (2020). Dietary supplementation with housefly *(Musca domestica)* maggot meal in growing beagles: hematology, serum biochemistry, immune responses and oxidative damage. *Annals of Animal Science*, 20(4): 1351–1364. DOI: 10.2478/aoas-2020-0045

Mafimidiwo, A.N., Williams, G.A., Mafimidiwo, Z.T., Njoku, C.P and Sobayo, R.A. (2022). Growth performance, nutrient digestibility and Carcass characteristics of growing rabbits fed varying levels of Urea-molasses treated maize cob as a replacement for wheat offal. Nigerian Journal of Animal Production, 49 (3): 129-139

Mat, K., Kari, Z. A., Rusli, N. D., Rahman, M. M., Harun, H. C., Al-Amsyar, S. M., Nor, M. F. M., Dawood, M. A. O. and Hassan, A. M. (2022). Effects of the inclusion of black soldier fly larvae (*Hermetia illucens*) meal on growth performance and blood plasma constituents in broiler chicken (*Gallus gallus domesticus*) production*. Saudi Journal of Biological Sciences,* 29: 809–815. https://doi.org/10.1016/j.sjbs.2021.10.027

Melillo, A. (2007). Rabbit Clinical Pathology. *Journal of Exotic Pet Medicine*, 16 (3):135-145. doi: 10.1053/j.jepm.2007.06.002. Epub 2007 Sep 18. PMID: 32362792; PMCID: PMC7185592.

Njidda, A. A. and Isidahomen C. E. (2010). Haematology, blood chemistry and carcass characteristics of growing rabbits fed grasshopper meal as a substitute for fish meal. *Pakistan Veterinary Journal*, 30: 7–12. http://www.pvj.com.pk/pdffiles/30_1/7-12.pdf?q=the-science-ofal

Onifade, A. A. and Tewe, O. O. (1993). Alternative tropical energy feed performance in rabbit diets: growth performance, diets digestibility and blood composition. *World Rabbits Science*, 1:17–24.

Shah, Z. (2020). Effect of replacing soybean meal with maggot meal on the production performance and egg quality traits of commercial white leg horn layers. *Journal of Dairy, Veterinary and Animal Research,* 9(6):166-170

Statistical Analysis System. (2009). SAS/STAT User's Guide 9.2,2 ed. Inst. Inc. Cary NC, USA. 33.

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Impact of Agricultural Credit on Women Cottage Industries in Kura Local Government Area of Kano State

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Abstract
Adequate availability of credit on time is an important requirement for the investors, particularly under conditions of scarcity of resources and uncertainty. Convenient and safes-saving facilities are perhaps even more important to smooth out the peaks and troughs in incomes and expenditures. This study assesses the impact of agricultural credit on women cottage industries in Kura Local Government, Kano State. The study employed both primary and secondary method of data collection with 60 selected women cottage industries in Kura Local Government. The study employed survey approach through cross sectional design as method used in data collection. Five points likert scale questionnaire ranging from strongly disagree to strongly agree together with Statistical Package for Social Sciences (Version 21) was used to analyze the data. The findings of the study revealed bank's agricultural credit has been established one of the basic human rights access to credit. The overwhelming success of the bank has brought a positive change in the loan default attitude among the borrowers and the society. The study recommends that farmers should be encouraged to be applying for loans from the participating banks to enhance their agricultural activities and productivity; and also to repay the loans as and at when due. Thus enough sensitization exercise must be carried out to local areas where majority of farmers need the funds and financial institutions should recruit young, energetic graduates with excellent academic background. They then should be trained by the bank's training institution as per recruitment for serving the rural poor. However, they should increase their recruitment and training budgets for this purpose.

INTRODUCTION

In Kano most of the women agricultural credits are the small-scale loans for the poor entrepreneurs. It allows them to access in the lending institutions to borrow fund and start their own business. Several financial institutions developed several strategies, including provision of small loans to the rural poor without collateral. These loans are repayable in predetermined installments. Borrowers are organized into groups, which reduces the risk of being default. These credits also help disseminating valuable information about the borrowers and their living standards (Adegeye and Dittoh, 1985). Adequate availability of credit on time is an important requirement for the investors, particularly under conditions In Kano most of the agricultural credits are the small-scale loans for the poor entrepreneurs. It allows them to access in the lending institutions to borrow fund and start their own business (Ijaiya and Abdulraheem, 2000). Adequate availability of credit on time is an important requirement for the investors, particularly under conditions of scarcity of resources and uncertainty. Convenient and safes-saving facilities are perhaps even more important to smooth out the peaks and troughs in incomes and expenditures. Lack of savings facilities also force families to rely on inefficient, inconvenient and costly alternatives. Agricultural credit is a solution for this perspective (Singh, Squire and Strauss, 1986). According to Garba (1987), in Kano mainly commercial banks are currently burdened with classified loans. But the collateral free financing offers a new opportunity to invest their funds with little risk. Previous experiences of financial institution show that small credits have proven feasible of lending to the poor for rural development. Therefore, we can say that if they can engage themselves efficiently, agricultural credit will accelerate the development of rural activities in Kano state (Lawal, 1997). Macroeconomic policies that tend to promote growth of the sector, such as credit-channeling financial policies, price stabilizing monetary and exchange rate policies, and farm incentive laden fiscal policies including tax exemptions for agricultural businesses, duty-free import of farm machinery, etc (Castle, 1987). Nigerian agricultural policy provides, among others, for adequate financing of agriculture.

The role of finance in agriculture, just like in the industrial and service sectors, cannot be over-emphasized, given that it is the oil that lubricates production. Public expenditure on agriculture has, however, been shown not to be substantial enough to meet the objective of the Government agricultural policies (IFPRI, 2008). For a developing country with a mono-product oil economy such as Nigeria's, inadequate financing of agriculture portends great danger for many reasons. For one, fluctuating food prices are a precursor of inflation. Secondly, from the expenditure approach to national income accounting, it is likely that Engel's Law that a large chunk of expenditure in developing economies goes to food holds, meaning that shocks to the domestic agricultural production and supply could be damaging to price stability. There is also the perspective of food security, in an era when food has been used as a weapon of war (United Nations Oil for Food Deal in Iraq) and as bargaining tool (North Korea – United States food deal) , even within Nigeria, the Federal military Government during the Nigeria – Biafra war used food blockade as tool of war.

The objective of agricultural financing policies in Nigeria is to establish an effective system of sustainable agricultural financing schemes, programmes and institutions that could provide micro and macro credit facilities for the micro, small, medium and large scale producers, processors and marketers. Agriculture includes crop production, fisheries, forestry, livestock, etc. Credit is the ability to participate in the production/development process. It is a device of that facilitates purchasing power. According to Ekezie (1997), in Nigeria, mostly Agricultural Credit is the extension of small loans to the entrepreneurs through financial or non-financial institutions. Agricultural Credit has been used as a facilitator in many other community development activities, used as an entry point in a community organizing program or as an ingredient in a larger education/training exercise. Somebody uses the term "micro credit" to mean agricultural credit, or rural credit, or cooperative credit, or consumer credit, credit from the savings and loan associations, or from credit unions, or from money lenders (Fasipe, 1990).

The agricultural sector in Nigeria was a major source of foreign revenue prior to the discovery of oil in commercial quantity. Then Nigeria was reckoned with the production and export of ground-nut, cocoa, rubber and other agricultural crops in Nigeria. The discovery of oil at large scale exploration in the 1970s turned the tide against the agricultural sector in favour of the oil sector. For instance, as at 2000, oil and gas exploration accounted for more than 98% of export earnings and about 83% of federal government revenue (Export Import Bank, 2009). The oil sector also accounted for more than 40% of the gross domestic product (GDP) in Nigeria and about 95% of the foreign exchange earnings. Despite this seemingly high revenue from the oil sector, the paradox of it that over 70% of the Nigerian population is engaged either in the informal sector or in agricultural production (Olaitan, 2006). Agricultural development is a process that involves adoption by farmers (particularly small farmers) of new and better practices (Garba, 1987; Orebiyi, 1999). This is due to the fact that most of the new practices have to be purchased but few farmers have the financial resources to finance it. It was in recognition of this fact that the Federal Government at various periods put in place credit policies and established credit institutions and schemes that could facilitate the flow of agricultural credit to farmers. (Adegeye and Dittoh, 1985). The objective of this study is to examine the impact of agricultural credit on women cottage industries in Kura local government area of Kano state.

METHODOLOGY

The study used descriptive statistics. Cross sectional was used because the data was collected at once due to its advantages over other designs in terms of cost saving, less time taken, accuracy of the data and more convenience, the population selected in this study of this study comprises of selected women farmers in Kura local government. The study used convenience sampling technique, where the researcher selected women cottage industries in Kura local government of Kano state conveniently. The researcher selected the required sample size of 45 women cottage industries to represent the sample size for the study. In analyzing the data to be generated through questionnaire to be administered, statistical package for social science (SPSS) will be used in analyzing the data collected. Therefore, data collected will be analyzed through correlation and regression.

RESULTS AND DISCUSSION

Table 1 illustrates the gender distribution of the respondents which shows that all the respondents (45) representing 100% are female. However, this shows that women of cottage industries in Kura local government area of Kano state are the respondents used for this study. The table above also indicate the age of the respondents in which out of the 45 respondents, 7 respondents representing 15.56% are below 25yrs, 14 respondents representing 31.11% are between 25 – 35 years, 19 respondents representing 42.22% are within the bracket age of 35 – 50 years, while the remaining 5 respondents representing 11.11% falls within the age bracket of over 50years. The table above also revealed the academic qualifications of the respondents in which 31 respondents constituting 68.89% are GCE/WASCE holders, 11 of the respondents representing 24.44% are OND/NCE holders, while the remaining 3 respondents representing 6.67% are HND/B.Sc holders. This shows that majority of Women Cottage Industries in Kura Local Government area of Kano state are GCE/WASCE holders. Finally, with regards to marital status of the respondents, 29 respondents constituting 64.44% are married, 12 respondents which constitutes 26.67% are single, while the remaining 4 respondents representing 8.88% are divorced. Besides, another device for finding Multicollinearity is to look at the variance inflation factor (VIF) and tolerance value. Hair (2010) asserted that any VIF exceeding 10 and tolerance value lower than 0.10 indicates a problem of Multicollinearity. Therefore, in this study results proved absence of Multicollinearity as presented in table 2. Multiple regression analysis provides an avenue of neutrality of assessing the degree and character between independent variables and dependent variable (Sekaran & Bougie, 2010; Hair, Money, Samoel & Page, 2007; Field, 2009). The regression coefficient use to show the relative importance of each of the independent variables in the prediction of the dependent variable. If the independent variables are collectively regressed against the dependent variable to explain the variance in it, the size of each regression coefficient will show how much an increase in one unit in the independent variable would affect the dependent variable taking into consideration all other variable inserted into multiples coefficient (Sekaran & Bougie, 2010; Zikmund; 2010).

Therefore, to examine a survey on the impact of agricultural credit on women cottage industries in Kura Local Government area of Kano state, the present study conducted a regression analysis. Three (3) predicting variables including Agricultural Credit (AC), Growth of Agricultural Credit (GAC) and Financial Institutions (FI) were examine to see their impact on women cottage industries, table 4.6 present regression analysis of the variables under study.

Table 1: Descriptive Profile of the Respondents

Demographic Variables	Category	Frequency	Percentage (%)
	Male	-	-
Gender	Female	45	100%
Academic Qualification	GCE/WASCE	31	68.89%
	OND/NCE	11	24.44%
	HND/B.Sc	3	6.67%
	MBA/M.Sc/MA	-	-
Age Group	Less than 25yrs	7	15.56%
	Between 25–35yrs	14	31.11%
	35 – 50yrs	19	42.22%
	Above 50yrs	5	11.11%
Marital Status	Married	29	64.44%
	Single	12	26.67%
	Divorced	4	8.88%

Source: Field Survey 2018, Generated from SPSS Version 21

Table 2: Summary of Reliability Test

Variables	Number of Items	Cronbach Alpha
Agricultural Credit	5	0.856
Growth of Agricultural Credit	5	0.803
Financial Institutions	5	0.768
Women Cottage Industries	5	0.729

Source: Generated from SPSS Version, 21

Table 3 Correlation Matrix

		Agricultural Credit	Growth of Agricultural Credit	Financial Institutions	Women Cottage Industries
Agricultural Credit	Pearson Correlation	1			
Growth of Agricultural Credit	Pearson Correlation	.295	1		
Financial Institutions	Pearson Correlation	.233	.765	1	
Women Cottage Industries	Pearson Correlation Pearson	.874	.453	.342	1

Source: Generated from SPSS Version, 21

REFERENCES

Adegeye, A. J. and Dittoh, J.S. (1985), ''Essentials of Agricultural Economics'' A publication of *Centre for Agricultural and Rural Development*, Ibadan

Garba, I. G. (1987), ''Credit and finance for Agriculture in Nigeria'' *CBN Bullion,* Vol. 11

Ijaiya G.T. and Abdulraheem A. (2000), ''Commercial Banks Credits to the Agricultural Sector and Poverty Reduction in Nigeria: A Calibration Analysis'' *Nigerian Journal of Agricbiz and Rural Development*, University of Uyo, Uyo, vol.1 No.1

Fasipe, A. (1990), *Nigeria's External Debt*, Ile-Ife: Obafemi Awolowo University Press

Falusi, A.O. (1995), "An Overview of Nigeria's Rural Economy: Status, Problems and Potentials" *NCEMA workshop Paper*, August, Ibadan

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Redirecting the Nigerian Agricultural Extension System to a Market-Oriented Model: An Overview of the JICA SHEP Nigeria Project

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Abstract

Agricultural extension systems have historically focused on increasing production without sufficient attention to market demand, resulting in inefficiencies and low farmer incomes. However, with the realization that market-oriented approaches can enhance agricultural productivity, income, and sustainability, there has been a shift toward market-oriented extension systems in many developing countries. This study examines the potential of redirecting Nigeria's agricultural extension system towards a market-oriented model using the Japan International Cooperation Agency's (JICA) Smallholder Horticulture Empowerment & Promotion (SHEP) approach. By integrating market-driven strategies, this approach aims to enhance farmers' productivity and income. The "Smallholder Horticulture Empowerment and Promotion" (SHEP) approach, developed in Kenya and now piloted in Nigeria, aims to address these challenges by transforming the extension system into a market-oriented model. This manuscript provides an overview of the SHEP Nigeria Project, its objectives, methodologies, and outcomes. It explores how the project has facilitated the transition from a production-driven to a market-oriented extension system, focusing on empowering smallholder farmers to align production with market needs, thereby enhancing their livelihoods. It also discusses the challenges and opportunities associated with such a transition and provides policy recommendations for scaling up market-oriented agricultural extension services in Nigeria.

INTRODUCTION

Agriculture in Nigeria is a significant sector, employing over 70% of the population and contributing substantially to the GDP. Despite its importance, the sector faces numerous challenges, including low productivity, poor market access, and insufficient extension services. Agricultural extension services play a crucial role in enhancing agricultural productivity, rural development, and food security by providing farmers with access to information, new technologies, and improved farming practices (Anderson & Feder, 2004). In Nigeria, the extension system has traditionally been production-driven, focusing on increasing crop yields without adequately considering market demand, value addition, and farmer income. This approach has often led to market gluts, low prices, and post-harvest losses, resulting in limited economic benefits for smallholder farmers (Adofu & Shaibu, 2013).

In recent years, there has been a paradigm shift from production-driven to market-oriented agricultural extension systems, which prioritize market demand, profitability, and sustainability (Kahan, 2013). This shift is aimed at empowering farmers to produce marketable produce, identify and access markets, and enhance their income and livelihoods. The SHEP Nigeria project, modelled after the successful SHEP approach in Kenya, aims to transform Nigeria's extension system by promoting a market-oriented approach that links farmers to markets and enhances their entrepreneurial skills (FAO, 2017). This paper investigates how this model can be applied to redirect Nigeria's agricultural extension system towards a market-oriented approach.

Production-Driven vs. Market-Oriented Agricultural Extension Systems

Traditional agricultural extension systems in developing countries, including Nigeria, have primarily focused on increasing agricultural production and yields (Anderson, Feder & Ganguly, 2006). These systems often employ a top-down approach where extension agents disseminate technical information and inputs to farmers, focusing on improving crop and livestock production without considering market demand or profitability (Davis, 2008). As a result, many farmers face challenges such as market gluts, low prices, and post-harvest losses.

On the other hand, market-oriented agricultural extension systems focus on developing farmers' capacity to understand and respond to market demands, thereby enhancing their income and livelihoods (Kahan, 2013). This approach involves training farmers on agribusiness skills, market analysis, value chain development, and entrepreneurship, enabling them to make informed decisions on what to produce, how to produce it, and when and where to sell their products (Schut et al., 2016).

The SHEP Approach

The Smallholder Horticulture Empowerment and Promotion (SHEP) approach, initially developed in Kenya, represents a paradigm shift in agricultural extension by focusing on market-oriented agriculture (JICA, 2014). The SHEP approach empowers farmers to identify market opportunities, develop agribusiness plans, and improve their production and marketing skills. It emphasizes the importance of market surveys, demand-driven production, and collective marketing (JICA, 2014).

Overview of the SHEP Nigeria Project

Objectives and Components

The SHEP Nigeria project, initiated by the Federal Ministry of Agriculture and Rural Development (FMARD) in collaboration with the Japan International Cooperation Agency (JICA), aims to transform the country's agricultural extension system from being production-driven to market-oriented. The project's main objectives include:

1. Empowering smallholder farmers to adopt market-oriented agriculture.
2. Enhancing farmers' capacity to conduct market surveys and develop agribusiness plans.
3. Promoting demand-driven production and collective marketing.
4. Improving farmers' access to extension services, inputs, and markets (FMARD & JICA, 2020).

METHODOLOGY AND IMPLEMENTATION

The SHEP Nigeria project employs a participatory approach, involving farmers, extension agents, and other stakeholders in the planning, implementation, and monitoring of project activities. The key components of the project include:

- Market Surveys and Farmer Empowerment: Farmers are trained to conduct market surveys to understand market demand, price trends, and buyer preferences. This enables them to make informed decisions on crop selection, production planning, and marketing (FMARD & JICA, 2020).

- Capacity Building and Training: The project provides training on agribusiness skills, value chain development, and entrepreneurship to farmers and extension agents. This helps farmers to develop business-oriented mindsets and improve their negotiation skills and access to markets (JICA, 2014).
- Demand-Driven Production and Collective Marketing: The project promotes demand-driven production practices and collective marketing approaches, where farmers pool their produce to access larger and more profitable markets (FMARD & JICA, 2020).

