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Table of Content

Adoption of bio fortified cassava varieties among cassava farmers in Ibadan/Ibarapa agricultural zone, Oyo state, Nigeria

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Abstract - Cassava (*Manihot esculenta)* is a staple crop found in the family of *Euphorbiaceae* that produces tapered edible roots. Those whose diets consist mostly of cassava (and cassava by-products) are potentially at risk of vitamin A deficiency, leading to efforts being intensified to develop and distribute vitamin-A-enriched cassava varieties across Nigeria through a process known as bio-fortification. Therefore, this research aims to describe the socio-economic characteristics of the respondents, identified the sources of information on bio – fortified cassava to the cassava farmers, examine the cassava farmers' level of knowledge on the attributes of bio –fortified cassava varieties, assess the constraints associated with adoption of bio – fortified cassava. The data for this research was collected using structured interview schedule. Multi-stage sampling technique was used to select 138 respondents (cassava farmers) from the study area. Descriptive statistical tools such as frequency counts, percentages, weighted mean score and ranking were used to analyse objectives of the study. Pearson Product Moment Correlation (PPMC) analysis was used to establish the relationship between socio economic characteristics of the respondents and the adoption of bio – fortified cassava varieties. The study found that radio (WMS = 1.71) was the major source of information ranked 1st. A large proportion of cassava farmers displayed a high knowledge that bio – fortified cassava is more nutritious than local cassava variety (WMS = 1.94) while the major constraints associated with adoption of bio-fortified cassava was high moisture content with WMS of 1.98. it could be concluded that most of the cassava farmers had low knowledge on the attributes of the bio – fortified cassava varieties. Thus, more awareness of the benefits and good attributes of biofortified cassava varieties be created among the cassava farmers.

Keywords: Adoption, knowledge, bio-fortified, cassava.

INTRODUCTION

Cassava (*Manihot esculenta)* is a staple crop found in the family of *Euphorbiaceae* that produces tapered edible roots (Sahel, 2016). It is a hardy crop that is extremely adaptable to harsh weather conditions like drought and can grow well on soils of low fertility (Adeola, Ogunleye, and Bolarinwa, 2017). As the most important crop by production and second most important crop by consumption, the edible tuber is the most desirable product (Sahel, 2016). The tubers produced are consumed locally as traditional meals in different processed food forms like fufu, cassava flour, cassava chips and garri (Davidson, Ene-Obong and Chinma, 2017). It is also used industrially in the production of starch, confectionaries and adhesive materials. The significant role of cassava in poverty alleviation, food security and rural employment cannot be overemphasized. Cassava is a starchy crop which contributes to the staples of millions in sub-Saharan Africa (SSA). Otekunrin and Sawicka (2019) reported that about 177,948 million tonnes of cassava were produced in Africa. Nigeria is regarded as the world's largest producer of cassava with a total of about 20.4 percent of the world export in year 2017 (Otekunrin and Sawicka, 2019).

Bio-fortification is an innovative process of enhancing the micronutrient composition of food crops (Olatade et al., 2016; Saltzman et al., 2016). Since local staple foods dominate the food consumption of the rural poor, bio-fortification of such local staples serves as an effective micronutrient deficiencies reduction strategy (Glopan, 2015; Rao and Annadana, 2017). Nigeria currently has a high Vitamin A Deficiency (VAD) problem; over 20% of pregnant women and children under five years are reportedly vitamin A deficient (Aghaji et al., 2019; Ayinde and Adewumi, 2016). Furthermore, Nigeria has a high incidence of impaired vision such as night blindness and xerophthalmia linked to vitamin A deficiency (Ayinde and Adewumi, 2016; Aghaji et al., 2019). Poor diet is an important cause of vitamin A deficiency in Nigeria, where rural dwellers consume mostly local staple food crops with relatively low micronutrients. The objective of the study examine the cassava farmers' level of knowledge on the attributes of bio –fortified cassava varieties while the specific objectives were to; describe the socio-economic characteristics of the respondents, identified the sources of information on bio – fortified cassava to the cassava farmers, examine the cassava farmers' level of knowledge on the attributes of bio –fortified cassava varieties, assess the constraints associated with adoption of bio – fortified cassava. . The hypothesis stated that there is no significant relationship between socio-economic characteristics of the respondents and the adoption of bio – fortified cassava varieties.