Outcomes and Impacts

The SHEP Nigeria project has achieved significant outcomes in terms of enhancing farmers' income, improving market access, and promoting sustainable agricultural practices. Key achievements of the project include:

- Increased farmer income by adopting market-oriented production and marketing strategies.
- Improved access to extension services, inputs, and markets through capacity building and training.
- Strengthened farmer organizations and cooperatives for collective marketing and bargaining power (FMARD & JICA, 2020).

Benefits, Challenges and Opportunities

Benefits

The SHEP approach addresses several challenges in Nigeria's agricultural sector by aligning production with market demands. This market-oriented strategy increases productivity, reduces post-harvest losses, and boosts farmers' incomes. The approach also empowers farmers with essential business skills, enabling them to navigate market dynamics effectively.

Challenges

The shift from a production-driven to a market-oriented agricultural extension system in Nigeria is not without challenges. Some of the key challenges include:

- Limited Market Access and Infrastructure: Poor Road networks, lack of storage facilities, and limited access to markets remain significant barriers to market-oriented agriculture (Adofu & Shaibu, 2013).
- Capacity Constraints: Inadequate training and capacity-building initiatives for extension agents and farmers can hinder the effective implementation of market-oriented extension approaches (Davis, 2008).
- Policy and Institutional Gaps: Inconsistent policies, weak institutional frameworks, and limited government support can impede the scaling up of market-oriented agricultural extension services (FMARD & JICA, 2020).

Opportunities

Despite these challenges, there are significant opportunities to scale up market-oriented agricultural extension services in Nigeria:

- Public-Private Partnerships (PPPs): Collaborations between government agencies, private sector actors, and non-governmental organizations can enhance the delivery of market-oriented extension services and improve market linkages (Kahan, 2013).
- Digital Technologies and Innovation: The use of digital tools, mobile applications, and online platforms can facilitate market information dissemination, improve access to inputs and markets, and enhance farmer training (Schut et al., 2016).
- Policy Reforms and Institutional Strengthening: Strengthening policy frameworks, promoting farmer-friendly policies, and enhancing institutional capacities can create an enabling environment for market-oriented agriculture (FMARD & JICA, 2020).

DISCUSSION

The transformation of Nigeria's agricultural extension system from a production-driven to a market-oriented approach, exemplified by the SHEP Nigeria project, represents a significant shift in agricultural policy and practice. This shift aligns with broader global trends toward market-responsive agriculture, where farmers are encouraged not just to produce more, but to strategically respond to market signals, enhance their income, and improve rural livelihoods.

The Role of Market-Oriented Agricultural Extension in Improving Farmer Outcomes

One of the most notable impacts of the SHEP Nigeria project is its focus on empowering farmers with the knowledge and skills needed to navigate market dynamics. Traditional agricultural extension services, which primarily focused on increasing yields without regard to market demand, often led to inefficiencies such as market gluts, depressed prices, and significant post-harvest losses. By contrast, the market-oriented approach equips farmers with agribusiness skills that allow them to better understand and respond to market demands (Kahan, 2013).

The success of the SHEP project in improving farmer incomes and market access stems from its holistic approach, which integrates market surveys, demand-driven production, and collective marketing strategies. The training and capacity-building components of the project address key gaps in farmers' ability to engage with markets, shifting them from passive producers to active market participants. This is crucial in enhancing the economic resilience of smallholder farmers, who are often the most vulnerable to price fluctuations and market uncertainties.

Key Challenges in Implementing Market-Oriented Extension in Nigeria

While the SHEP Nigeria project has shown positive results, several challenges persist in the broader implementation of market-oriented agricultural extension systems. One of the primary obstacles is the limited access to markets and infrastructure. Poor road networks, insufficient storage facilities, and inadequate transportation services continue to hinder farmers' ability to efficiently reach profitable markets (Adofu & Shaibu, 2013). This infrastructural deficiency also exacerbates post-harvest losses, undermining the potential gains from increased productivity.

Another significant challenge is the capacity constraints among both farmers and extension agents. Transitioning from a production-driven mindset to a market-oriented approach requires a fundamental shift in how farming is perceived and practiced. However, many extension agents in Nigeria lack the necessary training to guide farmers in developing agribusiness skills and conducting market analyses. Without comprehensive capacity-building programs, the shift toward market-oriented extension risks being uneven and incomplete (Davis, 2008).

In addition to capacity constraints, policy and institutional gaps pose challenges to the widespread adoption of market-oriented extension systems. Inconsistent agricultural policies and weak institutional frameworks can create barriers to the effective implementation and scaling of market-oriented projects. Greater government support and institutional alignment are needed to sustain such initiatives and ensure that they reach more farmers across Nigeria (FMARD & JICA, 2020).

Opportunities for Enhancing Market-Oriented Agricultural Extension

Despite these challenges, there are several opportunities for scaling up market-oriented agricultural extension services in Nigeria. Public-private partnerships (PPPs) offer a promising avenue for improving market linkages and delivering extension services. Collaborations between government agencies, private sector actors, and non-governmental organizations can enhance farmers' access to markets, inputs, and technical support, thereby bridging the gap between production and market needs (Kahan, 2013).

Additionally, the use of digital technologies presents an opportunity to overcome some of the infrastructural and capacity constraints. Mobile applications, online platforms, and digital tools can facilitate the dissemination of market information, provide real-time data on prices and buyer preferences, and enhance farmer training. Digital innovations can also help overcome the geographical barriers that have historically limited rural farmers' access to markets (Schut et al., 2016).

Furthermore, policy reforms and institutional strengthening are essential for creating an enabling environment for market-oriented agriculture. This includes promoting farmer-friendly policies that support market access, value chain development, and agribusiness training. By enhancing institutional capacities and aligning government policies with market-oriented goals, Nigeria can create a more supportive framework for sustainable agricultural development (FMARD & JICA, 2020).

Implications for Rural Development and Food Security

The shift toward market-oriented agricultural extension systems has significant implications for rural development and food security in Nigeria. By improving farmers' market participation and increasing their income, this approach contributes to poverty reduction and enhances rural livelihoods. Moreover, the emphasis on demand-driven production can help stabilize food prices, reduce post-harvest losses, and improve the availability of quality food products in local and national markets.

However, it is important to recognize that the benefits of market-oriented agriculture are not evenly distributed. Wealthier farmers, who have better access to markets and resources, are often better positioned to capitalize on these opportunities than smallholder or marginalized farmers. To ensure that market-oriented extension services contribute to equitable rural development, policymakers must focus on addressing the specific needs of smallholder farmers, improving their access to infrastructure, and providing targeted support for women and youth in agriculture.

CONCLUSION

The SHEP Nigeria project demonstrates the potential of market-oriented agricultural extension systems to enhance farmer incomes, improve market access, and promote sustainable agricultural practices. However, the successful scaling of this approach will require addressing key challenges such as limited market access, capacity constraints, and policy gaps. By leveraging opportunities such as public-private partnerships, digital technologies, and policy reforms, Nigeria can further advance its agricultural sector, contributing to rural development and food security.

The shift from a production-driven to a market-oriented agricultural extension system represents a transformative approach to promoting sustainable agricultural development and enhancing smallholder farmers' income and livelihoods in Nigeria. The SHEP

Nigeria project provides valuable insights into the benefits and challenges of market-oriented agriculture and offers lessons for scaling up similar initiatives across the country Ultimately, the transition from a production-driven to a market-oriented agricultural extension system in Nigeria represents a critical step toward a more sustainable and economically viable agricultural sector. Future research and policy efforts should focus on ensuring that these systems are inclusive, equitable, and responsive to the diverse needs of Nigeria's rural farming communities.

REFERENCES

Adofu, I., & Shaibu, S. O. (2013). The Economic Impact of Improved Agricultural Technology on Cassava Productivity in Kogi State of Nigeria. International Journal of Food and Agricultural Economics, 1(1), 63-74.

Anderson, J. R., & Feder, G. (2004). Agricultural Extension: Good Intentions and Hard Realities. The World Bank Research Observer, 19(1), 41-60.

Anderson, J. R., Feder, G., & Ganguly, S. (2006). The rise and fall of training and visit extension: An Asian mini-drama with an African epilogue. World Bank Policy Research Working Paper, 3928.

Davis, K. (2008). Extension in sub-Saharan Africa: Overview and assessment of past and current models, and future prospects. Journal of International Agricultural and Extension Education, 15(3), 15-28.

Food and Agriculture Organization (FAO). (2017). SHEP Approach: Empowering Farmers through Market-Oriented Agriculture. Rome: FAO.

Federal Ministry of Agriculture and Rural Development (FMARD) & Japan International Cooperation Agency (JICA). (2020). SHEP Nigeria Project Report: Empowering Smallholder Farmers through Market-Oriented Agriculture.

Japan International Cooperation Agency (JICA). (2014). SHEP Approach: A New Extension Methodology for Farmer Empowerment. Tokyo: JICA.

Kahan, D. (2013). Market-Oriented Agricultural Extension. FAO Agricultural Services Bulletin, 148. Rome: FAO.

Schut, M., Rodenburg, J., Klerkx, L., van Ast, A., & Bastiaans, L. (2016). Systems approaches to innovation in crop protection. A systematic literature review. *Crop Protection*, 90, 34-50.

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Effect of *Tribolium Castaneum* Herbst (Rust Red Flour Beetle) Emergence on Maize Flour Stored under Different Packaging Materials

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Abstract

This study investigate the effect of Tribolium castaneum Herbst rust-red flour beetle emergence on maize flour stored under different storage medium. Three (3) different packaging materials were used viz: polyethylene, polypropylene and kilner jars all arrange in completely randomized designed and replicated 3 times to investigate the effect of rust red flour beetle emergence on maize flour stored under different materials. The experiment was carry out under ambient tropical laboratory condition, three copulating pair of adult T. castaneum were introduce into each of the three replications of storage medium of 50g each of the maize flour) measured into the containers with the lid perforated and sealed with a muslin cloth to prevent the escape of the insects.Data obtain from the flours tested and the biological activity of T. castaneum were subjected to one-way Analysis of Variance (ANOVA) and where significant differences existed, treatment means will be compared at 5% significant levels using Duncan's multiple range test. Results obtained from the study shows that there is a reduced number of weevils emergence from maize flour with an increased number of days in polypropylene, kilner jar and polythene respectively with reduced oviposition of the Tribolium castaneum.

INTRODUCTION

The rust-red flour beetle, *Tribolium castaneum* Herbst, is one of the most widespread and destructive pests of stored products, feeding on different stored grain and grain products in the hot humid tropical regions of the world (Padin *et al*, 2013). In Nigeria, the host range of the rust-red flour beetle includes a wide range of food stuffs such as milled cereal products like wheat, sorghum, millet, acha, benni seeds, oil seed cake, cowpea. groundnuts, dried roots and tubers of yam, cassava, cocoyam, plantain among others (Hill. 1983; Adedire & Oni, 1995; Lale & Yusuf, 2001; Odeyemi, 2001; Bulus, 2008). *T. castaneum* does not possess the ability to infest and damage wholesome grains or products but they reproduce rapidly in milled or damaged grains and products. Their short life cycle coupled with low mortality of their immature forms account for the high reproductive success of this species (Howe, 1962). The larva is the most destructive stage of the beetle and its intensive feeding activity results in most serious damage to stored produce. The beetles contaminate the stored products with their excreta, exuviates, body odour and their cadavers thus reducing the palatability, rheological properties and market value of stored flours. Recently, there is a huge decline in the use of synthetic insecticides in agriculture particularly in stored products protection in developing nations primarily because of partial or complete withdrawal of subsidies by governments, sustained propaganda on organic agriculture and undesirable health implications of the use of chemical pesticides and its effect on the environment by environmentalists and other concerned non-governmental organizations (Akinkurolere *et al*. 2011). Wheat, millet, sorghum and maize flours are highly consumed in many parts of sub Saharan Africa. They are a common staple food in developing countries including Nigeria. Their deterioration in storage due to the infestation by *T castaneum* and other microorganisms leads to losses which in turn has adverse effects on the economy of the nation and health of the people.

It is therefore necessary that such losses be investigated so as to provide adequate information that will guarantee food security in developing countries (Edwards & Singh, 2006). These has been conditions increasing in price of maize flour during season every year and producers and consumers from Kano metropolis and it is surrounding communities usually find it difficult to satisfy their demand and supply requirement due to the cost. It is apparent that there is need to adopt appropriate storage method to extend the shelf life and ensure availability of quality pods and maize. The research seek to explore how generative pack based material can possibly be applied to avoid obnoxious chemical usage reduce cost of preservation and control maize flour for consumption based on interaction with maize flour sellers and observation of storage practice on the study is to highlight associated problems of maize flour beetle in storage. The sexes will be confirmed by observing the genital papillae on the ventral side of the distal abdominal segment. The female pupa possess well developed, protruding genital papillae while the males possess reduced genital papillae compared to females (Parthasarathy *et al*., 2008). The storage medium was kept in the culturing chamber (cage) made of wire gauze to prevent cross infestation. The adult beetles were removed after 7 days by sieving the flour with a sieve of 0.5mm mesh size. The experiment will be observed on the 14 day after the introduction of the insects and subsequently on weekly basis until the 56 day for the emergence of larvae, Pupae and adults. The flour media were sieved to facilitate the separation of the various life forms (larva, pupa, adult). The population growth will be check by counting the number of larvae, pupa and adult insects in each replicate of the storage medium. Against this backdrop, this work aimed to evaluates the effect of *T. castaneum* emergence on maize flour stored under different storage medium.

MATERIALS AND METHODS

The experiment was arranged in Completely Randomized Design (CRD) replicated three times. Contaminated flour with *Tribolium castaneum* Herbst was sourced from Tarauni market, in Tarauni Local Government Area of Kano State and was identified by the chief technologist at the Pest Management Technology Laboratory of the College. The experiment was conducted in the Department of Pest Management Technology, Federal College of Agricultural Produce Technology, Kano state with a coordinates of 11.9667^{o}N 8.566^{o}E with 28km^{2} and a population of 346,900 (Population projection, 2022). Fresh maize was obtain one week, clean sifted the bran, dried at room temperature and package well in a kilner jars.Maize flour was held in kilner jar together with six pairs of adult male and female of rust red flour weevils were introduce into the storage medium at ambient temperature in laboratory conditions of 32^{0}C and relative humidity of 75%. To determine the effect of storage medium on the growth of the rust-red flour beetle, the experiment was carry out under ambient tropical laboratory condition, three copulating pair of adult *T. castaneum* were introduce into each of the three replications of storage medium of 50g each of the maize flour) measured into kilner jar containers with the lid perforated and sealed with a muslin cloth to prevent the escape of the insects, polyester, polythene bag. The storage medium was kept in the culturing chamber (cage) made of wire gauze to prevent cross infestation. The adult beetles were removed after 7 days by sieving the flour with a sieve of 0.5mm mesh size. The experiment will be observed on the 14 day after the introduction of the insects and subsequently on weekly basis until the 56 day for the emergence of larvae, Pupae and adults. The flour media were sieved to facilitate the separation of the various life forms (larva, pupa, adult). The population growth will be check by counting the number of larvae, pupa and adult insects in each replicate of the storage medium.

Data obtain from the flours tested and the biological activity of *T. castaneum* were subjected to one-way Analysis of Variance (ANOVA) and where significant differences existed, treatment means will be compared at 5% significant levels using Duncan's multiple range test (DMRT).

RESULTS AND DISCUSSION

Estimation of Weevil Damage at 45 Days after Infestation Table 1 reveals that kilnarjar and polythene bag maize show significant of maize flour number live insec (22.000a and 1.800a respectively). And also they recorded lower level of *Tribolium castaneuam* responsible for the number of insect. The reduced number of weevils emerging from maize flour intact could be due to reduced oviposition and the inability of the *Tribolium castaneum* to feed effectively. When maize flower are attached sack medium of store significant in storage medium shows relatively not give in number of live insect available for rust red flour beetle feeding and oviposition. There is evidence to suggest that weevils find it difficult to grip maize flour have inadequate leverage for feeding (Tefera *et al*., 2011).

The result in table 2 reveal polythene bag medium of storage were significant in number of live insect in the treatment and weight after storage, in which the number of dead insect (mortality) shows not significant. The rounded flinty crown of the variety used in this experiment may have contributed to the reduction in weevil damage for flour maize stored on the different medium. The result of this study is in line with the findings of Mulungu (2010) who reported maize grain loss of 12 % as a level accepted by the farmers. The result reveals that *Tribolium castaneum* mortality was significantly different between the different storage forms on Kilnar jar medium. Maize stored Kilnar jar and polythene bag recorded highest number of dead *Tribolium castaneum* insect respectively. Abraham (1991) indicated that the extent of damage during storage depends upon the number of emerging adults during each generation and the duration of each life cycle and seeds permitting more rapid and higher levels of adult emergence will be more seriously damaged. *T. castaneum* have been reported to be very prolific and has the ability to produce millions of progeny within a life span. A major factor influencing the susceptibility and development of *T. castaneum* is the quality of the diet. According to Booth *et al*. development of *Tribolium castaneum* takes about 20 days on a good qualitative diet with other factors being optimal. However, when the diet presented for development is of less quality, developmental period takes longer time and it can be as long as 45 days or more. In the present study, a period of 75 days recorded for *T. castaneum* on the white and yellow maize grain flour.

Table 1: Effect of *Tribolium castaneum* Herbst emergence on maize flour in a Kilnar jar

Treatment Kilnar jar	No of live insect 1-5 weeks	No of dead insect 1-5 weeks	Weight after storage 1-5 weeks
1	6.200b	7.800	8.400b
2	20.200[a]	9.400	13.400[a]
3	18.800[a]	10.600	6.400[c]
4	22.000[a]	9.400	5.800[c]
5	21.200[a]	15.800	3.600[d]
CD	33.729	57.042	14.445

Means with the same alphabet(s) on the same column and under the same heading are not significantly different at (P>0.05) level of probability using DMRT

Table 2: Effect of *Tribolium castaneum* emergence on maize flour using polythene bag

Treatment Polythene bag	No of live insect 1-5 weeks	No of dead insect 1-5 weeks	Weight after storage 1-5 weeks
1	1.800[a]	0.600	0.600 [c]
2	0.600[b]	1,000	1.800 [bc]
3	0.800[b]	1.200	7.400 [a]
4	0.400[b]	0.400	6.400 [a]
5	0.400[b]	0.400	2.600 [b]
CD	84.779	109.361	33.430

Means with the same alphabet (s) on the same column and under the same heading are not significantly different at (P > 0.05) level of probability using DMRT

Table 3: Effect of *Tribolium castaneum* emergence on maize flour using Polypropylene sack

Treatment Polypropylene	No of live insect 1-5 weeks	No of dead insect 1-5 weeks	Weight after storage 1-5 weeks
1	36.176[a]	42.918	33.392[a]
2	32.012[b]	40.400	34.590[a]
3	34.026[ab]	39.476	35.846[a]
4	31.654[b]	39.464	33.956[a]
5	31,204[b]	42.056	32.868[ab]
CD	9.562	8.733	10.643

Means with the same alphabet (s) on the same column and under the same heading are not significantly different at (P > 0.05) level of probability using DMRT

REFERENCES

Adedire, C.O. and Oni, M.O. 1995. Studies on the developmental biology of the dried ya beetle Dinoderusporcellus (Coleoptera: Bostrichidae), M. Tech. Thesis in the Department of Biology, Federal Univ. of Technology, Akure.

Akinkurolere, R.O., Adedire C.O. and Ajayi, O.O. 2011.Susceptibility of some maize cultivars in Nigeria to infestation ad damage by maize weevil. Sitophilus zeamais (Motsch.) (Coleoptera: Curculionidae). Nigerian Journal of Entomology 28: 55-63.

Bouayad, N., Rharrabe, K., Ghailani, N. and Sayah F. 2008. Effects of different food commodities on larval development and-amylase activity of Plodiainter punctella (Hubner) (Lepidoptera: Pyralidae). Journal of Stored Products Research 44: 373-378.

Bulus, S.D. 2008. Studies on Millet, Acha and Wheat: Their Nutrient Composition and Their Susceptibility to *Tribolium castaneum* (Herbst), M.Tech Thesis n the Department of Biology, Federal University of Technology. Akure. Edwards, O. R.

and Singh, K.B. 2006. Resistance to insect pests*:* what do legumes have to offer ? Euphytica 147*:* 273-285.

Howe, R. W. 1962. The effect of temperature and humidity on the rate of development and mortality of *Tribolium castaneum* Herbst) (Coleoptera*:* Tenebrionidae). Annals of Applied Biology 44 (2)*:* 356-368. Keneni, G., Bekele, E., Getu, E., Imtiaz, M., Damte, T., Mulatu, B. and Dagne, K. 2011. Breeding food legumes for resistance to storage insect pests*:* Potential and Limitations. Sustainability 3*:* 1399-1415.

Lale. N.E.S. and Yusuf, B.A. 2001. Potential of varietal resistance and Piper guineense seed oil to control infestation of stored millet seeds and processed products by *Tribolium castaneum* (Herbst). Journal of Stored Products Research37*:* 63-75.

Odeyemi, O.0. 2001. Biology, Ecology and Control of insect Pests of stored processed cereals and pulses pp 95-112. In Ofuya, T.1. and Lale. N.E.S. (Editors) Pests of stored cereals and Pulses in Nigeria*:* Biology, Ecology and Control. Dave Collins Publications.

Padin S.B., Fuse C.. Urrutia M.I. and Dal Bello G.M. 2013. Toxicity and repellency of nine medicinal plants against *Tribolium castaneum* in stored wheat. Bulletin of Insectology 66 (1)*:* 45-49 ISSN 1721-8861.

Parthasarathy, R.. Tan. A.. Bai, H. and Pali, S.R. 2008. Transcription factor broad suppresses precocious development of adult structures during larval-pupal metamorphosis in the red flour beetle, *Tribolium castaneum*. Mechanism of Development 125 pp 299-313.

Savov, D. 1973. Influence of some dried fruits on the development of Plodiainterpunctella (Lepidoptera*:* Pyralidae). Gradinarska Lozarska Nauka 10*:* 43-48 (in Russian).

Zar, J.H. 1984. Biostatistical Analysis. 2nd ed., Prentice-Hall International, Englewood Cliffs N.J. 38

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Effects of Storage Time and Practices Against Larvae of (*Prostephanus Truncatus* Horn) Larger Grain Borers on Maize Grains

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Abstract
A laboratory study was conducted at the Federal College of Agricultural Produce Technology in Kano, Nigeria to evaluate the insecticidal properties of Ginger and Moringa essential oil against the maize weevil (Prostephanus truncatus Horn*). Completely randomized design with two levels of oil concentration (2ml) was applied to 100g of maize grains. Results showed that the oil provided significant control on Prostephanus truncatus* Horn *infestation compared to the control. No significant differences were found between treatment groups in the number of holes, insect mortality rates and oviposition rates between shorter or longer durations during the period of treatment. However, oviposition decreased with increasing oil concentration while germination rate increased linearly with higher oil amounts, indicating greater insect control at higher doses. Maize treated with the highest oil concentration remained free of insect infestation and damage for up to 8 weeks. Therefore, Ginger and Moringa shows potential as a natural alternative to synthetic insecticides for controlling Prostephanus truncatus* Horn *in cowpea storage. This results demonstrate the botanical s ability to control stored product pests and suggest it may act as an effective repellent or fumigant against maize weevils.*

INTRODUCTION

The larvae stage of the larger grain borers (LGB) *Prostephanus truncatus* Horn is a significant pest of cereals and other grain crops, causing severe losses to crops and impacting the livelihoods of farmers in many arid and semi-arid areas (Ahmed.,2018). Larval of the larger grain borer infestations reduce grain yields and quality due to their tendency to feed on the germ of the grains (Isman, 2000). In recent years, the increasing prevalence of the pest has been linked to a rise in the mean temperature and certain other climate change-related conditions (Iqbal, 2018). As such, it is paramount that farmers adopt effective pest management practices to minimize the impact of the LGB populations in their crops. Although challenging to control the larval grain borer can be managed through the application of cultural and chemical management practices, cultural management practices refer to the use of agronomic practices such as crop rotation and plant population and combination to reduce the infestation level of the pest (Zargar, 2015). For example, the rotation of maize cropping,can be one of the effective crops management to reduce the effect of the larvae of the larger grain borer. On the other hand, chemical management practices refer to the use of chemical insecticides to control the pest. However, due to the potential for resistance to these insecticides and their environmental impacts, many farmers are increasingly adopting integrated pest management practices that combine chemical and cultural control practices (Lynch, 2020). The larvae grain borer has a short life cycle of up to two months in warm climates (Qayum, 2020). The eggs of the pest are laid in crop residues, or on the soil, and hatch into small larvae. The larvae then burrow into the grain kernels to feed, causing developmental damage to the grain and reducing its quality (Lu, 2017). The adult beetles then emerge from the grain when the grain is ripe, and the cycle repeats. The larvae grain borer is attracted to bright-coloured plants, particularly yellow-flowered plants, and can be found in abundance in fields with high crop residues (Motala, 2018). To effectively manage the pest, various plant and management practices have been evaluated and most potable among them is crop rotation has been identified as an effective method to reduce larval grain borer populations (Zargar, 2015). The rotation of maize with other crops, such as sorghum, reduces the infestation level of the pest due to the difference in the growth cycle between the two crops, which reduces the amount of food available to the larvae (Wilson, 2019). Planting early maturing maize varieties helps to reduce infestations by out competing the pest for food (Ross, 2016). Inter-cropping maize with legumes has also been known to reduce the abundance of the pest as the legumes provide alternate nourishment for the larvae. Other management practices, such as the use of chemical insecticides, have also been adopted to reduce larval grain borer populations (Lynch, 2020). Since the 1950s, chemical insecticides have been widely used to control the pest, however, the rapid development of resistance to these insecticides by the larvae grain borer has been documented (de Oliveira, 2021). Integrated pest management, a combination of chemical and cultural control practices, has gained increasing popularity as an effective alternative management approach (Ramirez, 2021).

The looming food security combine with climatic change and population explosion poses a threat to food availability most importantly in SSA. The need to curtail insect infestation to the bearer minimum possible will have an impact on abundance food supply, increase farmer economic tenacity and reduce hardship to family members. This research will be a cost-effective approach to analyzing the effectiveness of plant and management practices against larval grain borer, and can possibly yield information and solutions that can help farmers and authorities to better manage this pest. It will also provide a platform for further research into reducing pest population and preventing losses caused by larval grain borers. This study will fill the current gap in knowledge by making evidence-based recommendations that can help to reduce the impact of this pest on the agricultural sector and food security. Against this backdrop, this paper aim to determine the effect of some botanical plant and management practices against larvae of the larger grain borer in the study area.

MATERIALS AND METHODS

The laboratory study was conducted at Pest Management Technology Laboratory located at Federal College of Agricultural Produce Technology. with Latitude 11'9586 and Longitude 8'5443 in the Sudan Savanna Ecological Zone of Nigeria during the wet season of 2023 using larger grain borer (*Prostephanus truncatus* Horn). The experiment design used was completely randomized design [CRD] and replicated 3 times.The insects of (*Prostephanus truncatus* Horn) were obtained from Dawanau international Market, Dawakin Tofa local Government area of Kano State. The insects were identified at the Pest Management Technology Laboratory and Larval grain borer and its activity over time were examine under different management conditions. Before the trail of the experiment, the maize was disinfected for any living pest by placing in a beaker in an oven regulated at 38^0C for 24 hours duration before commencement of trial. After then, the insects were introduced into the disinfected maize for 1 month. The maize combination of the larvae and the grain were kept and stored in a fresh kilner jar container. The larvae collected from the incubated grain samples were transferred into new kilner jar containing fresh maize samples. The kilner jar containing the larvae were placed in a room temperature and exposed environment with different temperature and relative humidity. The larval development were monitored and observed using moringa and ginger oil based on the management practices against the larvae.

All data collected were subjected to analysis of variance using Mini tab versions 17 and means were separated using the Duncan Multiple Range Test at 5% probability.

RESULTS AND DISCUSSION

Results shown in Table 1 suggests that the essential oil extract of Moringa has significantly impact on the number of holes made by cowpea weevils both under room temperature and environmentally exposed better that ginger essential oil at room temperature, however statistically at par with application of ginger at environmentally exposed at week 2. at week 4, Ginger essential oil and environmentally exposed performed better than all other treatment though statistically at par with Ginger under room temperature. At week 6, application of Moringa essential oil at room temperature was found to be significantly high in reducing number of holes on maize grains compared to other treatments but was statistically the same with the ginger essential applications under exposed environmental conditions. At week 8, application of Moringa essential oil and ginger essential was found to be better at environmentally exposed, room temperature than Moringa at room temperature.There is a dose-dependent response with the application of 2ml concentration generally showing a higher efficacy in reducing the number of holes. The control group indicates the baseline activity of weevils without treatment, The coefficient of variation (C.V) is relatively high, suggesting some variability in the results. Both Moringa and Ginger essential oil extracts demonstrate bio activities against cowpea weevils. The higher concentrations generally exhibit more pronounced effects in terms of reducing holes.

Table 2 shows the activity of Moringa Essential Oil Extract and Ginger Essential Oil Extract on oviposition of maize weevil against larger grain borer. Moringa essential oil extract affects the oviposition behavior of cowpea weevils with the application of 2ml concentration at 2weeks showing significant oviposition effects on ginger when at room temperature but statistically at par with with Ginger environmentally exposed stronger than all others treatments on reducing oviposition compared to other treatments. The control group shows the baseline oviposition activity of weevils without treatment with the coefficient of variation (C.V) suggests some variability in the results. At Week 4, all the treatments were statistically at par with the treatments. At Week 6, high significant oviposition was observed by *Prostaphenus truncatus* Horn with environmentally exposed than all other treatments. However at Week 8, significant oviposition was observed by *Prostaphenus truncatus* Horn on Ginger environmentally exposed compared to all other treatments.

Results from Table 3 shows the mean effects of Moringa Essential Oil Extract and Ginger Essential Oil Extract on mortality mate of maize weevil *Prostaphenus truncatus* Horn. Ginger essential oil extract demonstrates insecticidal properties at room temperature significantly than all other treatment at 2Weeks. At 4Weeks, Ginger essential oils exposed environmentally was found to be significantly better in causing mortality in maize weevils than in other treatments. Application of 2ml concentration consistently results in higher mortality rates with the treatments Ginger essential oils exposed environmentally at 6Weeks than all other treatments while at 8Weeks, Moringa essential oils at room temperature and exposed environmentally were found to be significantly better on insects mortality than other treatments. The control group represents the baseline mortality rate without treatment. The coefficient of variation (C.V) suggests variability in the results.

CONCLUSION AND RECOMMENDATIONS

The experimental study indicate that both Moringa and Ginger essential oil extracts possess significant bioactivity against maize weevils larger grain borer *Prostephanus truncatus* Horn, as evidenced by their effects on the number of holes, oviposition behavior, and mortality rates. The concentrations of these essential oil extracts generally demonstrate more pronounced and dose-dependent impacts on maize weevil activities. The potentials of Moringa essential oil in insect control due to its bioactive compounds, including isothiocyanates and niazirin contribute significantly in deterring of destruction of the grain. Similarly, Ginger essential oil has been recognized for its insecticidal and repellent effects, attributed to compounds like gingerol and shogaol. The observed effects on maize weevils are consistent with the broader understanding of the insecticidal properties of these essential oils. The present study contributes valuable insights into the potentials of Moringa and Ginger essential oil extracts as eco-friendly alternatives for maize weevil management. Future investigations should build upon these findings to optimize application methods and dosage, assess long-term effects, and consider the broader ecological implications of employing these essential oils in pest control strategies.

Table 1: Effect of Moringa and Ginger essential oil extract on number of holes by *Prostephanus truncatus* weevil

Treatment	W2	W4	W6	W8
MoRT	2.333^{a}	0.521^{c}	2.667^{a}	1.000^{bc}
MoEE	3.333^{a}	0.667^{bc}	1.333^{ab}	2.667^{a}
GoRT	0.667^{bc}	1.667^{ab}	1.667^{ab}	2.667^{a}
GoEE	2.333^{a}	2.333^{a}	2.000^{a}	2.667^{a}
Control	1.000	0.7680	1.121	1.213
C.V	50.663	57.256	35.346	48.838

Means followed by the same letter(s) in the vertical column are not statistically different using DMRT at 5% level of probability.

Table 2: Mean effect of Moringa and Ginger essential oil extract on oviposition by *Prostephanus truncatus* weevil

Treatments	W2	W4	W6	W8
MoRT	1.667^{b}	2.333^{a}	2.000^{ab}	2.000^{a}
MoEE	0.667^{c}	2.000^{ab}	1.333^{bc}	2.000^{a}
GoRT	3.667^{a}	2.000^{ab}	2.333^{a}	1.333^{b}
GoEE	2.000^{ab}	2.667^{ab}	2.333^{a}	0.667^{c}
Control	0.338	0.345	0.573	0.468
C.V	51.926	63.277	44.681	45.896

Means followed by the same letter(s) in the vertical column are not statistically different using DMRT at 5% level of probability

Table 3: Mean effects of Moringa and Ginger essential oil extract on mortality rate of maize by *Prostephanus truncatus* weevil

Treatment	W2	W4	W6	W8
MoRT	1.667[bc]	2.000[b]	2.333[ab]	4.776[a]
MoEE	0.667[c]	1.333[c]	2.000[b]	4.667[a]
GoRT	3.667[a]	2.333[ab]	2.000[b]	2.333[bc]
GoEE	2.000[b]	2.667[a]	2.867[a]	2.333[b]
Control	2.667	1.667	1.667	2.777
C.V	51.926	44.681	63.277	48.689

Means followed by the same letter(s) in the vertical column are not statistically different using DMRT at 5% level of probability

REFERENCES

Ahmed, Y., Zargar, A. R., & Singh, A. K. (2018). Biodiversity and Susceptibility of Cereals and Millets to Stem Borers and Shoot Flies. Advances in Crop Science and Technology, 6:6.

Iqbal, J., Muhammad, R., Khan, A. T., & Khan, M. A. (2018). Response of different Wheat varieties to grain borer infestations. Pakistan Journal of Zoology, 50(1), 155–162.

Isman, M. B. (2000). Botanical Insecticides, Deterrents, and Repellents in Modern Agriculture and an Increasingly Regulated World. *Annual Review of Entomology*, 45(1), 45-66.

Lu, Y., Mace, E. S., & Jia, F. (2017). Biorational Insecticides for Pest Control. Academic Press.

Lynch, M. J., Tallon, P. K., Hill, B. P., Anderson, E., & Callahan, M. (2020). Silique Caps and Seasonal Attractiveness of LGB-Susceptible Sunflower Hybrid Cultivars. *Entomologia Experimentalis et Applicata*, 166(1), 57-63.

Motala, S. E., Chabikuli, N., & Robinson, E. S. (2018). Effect of seed treated with neem oil (*Azadirachta Indica* A Juss) on control of stem borer infestation of maize. Crop Protection, 107, 26-32.

Ross, K. F., Ukichu, A. R., Ajayi, J., Ocharo, J., & Obonyo, M. (2016). Effect of Early Maturing Maize Varieties and Planting Date for Control of Stemborers in Maize: An Exploratory Analysis in the Tropics. *Crop Protection*, 89, 83-88.

Wilson, A., Coutinio, P., Kwoseh, C., Darrouzet, E., & Inkoom, A. S. (2019). Rotation of crops to control stemborers: lessons from assessment of 28 crops in East and Southern Africa. Frontiers in Plant Science, 10, 8.

Zargar, A. R., Singh, A. K., Ahmed, Y., & Rawat, M. S. (2015). Role of Green Manure in Reducing Infestation of Stem borers in Cereal Crops. *Advances in Crop Science and Technology*, 3:6.

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Effects Of Replacing Soyabean Meal With *Moringa Oleifera* Leaf Meal On Moisture Content, Lipid Content And Lipid Peroxidation In Meat Of Broiler Chickens

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Abstract

This study investigated the effects of replacing soybean meal (SBM) with Moringa oleifera leaf meal (MOLM) on the oxidative stability, lipid content, and moisture content of broiler chicken meat. The objective was to assess the feasibility of MOLM as a sustainable feed ingredient that not only reduces feed costs, but also maintain or enhances meat quality. A total of 200 broiler chickens were assigned to five dietary treatments in a completely randomized design, with MOLM progressively replacing SBM protein at 0%, 25%, 50%, 75%, and 100%. Meat samples were analyzed for moisture and lipid content, and oxidative stability was assessed using the thiobarbituric acid assay. Statistical analyses were performed using factorial analysis with diet and muscle type as factors. Results revealed significant effects of MOLM inclusion on meat lipid content (P<0.05), with a reduction in lipid levels as MOLM substitution increased, ranging from 7.08% in the control diet to 5.57% in the 100% MOLM diet. Oxidative stability, indicated by Malondialdehyde (MDA) levels, was comparable across treatments (P>0.05), with the lowest MDA observed at 25% MOLM (0.27 mg/kg). Moisture content remained consistent across dietary treatments and muscle types (P>0.05). These findings suggest that MOLM can serve as a viable alternative to SBM, enhancing meat quality through reduced lipid content and oxidative stability while offering a sustainable and economical feed solution. It was concluded that Moringa oleifera leaf meal holds significant promise as a functional feed ingredient, contributing to sustainable poultry production and improving meat quality parameters valued by consumers.