METHODOLOGY

The study was carried out in two Local Government Areas of Oyo State, specifically in Ido and Akinyele LGAs. Ido LGA has an area of 986km^2 and a population of 103,261 at the 2006 census. Ido was among the five in Ibadan district before it was

cancelled in 1956. Other four LGAs that were in existence at that time were Mapo, Akinyele, Ona Ara and Olode Olojumon. The Local Government with its headquarter in Ido town, was carved out of the former Akinyele Local Government. The area has also tremendously gained from industrialization process with the presence of industries such Nigeria Wire and Cable Ltd, Nigeria Mining Corporation and the NNPC among others. Equally, Akinyele Local Government is one of the eleven local governments that make up Ibadan Metropolis. Akinyele LGA was created in 1976, and it shares boundaries with Afijio Local Government to the North, Lagelu Local Government Area to the east, Ido LGA to the west and Ibadan North LGA to the south. It occupies a land area of 464.892 square kilometers with a population density of 516 persons per square kilometer. The estimated population for the Local Government is 239,745 and majority of the inhabitants are agrarian. Cassava is one of the major crops cultivated in Ido and Akinyele LGAs, Oyo State. It is locally called *Ege* in Yoruba. It grows well under poor soil, and it can be grown with other crops such as vegetable, oil palm, coconut, groundnut and melon.

For collection of quantitative information for bio- fortified cassava farmers, multi- stage sampling procedure was used to select sample using Oyo State Agribusiness Development Agency (OYSADA) extension structure in Oyo State in order to get registered bio – fortified cassava farmers. The OYSADA has four (4) zones. The first stage involved 25% random selection of one agricultural zone (Ibadan/ Ibarapa) from the four agricultural zones (Ibadan/Ibarapa, Oyo, Ogbomoso and Saki) in Oyo state. The second stage involved purposive sampling of two blocks (Ido and Akinyele) from nine blocks in Ibadan/ Ibarapa zone. This is due to the high concentration of bio-fortified cassava farmers that had access to the IITA distributed bio-fortified cassava planting materials in these blocks (Ido and Akinyele) than others. The third stage involved random selection of three cells each from the selected blocks. This was also due to high population of bio-cassava farmers in the communities in recent times. In the fourth stage, 95% of bio – fortified cassava farmers were sampled from each cell, using proportionate sampling to size to give a total of 138 respondents from the sampling frame of 145.

Both descriptive and inferential statistics were used to analyse the data. All stated objectives –were analysed using descriptive statistics (frequency, percentage and mean) while the hypotheses were analysed using inferential statistics tool such as Pearson Product Moment Correlation (PPMC).

RESULTS AND DISCUSSION
Socioeconomic characteristics

Result on Table 1 revealed that the mean age of the respondents was 53 years. This result implies that the bio-fortified cassava farmers in the study area are mature, productive, and still economically active. The mean age of the respondents is an indication that the respondents are still agile and might have accumulated experience that could have aided the adoption of bio-fortified cassava. This is because age is a major factor that influences adoption of innovation by farmers. This result is in line with the findings of Adeniran *et al.,* (2021) who reported the mean age of farmers that cultivate bio-fortified cassava to be 54 years, an indication that above 50 years of age farmers are likely to adopt the innovation in cassava cultivation. This finding agrees with Awotide et al., (2011), that as farmers advance in age, they tend to gain more experience, which could enhance their productivity and managerial ability. The mean number of years spent in acquiring formal education was 7 years and this is expected to influence their level of knowledge of attributes, benefits and adoption of vitamin A cassava and its products. This is in line with Sofoluwe et al. (2011), that education influences people's perception and adoption of innovations. The finding reveals mean of 6 members in the households of respondents in the study area. The result indicates that respondents in the study area have a fair large household size, and this is expected to influence the size of bio-fortified cassava variety cultivated in the study area. Large household size is assumed as an indicator of labour availability in the family. Considering the fact that labour is a major factor of crop production (Mbuk *et al.,* 2011), the findings imply that the presence of a considerable large household size, which could be used as source of labour for production, processing and marketing activities of bio-fortified cassava. Also, the household size of the farmers might influence their cultivation of the cassava variety. The fair large household size might influence the cassava farmers to adopt the bio-fortified cassava variety as they will provide nutrients to aid the well-being of the family members. The mean years of experience accumulated by cassava farmers in the study area was revealed to be 18 years. With long practicing mean of 18 years as farmers implies that the farmers are veterans in cassava production and could be able to effectively use the opportunity to have acquired requisite knowledge, skills and experience in deciding whether to adopt biofortified cassava or not. The finding is similar to the findings of Odediran and Ojebiyi (2017), who found that more than one- third (35%) of the cassava farmers in Southwest Nigeria had between 21 and 30 years of experience.