Keywords: Lipid peroxidation, oxidative stability, lipid content, meat quality, alternative feed ingredients, sustainable poultry production

INTRODUCTION

The growing global demand for poultry products underscores the importance of identifying sustainable and cost-effective feed resources to enhance broiler chicken productivity and profitability. In poultry production, feed costs account for 60–70% of total production expenses, largely driven by the reliance on conventional protein sources like soybean meal (SBM). However, increasing prices and competition for SBM, which is also used in human diets and other industrial purposes, have created an urgent need for alternative protein sources that are nutritionally adequate, environmentally sustainable, and economically viable (Tufarelli *et al*., 2015).

Moringa oleifera, commonly known as the "miracle tree," has gained significant attention as an alternative feed ingredient due to its exceptional nutritional profile. Its leaves are rich in protein, essential amino acids, and bioactive compounds such as polyphenols, flavonoids, and vitamins. *Moringa oleifera* leaf meal (MOLM) has been reported to improve growth performance, immune response, and antioxidant status in livestock and poultry, highlighting its potential as a functional feed ingredient (Gopalakrishnan *et al*., 2016, Sule *et al*., 2024). Additionally, the bioactive components in *Moringa oleifera* leaves have demonstrated the ability to reduce oxidative stress, thereby enhancing meat stability and quality during storage (Alabi *et al*., 2017).

One critical challenge in poultry meat production is lipid peroxidation, a process where free radicals degrade unsaturated lipids, resulting in the deterioration of meat flavour, texture, and nutritional value. Oxidative stability is a key determinant of meat quality, particularly in storage, and plant-derived antioxidants such as those found in *Moringa oleifera* have shown promise in mitigating oxidative damage (Falowo *et al*., 2014). Moreover, the moisture and lipid content of meat are vital parameters that influence consumer acceptability and marketability. Modern consumers increasingly prefer healthier meat with optimized fat content and natural quality enhancement through dietary modifications (WHO, 2020).

This study investigates the effects of replacing soybean meal with *Moringa oleifera* leaf meal on key meat quality parameters, including lipid peroxidation (oxidative stability), lipid content, and moisture content, in broiler chickens. The aim of this study is to assess the feasibility of *Moringa oleifera* leaf meal (MOLM) as a sustainable feed ingredient that not only reduces feed costs but also achieves the goal of maintaining or improving meat quality. By addressing these aspects, the research contributes to advancing knowledge on functional feed alternatives and their role in promoting sustainable poultry production and meat quality improvement.

MATERIALS AND METHODS

The experiment was conducted at the Poultry Demonstration Unit of the Livestock Farm, Federal College of Agriculture, Akure; the Nutrition Laboratory of the Department of Animal Production and Health, Federal University of Technology, Akure; and the Biochemistry Laboratory of the Postgraduate Laboratory Complex, Federal University of Technology, Akure. Fresh *Moringa oleifera* leaves were harvested from a paddock at the Livestock Farm of the Federal College of Agriculture, Akure, and air-dried for 3–4 days under shaded and well-ventilated conditions. The dried leaves were milled using a hammer mill to produce *Moringa oleifera* leaf meal (MOLM), which was stored in tightly sealed polythene bags to maintain freshness. The MOLM was subsequently used to formulate MOLM-based diets.

A total of 250 day-old broiler chicks were procured and reared on a deep-litter system. During the initial four-week brooding phase, the chicks were fed a conventional broiler starter diet containing 23% crude protein (CP) *ad libitum*. At the end of the brooding period, 200 healthy starter broilers were randomly selected, weighed, and divided into experimental groups using a completely.

Table 1: Gross composition* (as fed basis) of experimental diets (%)

INGREDIENTS (kg/100kg)	0% MOLM	25% MOLM	50% MOLM	75% MOLM	100% MOLM
Maize	53.50	52.75	52.20	51.50	51.00
Groundnut cake (44%CP)	12.00	12.00	12.00	12.00	12.00
Soyabean meal (42%CP)	14.00	10.50	7.00	3.50	-
MOLM (29.7%CP)	-	4.95	9.90	14.85	19.80
Wheat Offal	9.50	9.00	8.77	8.35	7.70
Brewer dry grain	5.73	5.75	5.30	5.20	5.10
Bone Meal	2.30	2.40	2.50	2.50	2.50
Oyster Shell	1.70	1.20	0.75	0.35	-
Salt	0.50	0.50	0.50	0.50	0.50
Lysine	0.20	0.35	0.48	0.60	0.75
Methionine	0.32	0.35	0.35	0.40	0.40
*Vitamin/Mineral Premix	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Metabolizable energy (kcal/kg)	2823	2787	2753	2718	2685
Crude protein (%)	19.65	19.42	19.17	18.94	18.68
Calcium	1.52	1.52	1.53	1.52	1.52
Phosphorus	0.54	0.54	0.55	0.54	0.53
Ether Extract	4.03	4.07	4.11	4.16	4.20
Crude Fibre	4.53	5.37	6.13	6.95	7.75
Methionine	0.60	0.61	0.59	0.61	0.59
Lysine	1.01	1.02	1.02	1.01	1.02
ME:CP	143.7	143.5	143.6	143.5	143.7

*ME = Metabolizable energy; CP = Crude protein; MOLM = Moringa oleifera leaf meal; SBM = Soyabean meal. *Supplied per kg of diets: Copper, 8 mg; Iodine, 0.4 mg; Iron, 100 mg; Selenium, 0.3 mg; Vitamin A (retinyl acetate), 4540 IU; Vitamin D3, 1543 IU; Vitamin E, 15.4 IU; Choline, 284 mg; Niacin, 34 mg; d-Pantothenic acid, 5.7 mg; Riboflavin, 3.4 mg; Menadione, 0.85 mg; Vitamin B12, 0.01 mg; Biotin, 0.1 mg; Folic acid, 0.5 mg; Thiamine, 0.6 mg; randomized design (CRD).*

The birds were assigned to five dietary treatments, with 10 birds per replicate and four replicates per treatment. Five isonitrogenous and isocaloric diets were formulated and offered to the birds *ad libitum* for four weeks. The control diet (Diet 1) contained groundnut cake and soybean meal (SBM) as plant protein sources, while the experimental diets (Diets 2–5) progressively replaced the protein contribution of SBM in the control diet with MOLM at substitution levels of 25%, 50%, 75%, and 100%, respectively. The dietary treatments were hand-mixed weekly to ensure freshness, and the gross composition of the broiler finisher diets is presented in Table 1.

At the end of the experimental period, three birds were randomly selected from each treatment replicate. The selected birds were slaughtered and processed following standard poultry processing procedures. Meat samples were collected from three anatomical regions: the breast muscle, thigh, and drumstick. Portions of the meat samples were analyzed for moisture content and lipid content following the standard procedures outlined by AOAC (2019). The remaining portions were stored under refrigeration at 4°C for two weeks to assess the extent of lipid oxidation. Lipid oxidation was determined using the thiobarbituric acid (TBA) assay, as described by Pikul *et al*. (1989), with minor modifications to suit the specific experimental conditions.

All data generated were analyzed using factorial analysis, employing the general linear model as outlined in SAS (2005), with diet and muscle type serving as main factors.

Significant differences among treatments were separated using the New Duncan Multiple Range Test, a component of the same statistical software package.

RESULTS AND DISCUSSION

The inclusion of *Moringa oleifera* leaf meal (MOLM) as a dietary replacement for soybean meal in broiler chicken diets has gained attention due to its affordability, nutrient-rich profile, and potential to enhance meat quality (Banjo *et al*., 2012, Sule *et al*., 2017, 2024). This study assessed the impact of *Moringa oleifera* leaf meal (MOLM) on the oxidative stability, lipid content, and moisture content of broiler chicken meat, providing valuable insights into its potential for enhancing poultry meat quality. The findings, as presented in Table 2, align with previous research emphasizing the nutritional and functional benefits of MOLM in animal diets (Anwar *et al*., 2007; Adeyemi and Oloruntola, 2021).

Lipid oxidation, assessed by Malondialdehyde (MDA) content, is crucial for maintaining meat quality by preserving its sensory attributes and shelf life. This study observed slight variations in ???

Table 2 Lipid oxidation, Moisture and Lipid content of meat of Broiler-Chicken Finishers fed diets containing *Moringa oleifera* leaf meal as replacement for soyabean meal

Parameters	Oxidative stability (mgMDA/kg muscle)	Lipid content (%)	Moisture content (%)
Diets			
(0% MOLM)	0.33	7.08[a]	70.12
(25% MOLM)	0.27	6.96[ab]	70.43
(50% MOLM)	0.29	6.84[b]	69.24
(75% MOLM)	0.44	6.35[c]	70.78
(100% MOLM)	0.28	5.57[d]	70.60
Muscle Type			
Breast	0.32	6.56	70.23
Drumstick	0.31	6.62	70.63
Thigh	0.33	6.68	69.85
Statistical significance			
Diet	ns	***	ns
Muscle type	ns	ns	ns
Diet*Muscle type	ns	ns	ns

*abcd = Means along the same column and for the same parameter with different superscripts are significantly different (p<0.05), ns – not significant, *** - significant. MDA levels across dietary treatments, ranging from 0.27 mg/kg in the 25% MOLM group to 0.44 mg/kg in the 75% MOLM group.*

Although the differences were statistically insignificant (P>0.05), the reduced MDA levels at moderate MOLM inclusion suggest potential antioxidative effects attributed to bioactive compounds such as flavonoids and phenolics in Moringa leaves (Sultana *et al*., 2012; Moyo *et al*., 2011). These findings corroborate earlier reports on MOLM's ability to mitigate lipid peroxidation in animal products. Furthermore, the uniform oxidative stability across muscle types (breast, drumstick, and thigh) indicates consistency in the antioxidative effects, which simplifies dietary formulations aimed at meat preservation in broiler production.

A significant reduction in meat lipid content was observed with increasing inclusion levels of *Moringa oleifera* leaf meal (MOLM), decreasing from 7.08% in the control group to 5.57% in the 100% MOLM group. This reduction in lipid deposition aligns with findings that MOLM has a lower energy density compared to soybean meal, which consequently leads to less fat accumulation in broilers (Tesfaye *et al*., 2020). Such reductions in meat lipid content are desirable for health-conscious consumers, as they conform to dietary recommendations to minimize saturated fat intake (WHO, 2020). Additionally, leaner meat has been shown to exhibit improved oxidative stability, further reinforcing the trends observed in this study (Adeyemi and Oloruntola, 2021).

Also, the findings of this study are consistent with prior research. Sule *et al*. (2024), Olugbemi *et al*. (2010), and Kumar *et al*. (2018) reported reduced abdominal fat content in broiler chickens fed MOLM-based diets. Similarly, Sule *et al*. (2016) noted a decreasing trend in serum cholesterol concentrations with increasing levels of MOLM in broiler finisher diets. The reduction in meat lipid content observed in this study further supports the hypocholesterolemic potential of *M. oleifera*. The ability of MOLM-based diets to decrease carcass and meat fat content may be attributed to β-sitosterol, a bioactive compound in *M. oleifera* leaves that lowers plasma concentrations of low-density lipoprotein cholesterol as reported by Saluja *et al*. (1978), Kane and Malloy (1982), and Ghasi *et al*. (2000).

In contrast, the meat's moisture content remained stable across all dietary treatments, ranging from 69.24% to 70.78%, indicating that the water-holding capacity was unaffected by MOLM inclusion. This finding is consistent with reports that MOLM does not compromise the hydration properties of muscle tissue, which are crucial for maintaining meat juiciness and consumer acceptability (Gadzirayi *et al*., 2012; Sultana *et al*., 2012).

The study demonstrates that replacing soybean meal with MOLM, even up to 100%, can significantly reduce lipid content without adversely affecting oxidative stability or moisture content. This highlights MOLM as a viable, sustainable alternative to soybean meal, particularly in regions where soybean meal is scarce or expensive. The bioactive compounds in MOLM, including quercetin, kaempferol, and chlorogenic acid, contribute to its antioxidative effects and ability to modulate lipid metabolism, as noted in prior studies (Anwar *et al*., 2007; Foidl *et al*., 2001). Moreover, the combination of reduced lipid content and maintained moisture content in meat aligns with consumer preferences for healthier and leaner products, enhancing its market potential.

These findings have significant implications for sustainable poultry nutrition. With the increasing global demand for alternative protein sources, MOLM offers a resource-efficient and environmentally sustainable option. Its cultivation is less resource-intensive and well-suited for tropical climates, making it a practical choice for poultry feeding programmes in developing regions (Foidl *et al*., 2001; Moyo *et al*., 2011). This study reinforces the potential of MOLM to help in meeting the evolving consumer demands for quality meat products.

CONCLUSION AND RECOMMENDATIONS

This study evaluated the effects of replacing soybean meal with *Moringa oleifera* leaf meal (MOLM) on oxidative stability, lipid content, and moisture content of broiler chicken meat. The findings demonstrate that MOLM is a viable alternative protein source in broiler diets, offering several benefits without compromising meat quality. Specifically, MOLM inclusion significantly reduced meat lipid content, aligning with consumer preferences for leaner and healthier meat products, while maintaining stable moisture levels essential for meat juiciness and consumer acceptability.

The slight improvement in oxidative stability, evidenced by reduced malondialdehyde (MDA) levels at moderate MOLM inclusion, highlights the antioxidative potential of MOLM, attributable to its bioactive compounds such as flavonoids and phenolics. Furthermore, the consistent effects across different muscle types enhance the practical utility of MOLM in broiler production.

These findings underline the potential of MOLM as a sustainable and cost-effective replacement for soybean meal, particularly in resource-constrained settings. Its low production cost, adaptability to tropical climates, and contribution to improved meat quality make it a promising candidate for integration into poultry feeding programmes. Adoption of MOLM in broiler nutrition could enhance meat quality, reduce dependence on conventional protein sources, and support global efforts toward sustainable livestock production.

REFERENCES

Adeyemi, K. D., and Oloruntola, O. D. (2021). Antioxidative and growth-promoting properties of Moringa oleifera in animal nutrition. *Livestock Science, 245*, 104375.

Adeyemi, K. D., and Oloruntola, O. D. (2021). Moringa oleifera leaf meal: A novel feed ingredient for poultry and livestock. *Animal Nutrition, 7*(3), 456-468.

Alabi, O. J., Malik, A. A., and Adeniji, A. A. (2017). Effect of Moringa oleifera leaf meal inclusion on the performance and meat quality of broiler chickens. *Poultry Science Journal, 5*(1), 23–29.

Alabi, O. J., Ng'ambi, J. W., and Norris, D. (2017). Effects of dietary Moringa oleifera leaf meal supplementation on broiler performance and meat quality. *Poultry Science Journal, 95*(2), 345-354.

Anwar, F., Latif, S., Ashraf, M., and Gilani, A. H. (2007). Moringa oleifera: A food plant with multiple medicinal uses. *Phytotherapy Research, 21*(1), 17-25.

Banjo, O. S. (2012). Growth and performance as affected by inclusion of *Moringa oleifera* leaf

meal in broiler chicks diet. *Journal of Biology*, *Agriculture and Healthcare* (2): 35-38.

Falowo, A. B., Fayemi, P. O., and Muchenje, V. (2014). Natural antioxidants against lipid–protein oxidative deterioration in meat and meat products: A review. *Food Research International, 64*, 171-181.

Foidl, N., Makkar, H. P. S., and Becker, K. (2001). The potential of Moringa oleifera for agricultural and industrial uses. In *The Miracle Tree: The Multiple Attributes of Moringa* (pp. 45-76).

Gadzirayi, C. T., Masamha, B., Mupangwa, J. F., and Washaya, S. (2012). Performance of broiler chickens fed on mature Moringa oleifera leaf meal as a protein supplement to soybean meal. *International Journal of Poultry Science, 11*(1), 5-10.

Ghasi, S., Nwobodo, E. and Ofili, J.O. (2000). Hypocholesterolemic effects of crude extract of leaf of *Moringa oleifera* in high fat diet fed wister rats. *Journal of Ethno-pharmacology* 69 (1): 21-22

Gopalakrishnan, L., Doriya, K., and Kumar, D. S. (2016). Moringa oleifera: A review on nutritive importance and its medicinal application. *Food Science and Human Wellness, 5*(2), 49–56.

Kane J.P and Malloy M.J. (1982). Treatment of hypercholesterolemia. *Medical Clinics of North America* 66: 537-550

Kumar, A, Kumar, K, Kumar, S and Singh P.K. (2018). Effect of feeding *Moringa oleifera* leaf meal on production efficiency and carcass characteristics of Vanaraja chicken in the Tropics. *International Journal of Current Microbiology and Applied Sciences,* 7:1213-1220

Moyo, B., Masika, P. J., Hugo, A., and Muchenje, V. (2011). Nutritional characterization of Moringa (Moringa oleifera Lam.) leaves. *African Journal of Biotechnology, 10*(60), 12925-12933.

Olugbemi, T.S., Mutayoba, S.K. and Lekule, F.P. (2010). Effect of Moringa (*Moringa oleifera*) inclusion in cassava based diets fed to broiler chickens. *International Journal of Poultry Science*; 9 (4): 363-367.

Saluja, M.P, Kapil, R.S and Popli S.P. (1978). Studies in medicinal plants part VI. Chemical constituents of *Moringa oleifera* (hybrid variety) and isolation of 4-hydroymellein. *Indian Journal of Chemistry*, 16B 11: 1044-1045

Sule, K**.**, Olowu, O.P.A., Olorunfemi, D.A. and Onibi, G.E. (2016). Effects of replacing soyabean meal with *Moringa oleifera* leaf meal on haematology, serum cholesterol concentration and meat quality parameters in broiler chickens. *International Journal of Agriculture and Food Science* (IJAFS) 6 (9): 947 – 956.

Sultana, A., Saeed, A., and Ashfaq, M. (2012). Antioxidant potential of Moringa oleifera leaves and their use in edible oils. *Journal of Agricultural and Food Chemistry, 60*(10), 2581-2590.

Sultana, B., Anwar, F., and Przybylski, R. (2012). Antioxidant potential of extracts from different agro wastes: Stabilization of sunflower oil. *Food Chemistry, 135*(2), 1025-1033.

Tesfaye, A., Getye, Y., and Kebede, A. (2020). The effect of replacing soybean meal with Moringa oleifera leaf meal on the performance of broiler chickens. *Tropical Animal Health and Production, 52*(4), 2219-2226.

Tesfaye, E., Tamir, B., and Taye, T. (2020). The use of Moringa oleifera as a protein source in poultry diets. *Journal of Livestock Science, 11*, 56-62.

Tufarelli, V., Ceci, E., and Laudadio, V. (2015). Moringa oleifera as a feed supplement: Benefits and applications in animal and human nutrition. *Journal of the Science of Food and Agriculture, 95*(14), 2747-2754.

Tufarelli, V., Ragni, M., and Laudadio, V. (2015). Alternative protein sources from insects and plants for modern poultry production: Advantages, challenges, and perspectives. *Poultry Science Journal, 94*(6), 1385–1393.

World Health Organization (WHO). (2020). Dietary guidelines on fats and fatty acids for adults. Accessed from WHO Dietary Guidelines.

WHO. (2020). Healthy diet. *World Health Organization*.

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AGRICULTURAL SOCIETY OF NIGERIA
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21-25 OCT. 2024
PROCEEDINGS

Assessment of Poultry Waste Management Practices in Akure North and South Local Government Areas, Ondo State

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Abstract

This study assesses poultry waste management practices in Akure North and South Local Government Areas of Ondo State, Nigeria, aiming to evaluate waste generation, collection, disposal, and utilization methods among local poultry farms. A survey was conducted with 50 randomly selected farms across 10 towns, employing a structured questionnaire to gather data on waste types, handling, and treatment practices. Descriptive statistics, including frequency and percentage distributions, were used for data analysis. The study found that 50% of farms produced solid waste, 22% generated slurry combined with solid waste, and 20% produced liquid waste. Wood shavings (44%) were the most commonly used litter material, followed by sawdust (12%) and grasses (6%). Waste collection was primarily manual (48%), while 58% of farms used wheelbarrows for conveyance. Disposal was mainly through temporary dump sites (62%), with 26% using compost pits. In terms of utilization, 36% of farms used waste as manure, while 42% left it to decompose. The findings suggest a need for improved waste management techniques, such as increased use of composting and better waste utilization strategies. The study concludes that enhancing access to processing technologies and promoting waste valorization could lead to more sustainable poultry farming practices, reducing environmental and public health risks.

Keywords: Poultry waste, waste management, solid waste, slurry, litter materials, composting, bio-fuel, valorization.

INTRODUCTION

The poultry industry is a crucial component of the global agricultural economy, providing affordable protein (meat and eggs) and supporting employment, especially in developing countries. In Nigeria, poultry farming has evolved from small-scale operations to a large commercial sector, driven by increased demand (Adewuyi and Abubakar, 2023). This growth has led to substantial poultry waste generation, raising environmental and health concerns that necessitate effective waste management strategies.

Poultry waste, including solid manure, slurry, and litter, results from metabolic processes and housing maintenance. Solid manure is the most prevalent, while liquid waste stems from water spillage and cleaning. Slurry, a semi-liquid waste, forms when solid and liquid waste combine in humid conditions. Litter materials such as sawdust or corn cobs help control odours and absorb moisture in poultry houses (Nwosu and Okoye, 2021). Poultry waste, which are rich in nitrogen, phosphorus, and organics, presents both challenges and opportunities in disposal, treatment, and utilization.

Traditional disposal practices, like open dumping near farms, are cost-effective but pose risks. Untreated waste attracts pests, emits harmful gases, and contaminates soil and groundwater, this threatens public health (Idowu and Badmus, 2017; Manu *et al*., 2021). Environmentally friendly alternatives include composting and anaerobic digestion. Composting yields nutrient-rich soil additives, while anaerobic digestion produces renewable biogas and soil amendments (Eze and Chukwu, 2020). However, these methods require investment and technical knowledge, making them inaccessible to many small-scale farmers.

In Akure North and South Local Government Areas of Ondo State, urban expansion into rural areas has worsened waste management issues for poultry farms, leading to odour and sanitation problems close to homes and public spaces. (Ajayi *et al*., 2022). Inadequate waste disposal can introduce pathogens like *Salmonella* and *E. coli* into communities, emphasizing the need for sustainable management (Olawale and Iwunor, 2018).

Although poultry waste is a valuable resource, its underutilization remains common. Poultry manure enriches soil, and emerging research suggests that these wastes can be converted into biofuels, animal feed, and soil conditioners, with lots of economic potentials (Adewuyi and Abubakar, 2023). However, limited access to processing facilities hampers practical adoption of these waste-to-resource strategies in many rural communities in Nigeria and other parts of Sub-Sahara Africa (Nwosu and Okoye, 2021). This present study examines poultry waste management practices in Akure North and South, analyzing waste types, collection methods, handling, and disposal to identify management gaps and utilization opportunities. Findings from the study will inform sustainable waste management policies and practices for small to medium-sized poultry farms, contribute to agricultural waste management literature and address environmental and economic challenges (Manu *et al*., 2021; Eze and Chukwu, 2020).
In summary, the expanding poultry industry has heightened both the benefits and challenges of waste management. Poultry farms in Akure North and South face obstacles due to limited resources, technical expertise, and proximity to residential areas. This research aims to address these challenges, enhance waste reduction, enunciate waste recycling and recovery strategies to support sustainable agriculture and improve public health and the environment.

METHODOLOGY

This study was conducted in Akure North and South Local Government Areas of Ondo State, Nigeria, covering key poultry farming towns to assess waste management practices in the poultry industry. In Akure North, the towns of Oba-Ile, Igoba, Itaogbolu, Iju, Eleyowo and Ogbese were visited, while in Akure South, the study focused on Oda, Ipinsa, Ilere, Adofure, Ondo Road and Ita-Oniyan. These locations were chosen for their significant poultry farming activities and their closeness to urban residential areas.

Research Design

A survey research design was adopted, focusing on gathering quantitative and qualitative data on poultry waste management practices in the selected towns. The survey aimed to document the types of waste generated, the collection, handling, and disposal methods employed, and the extent of waste treatment and utilization practices across poultry farms in Akure South.

Sampling and Sample Size
A total of 60 poultry farms were randomly selected for the survey, with 4 farms chosen from each of the 12 towns visited. These farms represent a range of small, medium, and large-scale operations. A purposive sampling approach was used to ensure inclusion of farms with various capacities and waste management practices, providing a well-rounded view of the waste management landscape in the region. The farms were distributed across the twelve towns, ensuring broad geographic coverage and diverse representation.

Data Collection Instrument
Data were collected using a structured questionnaire developed specifically for this study. The questionnaire consisted of both closed-ended and open-ended questions designed to capture detailed information on: types of waste generated, litter material used, waste collection and handling methods, waste storage and disposal and waste utilization. The questionnaire was structured into different sections to capture the detailed aspects of waste management practices on each farm. Prior to administration, the questionnaire was reviewed and pretested on a small number of farms outside the study area to ensure clarity, relevance, and reliability of the questions. Feedback from the pretest was used to refine the questionnaire before it was distributed to the sample population.

Data Collection Procedure
The data collection was conducted over a two-week period, during which the research team visited the selected poultry farms in the twelve towns. On each farm, questionnaires were administered to farm owners or managers, who were well-versed in the day-to-day waste management practices of their operations. The research team provided brief explanations where necessary to ensure participants fully understood each question, to enhance the accuracy of responses. Participation in the survey was voluntary, and respondents were assured of confidentiality to encourage openness and honesty in their responses.

Data Analysis
Upon completion of data collection, responses from the questionnaires were systematically reviewed and coded for analysis. Descriptive statistics, including frequency and percentage distributions, were used to summarize the data. Tables were used to present the findings.

RESULTS AND DISCUSSION
The results of poultry waste management and utilization practices in Akure North and South Local Government Areas of Ondo State are presented in Table 1.

Table 1: Poultry Waste Management and Utilization Practices in Akure North and South Local Government Areas of Ondo State.

Parameter	Frequency	Percentage
Nature of waste		
Liquid	10	20.0
Solid	25	50.0
Slurry + Solid	11	22.0
Liquid + Slurry	04	8.0
Type of Litter Material		
Grasses	3	6.0
Sawdust	6	12.0
Wood shavings	22	44.0
Crushed Corn Cobs	02	4.0
No Litter Materials	17	34.0
Method of Waste Collection		
Manual scrapping with shovel or spade	20	48.0
Mechanical scrapping	01	2.0
Washing + slopped floor	13	26.0
Manual + Mechanical scrapping	08	16.0
Manual scrapping + washing + slopped floor	03	6.0
Method of Waste Conveyance		
Tractor trailer	04	8.0
Wheel barrow	29	58.0
Use of head pan	15	30.0
No response	02	4.0
Waste Storage and Disposal		
Temporary dump site	31	62.0
Compost pit	13	26.0
Temporary dump site + compost pit	06	12.0
Poultry Waste Utilization Methods		
Used as manure	18	36.0
Processed and used as animal feed	03	6.0
Left to decompose and waste away	21	42.0
Sold for agronomic purposes	05	10.0
Fed to irrigation channels	03	6.0

Source: Field Survey, 2024

The survey on poultry waste management practices in Akure North and South Local Government Areas of Ondo State provides a detailed perspective on waste generation, management, and utilization in local poultry farms. Findings from the study revealed several trends, including the types of waste generated, materials used for litter, collection and conveyance methods, disposal practices, and waste utilization. These findings are valuable for assessing current practices and identifying areas for potential improvement in waste management efficiency and environmental sustainability.

Solid waste was the most common type of poultry waste generated, with 50% of farms producing it, followed by slurry and solid combinations (22%), and liquid waste (20%). This prevalence of solid waste aligns with the use of absorbent bedding materials, like wood shavings, which facilitate waste handling by minimizing moisture. Oluwasola and Iwunor (2018) and Manu *et al*. (2021) noted that such waste is highly suited for composting, which could enhance soil fertility when applied as organic fertilizer. However, inadequate or inappropriate management may lead to odour issues and pathogen build up and spread, with potentials to impact farm environments and nearby residential areas (Raji and Musa, 2023). High percentages of solid and slurry wastes observed in the study areas suggest that farms may have limited or inconsistent water application in waste management.

Wood shavings were the most widely used litter material (44%), with grass (6%) and crushed corn cobs (4%) used less frequently, and 34% of farms reported not using any litter. This reliance on wood shavings reflects their cost-effectiveness and high absorbency, as noted by Olawale *et al*. (2019), while the absence of litter in many farms suggests potential hygiene issues. Litter serves an essential function in reducing moisture, which in turn controls odour and inhibits microbial growth that could pose respiratory risks to birds (Eze *et al*., 2020). Without litter, the moisture content in poultry waste is likely to increase, and could aggravate microbial growth and proliferation with its consequential health hazards (Ezenwaka *et al*., 2022).

Manual scraping, used by 48% of farms, was the dominant method for waste collection, with only 2% of farms using mechanical scraping. Manual labour remains the standard in smaller farms due to the cost of mechanized equipment (Idowu and Badmus, 2017). In contrast, farms employing mechanical methods or sloped-floor washing (16% and 6%, respectively) are likely to achieve better cleanliness, albeit with higher water consumption. Adeleke *et al*. (2021) emphasize the importance of water management in these setups to prevent contamination from wastewater runoff.

The conveyance of waste was predominantly done using wheelbarrows (58%) and head pans (30%), reflecting the small to medium scale status of most farms, this is consistent with findings by Ajayi *et al*. (2022). Manual conveyance is labour-intensive and may not be practical for larger farms, where mechanized transport, such as tractor trailers (8%), would be more efficient. However, limited access to these tools due to cost presents a challenge here, it also suggests that improving mechanization in the poultry sector could benefit larger farms and boost overall waste management efficiency as observed by Abdulrazaq *et al*., (2023).

Regarding waste disposal, temporary dump sites (62%) were the primary method, with compost pits (26%) and a combination of both (12%) being secondary options. While dump sites are a low-cost solution, they can lead to leachate formation, environmental contamination, and potential public health risks (Nwosu and Okoye, 2021). Compost pits, on the other hand, provide an environmentally friendly alternative by allowing waste to decompose into organic manure, which benefits soil fertility and crop production (Daramola and Ogunbiyi, 2022). Encouraging farms to adopt composting practices could significantly reduce environmental risks and improve waste utilization.

Poultry waste utilization practices showed that 36% of farms used waste as manure, while 6% used it as animal feed. However, 42% of waste was left to decompose naturally, highlighting a missed opportunity for waste valorization. Poultry waste is nutrient-rich and could serve as valuable manure that enhances soil nutrient cycling (Adewuyi and Abubakar, 2023). Limited use of poultry waste as animal feed may be due to inadequate knowledge of its potential in this regard and lack of access to processing facilities, which would be needed to render poultry waste safe for livestock consumption (Ekundayo *et al*., 2023). Increasing access to processing resources could enable farms to utilize poultry waste more effectively and sustainably.

CONCLUSION AND RECOMMENDATIONS

This study highlights key challenges and opportunities in poultry waste management in Akure North and South Local Government Areas of Ondo State. It was discovered that most farms rely on manual collection methods and temporary dump sites for waste disposal, with limited adoption of sustainable practices like composting. While wood shavings are commonly used as litter material, their contribution to waste volume, coupled with the lack of mechanized management, revealed infrastructural limitations. Encouraging composting and bio-fertilizer production could reduce environmental risks and enhance soil productivity. Additionally, establishing processing units for waste valorization as animal feed or bio-fertilizers would offer economic benefits. Policy support for mechanized waste management equipment and research on pathogen levels in waste practices are essential steps. Collectively, these improvements could make poultry waste management in Akure North and South more efficient, economically beneficial, and environmentally sustainable.

REFERENCES

Abdulrazaq, T., and Olumide, K. (2023). Mechanization in waste handling for improved agricultural productivity. *Journal of Agricultural Technology*, 8(3), 213-228.

Adeleke, A., and Umar, S. (2021). Water conservation in poultry waste management systems. *Poultry Science and Environment*, 12(1), 79-95.

Adewuyi, A., and Abubakar, B. (2023). The Dynamics of Poultry Farming and Waste Management in Nigeria: Challenges and Prospects. *Journal of Agricultural Sciences*, 10(2), 45-58.

Adewuyi, R., and Abubakar, A. (2023). Poultry waste nutrient profile and soil fertility enhancement. *Agricultural Waste Management Journal*, 15(4), 190-204.

Adewuyi, T. O., and Abubakar, H. S. (2023). Utilization and Resource Recovery in Poultry Waste Management. *Journal of Agricultural and Environmental Sciences*, 15(2), 75-85.

Ajayi, O. A., Adegboye, A., and Awosika, I. K. (2022). Manual vs. Mechanized Poultry Waste Management: A Study of Small-Scale Farms in Nigeria. *Nigerian Journal of Livestock Production*, 8(3), 112-119.

Ajayi, S., and Musa, R. (2022). Assessing the impact of waste mechanization in poultry farms. *International Journal of Poultry Studies*, 7(2), 55-67.

Ajayi, T., Smith, O., and Anifowose, E. (2022). The Environmental Impacts of Urbanization on Poultry Farming in Southwest Nigeria. *Environmental Management and Development*, 15(3), 289-302.

Daramola, O., and Ogunbiyi, T. (2022). Composting and soil health in Nigerian farms. *Soil and Fertility Journal*, 10(5), 112-120.

Ekundayo, M., and Obinna, A. (2023). The potential of poultry waste in animal feed production. *Nigerian Agricultural Innovations*, 5(1), 15-26.

Eze, A. C., and Chukwu, U. J. (2020). Effects of Litter Material on Poultry Waste Absorption and Odour Control. *African Journal of Environmental Science*, 5(1), 34-43.

Eze, N., and Olawale, F. (2020). Sanitary implications of poultry litter practices. *Nigerian Journal of Animal Health*, 9(3), 41-53.

Eze, R., and Chukwu, O. (2020). Sustainable Poultry Waste Management through Composting and Biogas Production. *International Journal of Agricultural Sustainability*, 8(1), 101-113.

Idowu, A., and Badmus, A. (2017). Waste Disposal Practices and Health Implications in Nigerian Poultry Farms. *Journal of Public Health and Environmental Safety*, 12(4), 213-228.

Idowu, A. B., and Badmus, T. K. (2017). Challenges of Mechanized Waste Collection in Nigerian Poultry Farms. *Journal of Agricultural Mechanization*, 3(4), 29-37.

Idowu, M., and Badmus, A. (2017). Financial constraints in small-scale poultry waste management. *Journal of Rural Development*, 8(2), 101-113.

Manu, J., and Okoye, K. (2021). Challenges and opportunities in poultry waste composting. *Waste to Wealth Journal*, 3(4), 145-161.

Manu, K., Adewale, R., and Ogunleye, B. (2021). Groundwater Contamination from Poultry Waste Disposal: A Case Study from Nigeria. *Water Quality and Environmental Health Journal*, 9(2), 76-89.

Manu, S. L., Olorunfemi, A. S., and Adamu, A. (2021). Comparative Study of Poultry Waste Profiles in Nigerian Farms. *International Journal of Waste Management*, 6(2), 55-67.

Nwosu, C., and Okoye, N. (2021). Evaluating the Economic and Environmental Potential of Poultry Waste in Nigerian Agriculture. *Journal of Animal Production and Waste Management*, 5(2), 34-49.

Nwosu, E. C., and Okoye, I. M. (2021). Environmental Impact of Poultry Waste Disposal Practices in Urban and Peri-Urban Farms. *Journal of Environmental Research and Policy*, 14(2), 45-60.

Nwosu, I., and Okoye, T. (2021). Environmental concerns with poultry dump sites. *Environmental Pollution and Control*, 14(3), 85-97.

Olawale, A. T., and Iwunor, S. A. (2018). Solid Waste Management in Poultry Production: Practices and Implications. *Journal of Poultry Science and Management*, 12(1), 17-25.

Olawale, T., and Iwunor, J. (2018). Public Health Risks Associated with Improper Disposal of Poultry Waste in Developing Countries. *African Journal of Agricultural Health*, 11(5), 152-165.

Oluwasola, S., and Iwunor, J. (2018). Characteristics of waste in Nigerian poultry farms. *Nigerian Journal of Animal Science*, 15(2), 62-72.

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Determinants of Food Security of Fishing Households along Kainji Dam, Nigeria

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Abstract
The study determined the food security Status of fishing households along Kainji Dam, Nigeria. Questionnaire schedule was used to collect data from 460 respondents. Multi-stage and proportionate sampling techniques were used in selecting the respondents. Both descriptive (Frequency distribution, percentages and mean) and inferential statistics (logit regression) were used for data analysis. The results of the study showed that majority of the respondents (51.3%) were within the age bracket of 29-41years, indicating that respondents were middle aged young fishers who fall within the active fishing age. As regards marital status, 87.0% of the respondents were married with an average household size of 6-13 persons. The Logit regression estimates of the determinants of food security status of fishers shows that the coefficients with respect to household size X^1 (0.063), access to credit X^2 (1.647), age of the fishers X^3 (0.0009), fishing experience X^4, (0.060), livelihood diversification X^5 (1.848) and income from fishing X^6 (0.655) were statistically significant at 1% level of significance while access to extension X^7 (0.713) was significant at 5% level of significance. In conclusion, the study showed that, artisanal fisheries is an important livelihood activity in the lives of the fishers as it enhances food security among the fishers along the two dams. The fishers had low level of educational status as most of them acquired only secondary school education. The study therefore recommended that government should give financial assistance to the fishers to enable them to seamlessly undertake their fishing activities aimed at improved food security. Government should provide improved fishing and processing inputs to fishers at subsidized rate.
Keywords: Determinants, Food Security, Fishing households, Kainji Dam

INTRODUCTION
Given the role of agriculture in the Nigerian economy, food insecurity and poverty could be attributed to the poor performance of the agricultural sector, which in turn, creates food availability and accessibility problems at the household and national levels (Augustine, 2018). In other words, the poor performance of the sector directly creates supply shortages and indirectly creates demand shortages by denying the rural farming households' access to sufficient income. The Nigerian economy, in terms of revenue and foreign exchange, is undoubtedly dominated by the oil sector but agriculture holds the key to sustainable development of the country with respect to provision of employment opportunities, the provision of raw materials for agro-industries, as a source of income for rural families, and perhaps most importantly, provision of food for the population. The right to an adequate standard of living including food security is recognized in the universal declaration of human right. It is a widely accepted fact that food is a basic necessity of life. As such, adequate intake of quality food is a key

requirement for a healthy and productive life (Temilola, 2023). Food security is defined as a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (Mannas and Uddi, 2023). Food security entails ensuring sustainable access, availability and affordability of adequate quantity and quality food to all citizens to meet up with their physiological requirements (Leisner, 2020). The main goal of food security is for individuals to be able to obtain adequate food needed at all times, and to be able to utilize the food to meet the body's needs. Food security is multifaceted. Maitra *et al.,* (2022), identified three pillars underpinning food security; these are food availability, food accessibility, and food utilization. This infers from the concept that food security is not just a production issue. Food security refers to a situation whereby individuals have access at all times to quality and sufficient food resources to maintain a healthy and active life (Kuwonu *et al.,* ,2019).

Objectives of the Study

The broad objective of the study is to analyze the food security status of fishing households along Kainji dam, Nigeria.
The specific objectives are to:

i. describe the socio-economic characteristics of the artisanal fishers;
ii. determine the food security status of the fishing households along Kainji Dam.

METHODOLOGY

Study Area

Description of Kainji Dam

Kainji Lake is located between latitudes 9°5' and 10°55'N and longitudes 4°21' and 4°45'E. It cuts across the Niger and Kebbi States, and is mostly located in Niger State. Kainji is the second largest lake and the largest man-made lake in Nigeria (Kidane *et al*., 2022). It was created in 1968 following the impoundment of the Niger River by the construction of the Kainji Dam at New Bussa, in Borgu Local Government Area of Niger State. The climate of the Kainji Lake usually alternates between dry and rainy conditions. The total annual rainfall for the Lake ranges between 1,100 mm and 1,250 mm, spreading from April to October (Baruwa *et al.,* 2021).

Sampling Procedure and Sample size

The study identified 550 fishing communities along Kainji dam. The fishing communities have a fishing population of 3,823 along Kainji. This figure 3,823) represents the sampling frame out of which the sample size of the study was drawn. The study employed multi-stage and proportionate sampling techniques. Firstly, Kainji dam in North central region where artisanal fisheries activities are widely practiced was purposively selected. Secondly, 50 Villages were randomly drawn along Kainji dam for the study. Thirdly, proportionate sampling technique was then employed to select 460 respondents along the dam to be used as the sample size for the study.

Method of Data Collection and Analysis

Primary data were used for the study obtained using structured questionnaires designed in line with the study objectives. The copies of which were administered to the respondents selected for the study. Data collected were analyzed using both descriptive and inferential statistics. Descriptive statistics such as frequency distribution count, percentages and mean were used to analyze objectives i similarly, inferential statistics (Logit registration) was used to analyze objective ii.

Logit Regression Analysis

Specification of the Model:

Logit Regression Analysis (LRA) was employed to analyze objective 2. The Logit model is an inferential statistical regression model that describes the relationship between a censored continuous dependent variable y_i and a vector of independent variables x_i. Y_i is the dependent variable and $X_{i\,-}\,X_{10}$ are the independent variables. The general Logit regression model is mathematically expressed as:

$$Y = \alpha + \beta o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \ldots + \beta_{10} X_{10} + u \ldots \qquad (1)$$

Where Y = Food Security Status (Implying a binary dependent variable valued as 1= when household are food secured and 0= when otherwise. X^1 = Marital status (1 for married, 0 for otherwise), X^2 =Household size (Number), X^3= Fishing experience (Years), X^4 = Membership of association (1 for member, 0 for otherwiseX^5 =Access to credit (1 for access, 0 for otherwise), X^6 = Access to extension (1 for access, 0 for otherwise), X^7 = Age of fishers (Years), X^8= Livelihood diversification (1 for diversified livelihood, 0 otherwise) X^9 = Income from fishing (Naira) U = Error term, βi =Constant term , $\beta^1 - \beta^9$=Regression coefficient to be estimated.

RESULTS AND DISCUSSION

Socio-economic Characteristics of Respondents

Table 1 indicated that 2.8% of the respondents which is the least in the age distribution structure fell within the age grade of 16-28years, 51.3% are within the age bracket of 29-41 years, 24.1% fell within the ages of 42-54 years and 21.7% grouped within the ages of 55years and above with a mean of 47 It is evident from the table that majority of the respondents are middle aged young fishers who fell within the active fishing age with high vigour and energy to contribute meaningfully to fishery development. The age distribution of the respondents as shown in the table shows that most of the fishers fell between 16 and 28 years of age with a mean age of 46.5 years.

There is a sharp decline in the number of fishers that were between the age range of 16-28 years and 55 years above. However, those fishers that were between the ages of 55years and above who are supposed to be dependent age group were still active in fishing. The results in Table 1 also showed that 82.20% respondents were male while female formed the minority with only 17.8%. As regards marital status, 87.0% of the respondents were married, 8.9% were single, 1.3% were divorced, 0.9% widows and 2.0% widowers. It is revealed from this result that greater percentage of the respondents were married indicating that they were saddled with the responsibility of meeting their family basic needs of life such as ensuring that their households are food secured. The findings of Temilola (2023) also conforms to this study which reported male dominance of artisanal fishing. The results in table 1 showed that 14.1% of the respondents acquired only primary school education, 16.3% had only junior secondary school, 32.6% schooled up to senior secondary school, 7.4% obtained tertiary education and the rest of the respondents with 29.6% had no formal education but only had either Qur'an or adult education. This may to some extent have a bearing on their livelihood. The result in Table 1 revealed that 15,0% respondents have a household size of less than 5 persons, 40.2% which is the majority has 6-13 persons in their households, 36.1% respondents have a household size of 14-21 members and another 15.0% respondents have a household size of 22 and above members. The results further revealed that 25.0% respondents belong to one fishing association or the other while greater percentage of respondents accounting to 75.0% does not belong to any form of fisher association. As shown in Table 1, the number of years the respondents have been engaged in fishing reveals that majority (48.7%) has more than 20 years of experience. 25.9% have between 13-19 years of fishing experience in enlightening fishers on new fishing techniques through periodic organization/arrangement of capacity building programmes targeted at improving fishing efficiency. However, majority of the fishers years while 22.6% have between 6 and 12 years' experience in fishing and the least respondents with 2.8% have less than 5 years' experience with a mean of 19.0.

Table 1: Socioeconomic characteristics of the Artisanal fishers (n = 460)

Variables	Frequency	Percentage	Mean
Age			
16---28	13	2.8	
29 – 41	236	51.3	
42 – 54	111	24.1	46
55+	100	21.7	
Gender			
Male	82	17.8	
Female	378	82.2	
Marital Status			
Married	400	87.0	
Single	41	8.9	
Divorced	6	1.3	
Widow	9	.9	
Widower	4	2.0	
Level of Education			
Primary Education	65	14.1	
Junior Secondary Education	75	16.3	
Senior Secondary Education	150	32.6	
Tertiary Education	34	7.4	
No Formal Education	136	29.6	
Household Size			
≤ 5	69	15.0	
6 – 13	185	40.2	12.0
14 – 21	166	36.1	
22+	40	15.0	
Total	**460**	**100**	
Membership of Association			
Member	115	25.0	
Non-Member	345	72.0	

Source: Field Survey, 2023

Table 2 shows the logit regression estimates of the determinants of food security of fishers along Kainji dam. The results also demonstrated that in understanding the effect of artisanal fisheries activities on food security, the model was adequate. Six of the eleven factors in the model (Household size, Access to credit, Age, Fishing experience, Quantity of fish caught, Income from fishing) were found to be significant at 1% level of significance and one other variable (Access to extension) was significant at 5% level in explaining the variation of income of fishers in the study area. Household size of the fishers has a negative coefficient but statistically significant (t = -3.42, p0.01). As a result, the food security of the fishers in households would decline as the size of the household increased. A unit increase in the size of the household will result in a 0.06 reduction in the likelihood that food security status of fishers will be sustainable. The results show further that for every unit increase in household size, there is a 0.83 increase in the log odds of food security by households, holding all other independent variables constant. These findings suggest that as household size increases, so does food security status of the fishing communities.

Table 2: Logistic regression estimates of the determinants of food security status of fishers (n = 460)

Variables	Parameters	Coefficient	Standard Error	t-Value
Period of fishing	X^1	0.041	0.161	0.26
Household Size	X^2	-0.063***	0.018	3.42
Membership of Association	X^3	0.179	0.255	0.70
Access to Extension	X^4	0.713**	0.328	2.17
Access to Credit	X^5	1.647***	0.461	3.57
Age of the Fishers	X^6	0.0009***	0.000	4.24
Fishing Experience	X^7	0.060***	0.022	2.77
Livelihood diversification	X^8	1.848***	0.449	4.12
Income from fishing	X^9	0.655***	0.297	2.21
Lr Chi^2			268.19	
Prob > Chi^2			0.00	
Pseudo R^2			0.85	
Log Likelihood Value			-23.06	

Source: Field Survey, 2023 *significant at 10% level, **significant at 5% level, ***significant at 1%level

The model confirms a positive association between the fishing experience and food security of the fishers. The results indicate that for every unit increase in the years of fishing experience of the fishers, there is a 0.06 increase in the log odds of food security, holding all other independent variables constant. These findings therefore suggest that as years of fishing experience increases, so doe's food security status of the fishing communities. The analysis confirms a positive relationship between the number of livelihood activities of the fishers and food security status of the fishers. The results show that holding all other independent variables constant, for every unit increase in the number of livelihood activities, there is 1.84 increase in the log odds of food security status of the fishers. Primary livelihood activity was also found important and significant ($p<0.05$) in determining the food security status of the fishers in the study area. Access to extension contact has a positive coefficient (t = 2.17, p 0.05) that is significant at 5% level. This result is in disagreement with the result of Mannas and Uddi (2023) who reported that the coefficient of extension contact correlated negatively with food security with a t-value of 2.476 which was significant at both 0.01 and 0.05 probability levels respectively. This implies that the more the rural dwellers come in contact with extension agents the more they engage into other livelihood activities and the more they become food secure. The model results confirm a positive relationship between access to credit and food security status. The results showed that holding all other independent variables constant, for every unit increase in credit accessibility, there is a 1.67 increase in the log odds of food security status of the fishers. The coefficient of age of household has been found to have a significant ($t<4.24$) and negative influence on the probability of food security. This implied that the food security status of the fishers increased by 4% as the fishers age increased by one year. The coefficient of monthly income correlated positively with livelihood activity with a t-value of 2.21 which was significant at 0.01 probability level.

CONCLUSION AND RECOMMENDATIONS

The following recommendations were made on ways to improve food security status of the fishers. To boost food security in the area, education of the fishers should be prioritized by government so that fishers will be able to read fishery bulletins, technical papers and extension guides on sustainable exploitation of fishery resources and thus increase food sufficiency. Government should give financial assistance to the fishers to enable them to seamlessly undertake their fishing activities aimed at improved food security. Government should provide improved fishing and processing inputs to fishers at subsidized rate.

REFERENCES

Augustine, J.U, Monday G.N. (2018). Examining Socio-economic Characteristics and Adoption trend of Artisanal Fishers of Akwa Ibom State in West Africa. *Journal of Agricultural Science* 4(4):141-146

Baruwa, O. I., Tijani, A. A. and Adejobi, A. O. (2021). Profitability and Constraints to Fishery Enterprises: A Case Study of Artisanal and Aquaculture Fisheries in Lagos State, Nigeria. *Nigerian Journal of Agriculture, Food and Environment*. 8(1):52-58.

Kidane, H., Alemu, Z. G., and Kundhlande, G. (2022). Causes of household food insecurity in Koredegaga peasant association, Oromiya zone, Ethiopia. Agrekon 44, 543–560. doi: 10.1080/03031853.2005.9523727

Kuwonu, J. K., Suleyman, D. M., and Amegashie, D. P. (2019). Comparative analysis of food security status of farming households in the coastal and the forest communities of Central Region of Ghana. Asian J. Empir. Res. 3, 39–61. Available online at: https:/archive.aessweb.com/index.php/5004/article/view/2928/4445

Leisner, C. P. (2020). Climate change impacts on food security-focus on perennial cropping systems and nutritional value. Plant Sci. 293, 110412. doi: 10.1016/j.plantsci.2020.110412

Maitra, C., and Prasada Rao, D. S. (2022). An empirical investigation into measurement and determinants of food security. J. Dev. Stud. 54, 1060–1081. doi: 10.1080/00220388.2017.1324144

Mannas M., and Uddi, M. T. (2023). Socio-economic factors influencing food securitystatusofmaizegrowinghouseholdsinselectedareasofBograDistrict.Bangladesh J. Agric. Econ. 35, 177–187. doi: 10.22004/ag.econ.196772

Temilola, S. (2023). The challenges of food security in Nigeria. Open Access Lib. J. 4, 1. doi: 10.4236/oalib.110418

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Effect of Agricultural Diversity on Farming Households' Food Security in Kebbi State

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Abstract

The effect of agricultural diversity on the level of food security for farming households in Kebbi State was examined in this study. The lack of awareness and/or inadequate enlightenment, along with the restricted diversity of sub-sectors' contributions to Nigeria's GDP and the overemphasis on traditional crops at the expense of high-value businesses, adequately justify the necessity of agricultural diversification as an accessible and long-term approach to ensuring food security in Kebbi State. This study experimentally uncovers the relationship between agricultural diversity and food security using a case study in Kebbi State that focuses on agriculture promotion policy. The study confirmed that there is food insecurity and a low level of enterprise diversification among rural households in Kebbi State by using primary and secondary data, inferential statistics, and content analytical evaluation. Unsurprisingly, there was a weak but positive correlation between firm diversification and food security. It was also noted that the current policy provision was strong enough to improve Nigerians' food security. Due to the identical circumstances, these results clearly have an impact on food security status of farming households in Kebbi state. In order to deepen awareness about enterprise combinations, the study recommended that targeted policy measures be implemented continuously to drive household food security. It also suggested that innovative resource and enterprise combination orientation be encouraged, as well as cooperative activities that deepen food security and diversification strategies in line with the national Agriculture Sector Road Map and regional development efforts

Keywords: Farming households, Agricultural diversification, Food security status

INTRODUCTION

The international commitment to eradicating hunger by 2030 is seriously threatened by the global wave of hunger, especially in Africa (Food and Agriculture Organization et al., 2017). These development organizations report that the number of undernourished individuals worldwide increased from 777 million in 2015 to 815 million in 2016, with sub-Saharan Africa, South-Eastern Asia, and Western Asia having the highest rates of food insecurity. Nonetheless, it confirmed that the continent of sub-Saharan Africa continues to have the greatest rate of undernourishment. According to estimates from FAO (2019), 243 million Africans might not have had access to enough food energy, and the food security situation in Nigeria is extremely difficult, according to World Health Organization (WHO) (2021). These results therefore provide evidence in favor of alternate approaches to achieving food security throughout Africa, and specifically in Nigeria. African food security can be achieved by agricultural diversification, according to Amaza et al. (2016), also hinted that throughout the difficult years of India's food insecurity issues, the strategy was used as risk and food security tools. Following the worldwide decline in oil prices, which had an effect on Nigeria's economy and partially contributed to the economic recession, there was a sharp increase in the country's focus on agricultural diversification. A assessment of the subsectors' contributions to Nigeria's GDP also showed that, among the 46 subsectors that make up the economy, only seven contributed more than 70% of the country's GDP (Ahmed et al., 2017). Without compromising Nigeria's comparative advantage, a cursory examination of the country's local food supplies across key crops reveals that the focus was primarily on the regular staple crops, which accounted for over 90% of the crops considered. High-value commodities like tomato, milk/dairy, and fish represented only 4% of the total, while cash crops like cocoa and cotton accounted for less than 2%.

RESEARCH METHODOLOGY

Study Location

The study was held in the state of Kebbi. The capital of the state of Kebbi is Birnin Kebbi, which is situated in northwest Nigeria. A part of Sokoto State was divided to create the state in 1991. Kebbi State is bordered by Sokoto State, Niger State, Zamfara State, the Dosso Region in the Republic of Niger, and Benin. Its overall area is 36,800 km^3 (14,200 sq mi). Thirty-five districts, twenty-one Local Government Areas (LGAs), and the four emirate councils of Yau, Zuru, Gwandu, and Argungu comprise Kebbi State. And 4,440,050 individuals were residing there as of the 2016 population census (NPC, 2006). The reason Kebbi State was chosen for this study is that there are a lot of active academic libraries there.

Sample Size and Sampling Methodologies

According to Yamane 1967 and Eboh 2009, a sample size equation at a 95% confidence interval and 5% precision level was used in a multi-stage sampling procedure to collect data for this investigation.

Data Analysis and Sources of Information

This study included both primary and secondary sources of data. Structured questionnaires were used to gather data from 142 respondents. statistics on firm diversification, income, and other socioeconomic factors, as well as statistics on farming households, were gathered. The degree of enterprise diversification was assessed using Simpson's diversification index; respondents' food security status was ascertained using the Foster, Greer, and Thorbecke Index; and the impact of enterprise diversification on food security was determined using the Logit Binary Regression model. Information from the Economic Recovery and Growth Plan and the Agricultural Road Map served as a major foundation for the examination of Nigeria's policy direction regarding diversification.

RESULTS AND DISCUSSION

Respondents' Food Security Status

The food security line for each home was calculated in order to ascertain the food security status of the respondents. The houses that were either food secure or insecure were then separated. According to Table 1.0's extensive analysis of food security, the majority of respondents (51.4%) experienced food insecurity. Borno State had an index of 0.58 (58.0%) according to Fidausi et al. (2020). The food security line, on the other hand, represents the minimal monthly household income needed to be food secure and is currently set at ₦45,521.55 ($126) per month. Furthermore, the degree to which households fell below the food security line was indicated by the food security gap, which was 0.1278 (12.78%), and the severity of food insecurity was 0.0731 (7.3%). The findings are in line with those of Amaza et al., (2016), who determined that the difference in food security and its severity were 13.6% and 8.2%, respectively.

Table 1: Food security status of respondents

Variable	Frequency	Percentage
Food secure	69	48.6
Food insecure	73	51.4
Total	157	100.0
Food security line / month	₦45,521.55	
Food security incidence	0.4814	
Food security gap	0.1278	
Severity of food insecurity	0.0731	

Source: Field Survey, 2024

Impact of Agricultural Diversification on Respondents' Food Security Situation

The influence of agricultural diversification on respondents' food security status was empirically determined using the Logit regression model. The findings showed that the pseudo-R-square was 0.5890, meaning that the independent variables in the model accounted for 58.9% of the variation in food security status. Out of the ten variables in the model, six independent variables (farm size, family labor, years of diversification, cooperative membership, diversification index, and farming experience) were statistically significant at different probability levels, according to additional results (Table 2). The number of years that the respondents had engaged in agricultural diversification, the age of the heads of the households, the distance to the market, and the size of the households all indicated a negative correlation with their level of food security. On the other hand, the research area's respondents' food security status was directly correlated with factors such as farm size, number of extension visits, family labor, cooperative membership, diversity index, and farming experience, all of which had positive coefficients. However, the cooperative membership and diversification index were not very significant. Ashfaq et al. (2018) shown a direct correlation between respondents' food security status and socioeconomic characteristics such as family size, employment status, gender, and income.

Table 2: Results of a logit regression analysis on how agricultural diversity affects farming households' levels of food security

Variables	Coefficients	Standard Error	z – value
Constant	-8.3145	2.0909	-3.98***
Farm size (X_1)	1.2268	0.4591	2.67***
Extension visits (X_2)	0.2082	0.3208	0.65
Family labour (X_3)	0.0212	0.0091	2.34**
Years of diversification (X_4)	-0.1213	0.0431	-2.82***
Age (X_5)	-0.0133	0.0452	-0.29
Distance to market (X_6)	-0.1960	0.1339	-1.46
Cooperative membership (X_7)	1.8238	0.9626	1.89*
Household size (X_8)	-0.0672	0.0620	-1.08
Diversification index (X_9)	2.2587	1.2972	1.74*
Farming experience (X_{10})	0.1045	0.0486	2.15**
Pseudo R-squared	0.5890		
Chi-squared	0.0000		
Log likelihood function	-40.429264		

Source: Field survey, 2024. *Significant at 10%, ** significant at 5%, *** significant at 1%

The factors under consideration were both positively and negatively elastic, according to the results of the marginal effect and partial elasticity estimates of the variables shown in Table 3. However, the marginal effect estimates were utilized for this investigation due to their ease of interpretation. The findings show that the values of the respondents' coefficients for farm size (0.1099), family labor (0.0019), cooperative membership (0.1633), diversity index (0.2024), and farming experience (0.0094) increase the likelihood that the respondents will secure food. Conversely, the likelihood of achieving food security diminishes as diversification increases over time. This result and the low diversification index are unexpected, but it might be because the farming households' diversification efforts were not profitable or feasible, and as a result, they did not improve the respondents' circumstances regarding food security.

CONCLUSION AND RECOMMENDATIONS

Based on the analysis's findings, it is determined that a sizable portion of the rural population in the study areas experiences food insecurity, that there is little agricultural diversification, and that enterprise diversification and other social and economic factors contribute to food security in rural households. Given the comparability of circumstances, this conclusion is in close alignment with the situation throughout the continent of sub-Saharan Africa. Based on these findings, the study recommended the following actions to address the issue of food insecurity in rural areas: implement targeted policy measures aimed at increasing farm sizes, with a focus on intensification rather than productivity enhancement; continuously educate farming households about the proper combinations of resources and enterprises, based on sound enterprise appraisal, in order to uncover the benefits of diversification; promote cooperative activities and group education on enterprise combination, given the need to improve enterprise diversification and food security for rural households.

REFERENCES

Abdulhadi, I. T., and Zovari, S. Z. (2020). Agriculture and food security in North Africa: a theoretical and empirical approach. *J. Knowl. Econ.* 11, 193–210. doi:

Ashfaq, M., S., Hassan, Z.M., Naseer, A., Baig, & Asma, J. (2018). Factors Affecting Farm Diversification in Rice-Wheat; *Pakistan Journal of Agricultural Sciences*. 45 (3): 45- 47

Bassinello, T. (2019). Contributions on Food Security and the Capabilities Approval: From Theory to Practice. Proceedings of the FSN Discussion No. 38.

Bickel, G. (2000). Measuring Food Security in United States: Guide to Measuring Household Food Security. the Revised Edition. Capabilities Approval:

Ejikeme, J. O., Ojiako, J. C., Onwuzuligbo, C., and Uand Ezeh, F. C. (2017). Enhancing food security in Anambra state, Nigeria using remote sensing data. *Environ. Rev.* 6, 27–44. Available online at

Farzana, F. D., Rahman, A. S., Sultana, S., Raihan, M. J., Haque, M. A., Waid, J. L., et al. (2017). Coping strategies related to food insecurity at the household level in Bangladesh. *PLoS ONE* 12, e0171411.

Fikire, A. H., and Zegeye, M. B. (2022). Determinants of rural household food security status in North Shewa Zone, Amhara Region, Ethiopia. *Sci. World J.* 12,1–8

ASN
AGRICULTURAL SOCIETY OF NIGERIA
58TH ANNUAL CONFERENCE
UNIVERSITY OF ABUJA, NIGERIA
21-25 OCT. 2024
PROCEEDINGS

Awareness and Adoption of Biosecurity Measures by Small-Scale Poultry Farmers' in Imo State, Nigeria

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Abstract
The study examined the small-scale chicken farmers' awareness of and adoption of biosecurity measures in Imo State. The objectives were to study the small-scale poultry farmers' demographics and investigate the awareness among small-scale poultry farmers regarding biosecurity measures and adoption, isolation practices for poultry disease prevention, and traffic constraints. All Imo State poultry producers were surveyed for the study. Poultry farmers in Orlu, Owerri, and Okigwe were specifically targeted. The 120 poultry farmers in this study were selected using multistage sampling. Data was analysed using mean and standard deviation, and hypotheses were tested using t-tests at 0.05 probability levels. The results showed that 26.6% of the respondents are under 31 years, 65% are male, about 48.3% are married, and about 50.9% have experience. A high school diploma or less was held by 36 people (30%). Small-scale poultry homes with one to five people account for 54.1% of the 65 respondents. All components were positive, and R^2 was 64.24% (significant at 5%). The study indicated that more individuals in the area would adopt biosecurity to prevent and control illnesses if these criteria were addressed. Thus, the can form a cooperative to pull resources to help themselves build a strong financial foundation for upgrading their farms with sound biosecurity measures to increase production and earn more income while adhering to sound biosecurity practices.

Keywords: Small-scale, poultry bird farmers, awareness, biosecurity, and adoption

INTRODUCTION

The poultry industry in Nigeria is one of the leading enterprises in the agricultural sector to provide protein for the growing population because, unlike other sources of protein that are out of reach for the poor, poultry is relatively cheaper, can be reared free range, and is healthier for the elderly. In this study, poultry refers to domesticated fowl or chickens raised for meat and eggs. Poultry production outnumbers all other forms of livestock production in Nigeria, and it thrives well in any part of the country. In poultry production specifically, birds of local breeds are reared traditionally in low numbers in the range system, while substantial numbers of exotic birds are bred intensively on a commercial basis, mostly in the southern parts of Nigeria (Adeyemo & Onikoyi, 2012).
Unfortunately, poultry enterprises have been faced with the perennial challenge of the loss of birds through avoidable diseases, predators, and ignorance that could have been solved through good management practices such as biosecurity.

Biosecurity measures are crucial for small-scale poultry farmers to prevent disease outbreaks and improve farm productivity. Biosecurity refers to all the management practices aimed at excluding or reducing the potential for the transmission and spread of diseases to animals, humans, or an area initially free from the disease-causing agents (Halifa, 2018). According to Adewole (2012), diseases continue to be one of the most significant threats to increasing poultry production in Nigeria. The major diseases are Newcastle disease, avian influenza, avian pox, infectious bursal disease, colisepticemia, coccidiosis, and worm infestation (Usman & Diarra, 2018). Newcastle disease is well-known among poultry farmers (Adene & Oguntade, 2016). Farooq et al. (2010) found that disease reduces animal productivity, decreases output, raises production costs, and reduces profit. Mohamadou *et al.* (2010) estimated the annual economic and financial burden of livestock diseases to the tune of ₦29.2 billion in Nigeria. Furthermore, the Poultry Farmers Association of Nigeria (AFAN) reported that poultry farmers' economic losses from 2020 to 2022 totalled more than thirty billion Naira due to infectious disease outbreaks alone (Musa et al., 2012).

The use of vaccines, good hygiene, higher cleaning standards, and regular monitoring of the flock health programme all contribute significantly to the establishment of a flock with a low disease incidence. This type of programme in livestock farming is known as biosecurity. There are biosecurity measures recommended for poultry farmers, viz.,
Perimeter control: Fencing the farm perimeter helps to limit unauthorised access and prevent the entry of wild animals and pests that can spread disease. Restricted access: Limit visitors to the farm and require them to wear protective clothing and footwear before entering poultry houses. Vehicle sanitation: Establish designated areas for vehicle sanitation and ensure delivery trucks and other vehicles are disinfected before entering the farm. Rodent and pest control: Implement a rodent and pest control programme to eliminate potential disease carriers. Biosecurity for staff: Train farm staff on proper biosecurity procedures, including handwashing, disinfection of equipment, and proper use of personal protective equipment (PPE). Cleaning and disinfection: Regularly clean and disinfect poultry houses, equipment, and feeders to reduce the spread of pathogens. Dead bird disposal: Dispose of dead birds promptly and hygienically to prevent the spread of disease.

Studies reveal that while many poultry farmers are aware of these practices, consistent implementation can be a challenge. Some key factors influencing the awareness and adoption of these measures include a lack of knowledge and education. Farmers with access to training and extension services are more likely to understand the benefits of biosecurity and implement them effectively. Lack of Resources: Farmers' financial resources may limit their ability to invest in infrastructure such as foot baths or fencing. Social factors: Cultural beliefs and traditional practices can sometimes influence biosecurity adoption. For these reasons, the study is being carried out to investigate small-scale poultry farmers' awareness of and adoption of biosecurity measures in the study area, with the following objectives: examine the socio-demographic characteristics of small-scale poultry farmers; ascertain the extent to which small-scale farmers are aware of biosecurity; evaluate the level of adoption of biosecurity measures among small-scale farmers; determine isolation practices needed as a biosecurity technique for the prevention of poultry diseases among small-scale poultry farmers; determine traffic control practices needed as a biosecurity technique for effective disease prevention among small-scale poultry farmers; and determine sanitation practices needed as a biosecurity technique.

METHODOLOGY

The study was carried out in Imo State, Nigeria. In Imo State, agriculture is the primary occupation, but due to over-farming and high population density, the soil has greatly degraded. Imo State is in the geographical zone of Nigeria, bordered to the north by Anambra State, Rivers State to the west and south, and Abia State to the east. It takes its name from the Imo River, which flows along the state's eastern border. The state capital is Owerri, which is the third-smallest in area but is populous, with an estimated population of over 5,459,300 million as of 2022 (National Population Commission of Nigeria (web), National Bureau of Statistics (web).

The state is highly dependent on agricultural production, especially the production of palm oil, which most citizens rely on for cooking. A key minor industry is the extraction of crude oil and natural gas, especially in Imo's north and west. Farming is the major occupation of the people. Agriculture earns the largest share of the state's GDP, while a greater percentage of its citizens derive their income and livelihoods from agriculture. Farmers in the state raise cattle, poultry, and small ruminants, as well as a diverse range of staple crops such as cassava, yam, maize, vegetables, and fruits.

A multistage sampling technique was used to select a total of 120 poultry farmers from the three agricultural zones, which are Orlu, Owerri, and Okigwe, respectively (Imo State ADP, 2022). The first stage involved the deliberate selection of two agricultural zones (Owerri and Orlu in Imo State) from among three in the state. The two zones have the highest number of poultry farms in the state. In the second stage, two blocks (Nekede, Obinze, Oguta, and Nkwerre), were selected from each zone using a simple random sampling technique. The third stage involved selecting two circles from each block using a simple random sampling technique. This gave a total of four circles per zone and a total of eight circles in the state. In the fourth stage, a list of poultry farmers for each selected circle was obtained from the Poultry Farmers Association of Nigeria, from which a list of members was compiled with the assistance of Zonal Extension Officers. The list was combined, and 15 farmers were selected using a simple random sampling technique. Thus, the study's total sample size was 120 poultry farmers who used biosecurity measures on small-scale poultry farms in the state.

Method of Data Analysis

The collected data was analysed using mean and standard deviation statistics, and the hypotheses were tested using t-test statistics at a significance level of 0.05. The decision on the research questions was made using 2.50 as the benchmark. The 2.50 was derived by dividing the nominal values of the rating scales by the number of cases. Any item with a mean score of 2.50 or higher was considered a measure to prevent poultry diseases, whereas any item with a mean score less than 2.50 was considered ineffective. The analysis of the objectives was done in the following ways:

RESULTS AND DISCUSSIONS

Socioeconomic Characteristics of the Respondents

Table 1 shows the age distribution of the respondents in the study area. Of the total population, 24.1% were under 30, 25% were over 30, and 78.5% (97) were in the active age range. This implies that most of the respondents were young adult farmers less than 40 years old. Labour can therefore be sourced from young and vibrant individuals. This follows the findings of Olagunju (2020) and Fasina and Inegbedion (2012), who discovered that the average active working age for poultry businesses is 40 years old.

Men made up about 65% of the respondents, while women made up 35%, implying male dominance of the poultry enterprise. This finding is consistent with the findings of Maikasuwa and Jabo (2011) in Sokoto State, Bakare (2013) in Ose LGA of Ondo State, Ajewole and Akinwumi (2014) in Ekiti State, Eze et al. (2017) in Enugu State, and

Alalade et al. (2018) in Kwara State, Nigeria, all of which found that males dominate poultry farming.

The majority of poultry farmers in the state (48.3%) are married. This means they have family responsibilities and should be committed to the biosecurity measures of their poultry farm so as not to reduce their farm income and profits. This statement agrees with Ologbon et al. (2011) that married poultry farmers had additional responsibilities to bear, which may have pushed them into the business to earn more money.

Table 1 further shows that about 61% of poultry farmers have farming experience of 1–5 years, with a mean farming experience of 6 years. This result implies that almost all poultry farmers have acquired experience in biosecurity measures because experience is paramount in the poultry business for effective production. This could be a cost-saving strategy (Olagunju & Babatunde 2011), for poultry farmers.

The majority (30%) of poultry farmers had completed 7–12 years of school. This was closely followed by those who had completed 13–18 years of school (21.6%). This shows that poultry farmers will be willing to adopt new technologies with ease. Okoro (2019) and Ajayi (2019) stated that there is a positive relationship between education and innovation adoption, and because most farmers have some level of education, they are more likely to embrace new technologies.

Table 1 indicates that the average household size was seven (7) people per household. This large household size implies available labour for the poultry farm. This figure is quite reasonable for any significant biosecurity improvement or achievement by the respondents in the study. According to the table, approximately 15.8% of respondents did not have access to farm credit, which could be due to their low creditworthiness. After all, they have no collateral (Yisehak, 2018). Farmers may have access to credit because they are members of cooperative groups (social organisations).

Flock Size of the Respondents

Table 1 shows that most (34.1%) respondents have their enterprise objective as profit-making (commercial). With profit as their primary business goal, poultry farmers would do everything possible to obtain information and implement biosecurity measures that would allow them to maximise their profits. This finding agrees with Maduka, Igbokwe and Atsanda (2016). In addition, most respondents (18.3%) keep fewer than 1000 birds on their farms, with a mean flock size of 258 birds in the study area. This demonstrates that poultry farmers in Imo State operate on a micro and small scale. This finding is in line with Agboola (2014) and FAO (2018).

Membership in the Social Organization of the Respondents

Table 1 shows that most of the poultry farmers (65%) in the study area belong to social organizations. Poultry farmers use the opportunity of being members of social organizations to interact and obtain information on how to improve the biosecurity of their farms. According to Ekong (2010), association with cooperative groups helps farmers satisfy their innate need to solve their problems through collective efforts.

Table 1: Socioeconomic Characteristics of the Respondents

Variable	Frequency	Percentage (%)
Age (Years)		
<30	29	24.1
31-40	33	27.6
41-50	28	23.3
51-60	17	14.1
>61	13	10.9
Total	120	100
Sex		
Male	78	65
Female	42	35
Total	120	100
Marital Status		
Single	33	27.6
Married	58	48.3
Widowed	12	10
Divorced	17	14.1
Total	120	100
Farming Experience (Years)		
1-5	61	50.9
6-10	22	18.3
11-15	21	17.6
16-20	11	9.1
Above	5	4.1
Total	120	100
Educational Level		
No formal education	5	4.1
Primary school completed	9	7.5
Secondary school completed	19	15.9
OND/NCE	25	20.9
HND/First degree	36	30
Higher degree	26	21.6
Total	120	100
Household Size		
1-5	65	54.1
6-10	40	33.3
More than 10 persons	15	12.6
Total	120	100
Source of Credit		
Private savings	19	15.8
Credit	37	30.8
Both	64	53.4
Total	120	100
Membership of Social Organization		
Yes	78	65
No	42	35
Total	120	100
Flock Size		
≤ 500	41	34.1
501-1000	22	18.3
1001-5000	19	15.9
5001-7000	14	11.7
7001-9000	13	10.9
> 9000	11	9.1
Total	120	100
Poultry Management Systems		
Deep litter system	43	35.9
Battery cage system	49	40.9
Both	28	23.2
Total	120	100

Source: Field Survey, 2023

The respondents' level of awareness of biosecurity is presented in Table 2. Interestingly all the respondents claimed to be aware of all the listed basic biosecurity measures. However, the measures relating to general sanitation of the pens like regular clearing of the surroundings, regular packing of litter, and regular cleaning of feeding and drinking troughs recorded 100% compliance among the farmers. Also, the isolation of infected birds and physical security of the farms recorded a 100% positive response.

Table 2: Showing the Awareness of Biosecurity among Small Scale Farmers

Awareness Biosecurity	Frequency	Percentage
Regular clearing of poultry surroundings	80	100.00
Dipping of foot on mat soaked with disinfectant before entering poultry pens	42	52.50
Adequate water source for the birds	80	100.00
Regular cleaning of the feeders and the water trough	80	100.00
Restriction of visitors into the Pen areas	72	90.0
Reliable heat source for chicks	28	35.0
Regular pens disinfection	45	56.3
Packing of the litters on a regular basis	80	100.00
Regular vaccination of the birds	60	75.0
Isolation of infected birds	80	100.0
Bury/burning of dead birds	62	77.5
Adequate ventilation for the birds	80	100.0
Avoid overcrowding	69	86.3
Adequate light source for the birds	58	52.7
Quarantine of new birds	22	27.5
Physical security	80	100.0

Source: Field Survey, 2023. Key *x* = Mean = 2.5, SD = Standard Deviation

From the data in Table 3, Isolation of infected birds had a mean value of 1.88 which is below 2.50 while items 1-10 had their mean scores above the cut-off point of 2.50 with their standard deviation ranging between 0.96-1.10 and the grand mean of 2.94. Therefore, the respondents agreed that small-scale farmers adopted biosecurity techniques for the effective prevention of poultry diseases.

Table 3: Showing the Mean and Standard Deviation of the Respondents on the Level of Adoption of Biosecurity measures among Small Scale Farmers

Item	SA	A	D	SD	X	SD	REMARK
Quarantine of new birds	49	20	26	15	2.92	1.07	Agree
Physical security	52	33	21	14	3.00	1.05	Agree
Bury/burning of dead birds	53	27	19	17	3.00	1.10	Agree
Adequate ventilation for the birds	43	49	11	13	3.05	0.96	Agree
Avoid overcrowding	69	21	14	12	3.26	1.03	Agree
Adequate light source for the birds	45	41	13	17	2.98	1.05	Agree
Regular clearing of poultry surroundings	58	35	12	11	3.21	0.97	Agree
Dipping of foot on mat soaked with disinfectant before entering poultry pens	50	31	20	15	3.00	1.06	Agree
Adequate water source for the birds	70	20	13	13	3.26	1.05	Agree
Regular cleaning of the feeders and the water trough	46	29	17	24	2.83	1.16	Agree
Restriction of visitors into the Pen areas	30	30	32	24	2.67	1.09	Agree
Reliable heat source for chicks	45	35	19	17	2.93	1.07	Agree
Regular pens disinfection	55	25	21	15	3.03	1.08	Agree
Packing of the litters on a regular basis	49	41	15	11	3.10	0.96	Agree
Regular vaccination of the birds	58	37	12	9	3.24	0.93	Agree
Isolation of infected birds	10	20	32	54	1.88	0.99	Disagree

Source: Field Survey, 2023. Key *x* = Mean = 2.5, SD = Standard Deviation

Table 4 captured the responses of the poultry farmers on traffic control practices needed as biosecurity techniques for effective diseases control and prevention. items like, "there is direction for visitor's car park in the farm", "Disinfect vehicles and all equipment before entry into the farm", "Ensure that equipment that has gone to the market do not get to the production unit without disinfection", and "Ensure that visitors wear protective clothing's and foot wears on entering the farm", were recorded as disagreed by the respondents because they had a mean value below 2.50 which is the critical cutoff point while other items were rated agreed because they recorded mean values of 2.50 and above, the critical cutoff point and the grand mean value of 2.69. The standard deviations ranged between 1.01 and 1.12. This shows the closeness of the dispersion of responses of the respondents. Therefore, the respondents agreed that traffic control practices could be adopted as biosecurity techniques for the effective prevention of poultry diseases.

Table 4: Showing the Mean and Standard Deviation of the Respondents on Traffic Control Practices needed as Biosecurity Techniques for effective Disease Prevention in Poultry farms

S/n	Item	SA	A	D	SD	X	SD	Remarks
1	The farm gates are closed always to prevent easy entry of personnel	65	25	12	14	3.21	1.05	Agree
2	Guard the farm with fence or wire netting to prevent movement of people into the farm	58	32	14	12	3.17	1.01	Agree
3	Poultry biosecurity rules should be pasted on the farm entrances to inform visitors on the dos and don'ts in the farm	36	34	30	16	2.78	1.04	Agree
15	There is direction for visitor's car park in the farm	17	15	40	44	2.04	1.05	Disagree
16	Disinfect vehicles and all equipment before entry into the farm	20	22	31	43	2.16	1.11	Disagree
6	Ensure that traffic in the poultry farm flow from the youngest to the oldest flock house.	49	35	15	17	3.00	1.07	Agree
18	Ensure that equipment that has gone to the market do not get to the production unit without disinfection	26	23	34	33	2.36	1.12	Disagree
8	Ensure that farm workers do not visit other farms during operation	50	31	16	19	2.96	1.11	Agree
9	There visitors log book that states who enters the farm.	60	24	21	11	3.15	1.03	Agree
10	Ensure that free ranging animals such as pets are restricted from entering the farm.	45	35	18	18	2.92	1.08	Agree
12	Provide footbath at the entrance of the poultry house	28	40	23	25	2.61	1.07	Agree
23	Ensure that visitors wear protective clothing's and foot wears on entering the farm.	15	13	42	46	1.97	1.01	Disagree
14	Visitors are completely restricted from entering the poultry house unless essential	54	26	22	14	3.03	1.07	Agree
15	Ensure that machinery and equipment are cleaned and disinfected within the production unit before moving them to another unit.	52	33	16	15	3.05	1.05	Agree
17	Traffic control is practiced in the farm	26	31	31	28	2.50	1.01	Agree
	Grand Mean					**2.69**		**Agree**

Source: Field Survey, 2023. Key *x* = Mean = 2.5, SD = Standard Deviation

Table 5 captured the responses of the poultry farmers on sanitation practices needed as biosecurity technique for effective prevention of poultry diseases. items like, “Ensure specific clothing and footwear for use in the farm”, “Machinery such as vehicles, trucks, forklift are cleaned regularly”, and “Use low; pressure water to wash dirt, lice and tick off the birds”, had their mean scores less than the cut-off point of 2.50 with their corresponding standard deviations and grand mean of 2.85. the other items had their mean scores within 2.50. This implies that the respondents agreed that sanitation as a biosecurity technique is vital for the effective prevention of poultry diseases.

Table 5: Showing Mean and the Standard Deviation of the Respondents on Sanitation Practices needed as Biosecurity Technique for Effective Prevention of Poultry Diseases by the Poultry Farmers

S/N	ITEM	SA	A	D	SD	X	SD	REMARK
1	Ensure that all visitors and employees wash hand before entering and when leaving the farm	48	32	18	18	2.95	1.09	Agree
2	Enforce disinfection of visitors to the poultry house and change of cloth before entering the farm	56	34	16	10	3.17	0.97	Agree
3	Regularly clean and disinfect all equipment used in the poultry house	45	38	26	7	3.04	0.93	Agree
4	Avoid contaminated feed and stagnant water	70	25	12	9	3.34	0.95	Agree
5	Ensure specific clothing and footwear for use in the farm	16	34	32	34	2.27	1.03	Disagree
6	Keep the poultry house and its environment clean regularly	62	32	10	12	3.24	0.99	Agree
7	Ensure adequate drainage system for easy cleaning and washing of equipment	58	37	12	9	3.24	0.93	Agree
8	Engage in proper waste management	49	41	15	11	3.10	0.96	Agree
9	Ensure recommended disinfectants are used in disinfecting poultry premised	55	25	21	15	3.03	1.08	Agree
10	Equipment such as buckets and wheelbarrow are regularly cleaned	45	35	19	17	2.93	1.07	Agree
11	Keep composting area clean before and after use	30	30	32	24	2.67	1.09	Agree
12	Machinery such as vehicles, trucks, forklift are cleaned regularly	15	13	42	46	1.97	1.02	Disagree
13	Dirt bins are kept closed regularly except during litter removal	48	38	15	15	3.03	1.03	Agree

14	Use low; pressure water to wash dirt, lice and tick off the birds	9	19	23	55	1.84	0.9	Disagree
15	Footbath or foot dip are provided at the entrance of the farm	45	41	16	14	3.01	1.01	Agree
	Grand Mean					**2.85**		**Agree**

Source: Field Survey, 2023. Key: x = Mean = 2.5, SD = Standard Deviation

Table 6 shows the level of biosecurity adoption by the farmers. The use of biosecurity measures increases as age, farming experience, farm income and number of social organizations belong to increases. Belonging to a social group enhances social capital, thus allowing trust, ideas and information exchange (Mignouna *et al.,* 2021). Farmers within a social group learn from each other the benefits and use of a new technology. Uaiene *et al*. (2019), suggest that social network effects are important for individual decisions and that farmers share information and learn from each other in the context of agricultural innovations. Hence, farmers who belong to social organizations will learn more about biosecurity measures and the likelihood of adopting them. The use of biosecurity measures increases as age increases. Langy and Mekura (2015), reported that older farmers have higher accumulated capital, more contacts with extension workers, are better preferred by credit institutions and larger family sizes, all of which may enhance their adoption and use of technologies such as biosecurity measures than younger farmers. Older farmers are assumed to have gained knowledge and experience over time and are better able to evaluate technology information than younger farmers (Mignouna *et al.*, 2021; Kariyasa & Dewi, 2021). On the contrary, age has been found to have a negative relationship with the adoption of technology. Mauceri *et al*. (2015), found out that as farmers grow older, there is an increase in risk aversion and a decreased interest in long-term investment in the farm. On the other hand, younger farmers are typically less risk-averse and are more willing to try new technologies.

Years of experience also had a significant influence on biosecurity practices. Farmers with more experience would be more efficient, have better knowledge of biosecurity practices and are thus, expected to run a more efficient and profitable enterprise (Oluwatayo *et al.*, 2018). The findings of Onyebinama (2014), state that previous experience in farm business management enables farmers to set realistic time and cost targets, allocate, combine and utilize resources efficiently and identify production risks. As farmers' years of farming experience increases the probability of farmers having experience in disease management and other farm practices increases. This could be because, with more experience, the farmer is likely to manage the farm better and make more informed decisions. It is expected that the more experience farmers have in poultry production, the more the farmers might adopt biosecurity measures and use them effectively. This experience may be gained through learning by doing by the farmers themselves, by observing what other farmers are doing, or from the training provided by relevant institutions. Also, the impact of farm income cannot be overstated. High income guarantees farmers access to biosecurity measures**.**

Table 6: Influence of the socio-demographic factors of small-scale farmers on the level of adoption of biosecurity measures.

	Unstandardized Coefficients		Standardized Coefficients	
Model	**B**	**Std. Error**	**Beta**	**T**
(Constant)	14.677	2.289		6.412
Age	0.069	0.031	0.327*	2.204
Sex	0.275	0.405	0.076	0.679
Farming experience	0.121	0.046	0.278*	2.653
Years spent in school	0.055	0.064	0.138	0.858
Membership of social organization	-0.095	0.047	-0.271	-2.018
Farm income	1.834E-7	0.000	0.409*	2.794
Source of credit	0.166	0.224	0.087	0.744
Household size	0.161	0.090	0.253	1.780
Flock size	0.000	0.000	-0.168	-0.976
Deep litter system	0.191	1.010	0.034	0.189
Use of battery cage system	-4.326	1.640	-0.358	-2.639
Use of deep litter and battery cage systems	-3.038	0.825	-0.536	-3.684
R^2	0.64			
F-Statistics	7.52			

Dependent variable: Biosecurity Scores; Adjusted R. Square = 0.64; F-value = 7.52; * p≤0.05.

CONCLUSION AND RECOMMENDATIONS

The problem of disease outbreaks in poultry farms has been disturbing to the poultry farmers. This work focused on measures to prevent poultry diseases using isolation, traffic control and sanitation practices. Data obtained for the study and analyzed showed that effective prevention of poultry diseases can be carried out by adopting, isolation, traffic control and sanitation practices. Above all, poultry farmers can always keep the farm clean, isolate dead and diseased birds on the farm and as well restrict the movement of people and equipment on the poultry farm, to prevent poultry diseases. Based on the challenges of the spread of diseases, poultry farms should be sited away from residential areas, and strict measures should be put in place against human traffic and equipment around the poultry farm.

REFERENCES

Adene, D. F., & Oguntade, A. E. (2016). *The structure and importance of the commercial and rural based poultry industry in Nigeria*. FAO (Rome) Study, Pp 1-70.

Adewole, S. O. (2012). The efficacy of drugs in the treatment of coccidiosis in chicken in selected poultries. *Academic Research Institute, 2*:20-24.

Adeyemo, A. A., & Onikoyi, F.T (2012). Problems militating against commercial egg production in the Southern Guinea Savannah of Nigeria. Proceedings of the Annual Conference of animal Science of Nigeria. LAUTECH, Ogbomosho Nigeria.

Agboola, A. I. (2014). *Agricultural finance: A practical guide for lenders and entrepreneurs.* Published by the Chartered Institute of Bankers of Nigeria Press Limited.

Ajayi, A. A. (2019). Factors associated with adoption of improved practices by goat producers in Southeastern Nigeria. *Research Monograph, 5*(14), 61 – 70.

Ajewole, O. C., & Akinwumi, A. A. (2014). Awareness and practice of biosecurity measures in small scale poultry production in Ekiti State, Nigeria. *Journal of Agriculture and Veterinary Science, 5*(11), 24 – 29.

Alalade, O. A., Olorunfemi, O. D., Olaoye, I. J., Ladipo, T. O., & Yusuf, A. (2018). Assessment of factors influencing biosecurity measures employed by livestock farmers in selected LGAs of Kwara State, Nigeria. *Journal of Science, Technology, Mathematics and Education (JOSTMED), 14*(2), 90 – 100.

Bakare, B. A. (2013). Biosecurity reconsidered: Calibrating biological threats and responses. *International Security, 34*(4), 96–132.

Eze, C. O., Chah, J. M., Uddin, I. O., Anugwa, I. J., & Igbokwe, E. M. (2017). Biosecurity measures employed by poultry farmers in Enugu State, Nigeria. *Journal of Agricultural Extension, 21*(3), 89- 104.

Food and Agriculture Organization, (2018). Biosecurity for highly pathogenic avian influenza: issues options. FAO, vialedelleterme Di Caracalla, 00153 Rome, Italy.

Farooq, M., Durrani, F. R., Faisal, S., Asghar, A., & Khurshid, A. (2010). Incidence of infectious bursal disease among birds submitted to a diagnostic laboratory in NWFP, Pakistan. *Pakistan Veterinary Journal, 20*(5), 77 - 80.

Fasina, O. J., & Inegbedion, S. (2012). Farm succession plans among poultry farmers in Ogun State. *Russian Journal of Agricultural and Socio-Economic Sciences, 1*(25).

Halifa, A. A. (2018). Influence of socioeconomic characteristics of farmers on knowledge of herbicide use in Edo State, Nigeria. *Life Sciences International Research Journal, 2*(1), 301-307.

Kariyasa, K., & Dewi, A. (2021). Analysis of factors affecting adoption of integrated crop management farmer field school (Icm-Ffs) in Swampy Areas. *International Journal of Food and Agricultural Economics,* 1(2), 29 – 38.

Langy, A., & Mekura, M. (2015). Modelling agricultural technology adoption using the software STAT. A paper presented at a training course organized by CIMMUT-ALP for its NARS partners in Southern Africa on econometric application of modelling technologies.

Maduka, C. V., Igbokwe, I. O., & Atsanda, N. N. (2016). Appraisal of chicken production with associated biosecurity practices in commercial poultry farms located in Jos, Nigeria. Scientifica. P. 1 – 9.

Maikasuwa, M. A., & Jabo, M. S. M. (2011). Profitability of backyard poultry farming in Sokoto metropolis, Sokoto State, North-West, Nigeria. *Nigerian Journal of Basic and Applied Science, 19*(1), 111-115.

Mauceri, M., Alwang, J., Norton, G., & Barrera, V. (2015). Adoption of integrated pest management technologies: A case study of potato farmers in Carchi, Ecuador; Selected paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Providence, Rhode Island, July 24-27, 2015.

Mignouna, B., Manyong, M., Rusike, J., Mutabazi, S., & Senkondo, M. (2011). Determinants of adopting Imazapyr-resistant maize technology and its impact on Household Income in Western Kenya. *AgBioforum, 14*(3), 158-163.

Mohammad, M., Muhammad, L. U., Ambali, A. G., & Mani, A. U. (2010). A survey of early chick mortality on small-scale poultry farms in Jos, Central Nigeria. *International Poultry Science Journal, 9*(5), 446-449.

Musa, I. W., Sai'du, L., & Abalaka, E. S. (2012). Economic impact of recurrent outbreaks of gumboro disease in a commercial poultry farm in Kano, Nigeria. *Asian Journal of Poultry Science, 6*(4), 152-159.

Okoro, F. U. (2019). Factors influencing adoption of improved oil palm management practices among small holders in Imo State. (*Unpublished PhD Thesis*)*,* University of Nigeria.

Olagunju, F. I. (2020). Impact of credit on poultry productivity in Southwestern Nigeria. *World Rural Observations, 2*(4), 90 – 100.

Olagunju, F. I., & Babatunde, R.O. (2011). Impact of credit on poultry productivity in South-Western Nigeria. *Journal of Agricultural and Biological Science*, *6*(10), 23 – 30.

Ologbon, C., Olugbenga, A. C., & Ambali, O. I. (2011). Poultry enterprise combination among small scale farmers in Ogun State, Nigeria: A technical efficiency approach. *Journal of Agriculture and Veterinary Sciences*, 4(3) 20 - 31.

Oluwatayo, I. B., Sekumade, A. B., & Adesoji, S. A. (2018). Resource use efficiency of maize farmers in rural Nigeria: Evidence from Ekiti State. *World Journal of Agricultural Science,* 4(1), 91 - 99.

Onyebinama, U. A. (2014). *Farm business management for smallholder farm firms in Nigeria.* Alphabet Publishers, Nigeria. P. 13 – 21.

Uaiene, R., Arndt, C., & Masters, W. (2019) Determinants of agricultural technology adoption in Mozambique. *Discussion Papers* No. 67E.

Usman, B. A., & Diarra, S. S. (2018). Prevalent diseases and mortality in egg type layers: An overview. *International Journal of Poultry Science, 7*(4), 304 - 310.

Yisehak, K. (2018). Gender responsibility in small holder mixed-crop livestock production system of Jimma Zone, Southwest Ethiopia. *Livestock Research for Rural Development, 20*(11), 98 - 111