Table 1: Distribution of Respondents by Socio-economic Characteristics, n=138

Socio-economic characteristics	Frequency	Percentage	Mean
Age (years)			
35-42	8	5.8	53
43-50	67	48.6	
51-58	23	16.7	
59-66	31	22.5	
67-74	8	5.8	
74 and above	1	0.7	
Years spent in school			
1-4	22	15.9	7
5-8	80	58.0	
9-12	31	22.5	
13-16	2	1.4	
16 and above	3	2.2	
Household size			
3-4	22	15.9	6
5-6	88	63.8	
7-8	26	18.8	
8 and above	2	1.4	
Years of experience			
8-14	34	24.6	
15-21	57	41.3	18
22-28	31	22.5	
29-35	13	9.4	
36-42	2	1.4	
42 and above	1	0.7	

Source: Field survey, 2024

Respondents' source of information on bio–fortified cassava production

Table 2 reveals the source of information available to the respondents on bio-fortified cassava in the study area. From the responses gotten, it was affirmed that the cassava farmers have access to various sources of information. The result reveals that radio, family and friends, IITA, fellow farmers and extension agents were ranked 1st, 2nd, 3rd, 4th and 5th with a Weighted Mean Score (WMS) of 1.71, 1.62, 1.36, 1.30 and 1.17 respectively. This result is an indication that the respondents got information from reliable sources, and this might have influenced their adoption of the bio-fortified cassava tubers. The validity of the source of information is an indication of the acceptance level which the cassava farmers displayed in the adoption of the bio-fortified cassava variety. This result implies that farmers are liable to adopt innovations in agriculture if the information is dispersed to them through reliable and professional bodies.

Table 2: Distribution of sources of information on bio–fortified cassava among cassava farmers, n=138

Source of information	Always	Sometimes	Never	WMS	Rank
Family and friends	89 (64.5)	46 (33.3)	3 (2.2)	1.62	2nd
Extension agent	37 (26.8)	88 (63.8)	13 (9.4)	1.17	5th
IITA	51 (37.0)	85 (61.6)	2 (1.4)	1.36	3rd
Fellow farmers	83 (60.1)	14 (10.1)	41 (29.7)	1.30	4th
Mobile phone	11 (8.0)	12 (8.7)	115 (83.3)	0.25	7th
Television	0 (0.0)	8 (5.8)	130 (94.2)	0.06	8th
Markets	12 (8.7)	22 (15.9)	104 (75.4)	0.33	6th
Radio	106 (76.8)	24 (17.4)	8 (5.8)	1.71	1st

Source: Field survey, 2024
WMS: Weighted mean score

In addition, markets, mobile phones and television were all indicated as sources of information available for the bio-fortified cassava farmers with a weighted mean score of 0.33, 0.25 and 0.06 and ranked 6th, 7th and 8th respectively. Generally, this result implies that majority of the farmers in the study area obtained information particularly on their planting materials and had

contact with IITA, family and friends, extension agents and fellow farmers, which may easily expose the farmers to new technologies, how to go about them and the benefit. The greater the contacts with IITA, extension agents and fellow farmers who already experienced, the better the farmers are informed about new technology. This result corroborates with the findings of Oseni et al. (2015) who posited that farmers, through extension visits become better informed about farm management planning and new technologies.

Farmers' knowledge on attributes of bio–fortified cassava varieties

Result in Table 3 reveals the knowledge level of the cassava farmers on the adoption of bio-fortified cassava varieties which might have influence their decision to adopt the cultivation. An average score of 1.56 was gotten from the responses on the respondents on their knowledge about the adoption of bio-fortified cassava and this was used as benchmark to categorize their knowledge about the cassava variety. Using the mean score, the result reveals that majority of the cassava farmers have higher knowledge level that bio-fortified cassava are more nutritious than local cassava variety with a mean score ($\bar{x}$) of 1.94 tanked 1st; it is resistant to disease and pests, bio-fortified cassava has low level of cyanide acid, thrives in all weather conditions and it has high nutritional content and a potential for food security were all ranked 2nd with each having a mean score of 1.93. In addition, they acknowledged that they have a higher knowledge that bio-fortified cassava attracts premium price compared to other varieties; it requires less irrigation and water saving with both having a mean ($\bar{x}$) score of 1.88 were ranked 6th while bio-fortified variety gives more yield than the local variety ($\bar{x}$=1.62) was ranked 9th based on the mean score ranking. The higher knowledge level of the respondents on bio-fortified cassava is an implication that extension services is well grounded in the study area because it has aided the dissemination of information and enlightenment needed to enable farmers to embrace the new variety of cassava. Their level of higher knowledge about it is an indication that they have adopted it and have affirmed the benefits that comes along with the cultivation, consumption and economical aspect of the bio-fortified cassava variety. Meanwhile, the cassava farmers also indicated their knowledge about other attributes that the bio-fortified cassava is characterised with though on a low level of knowledge based on the mean score gotten from the responses indicated by the respondents. The respondents indicated low level of knowledge on the early maturing characteristics of the cassava variety with a mean score of 1.40; it tastes better ($\bar{x}$=1.38);

planting can be done at any season in the year ($\bar{x}$=1.37) and bio-fortified cassava does not need nutrient rich soil or extensive land preparation with a mean score of 1.35 were ranked 10th, 11th, 12th and 13th respectively. In addition, the respondents indicated their lesser low-level of knowledge about bio-fortified cassava attribute such as having high dry matter content compared to local varieties ($\bar{x}$=1.08); there is high market demand for bio-fortified produce ($\bar{x}$=1.04); bio-fortified can be stored for a long time compared to local varieties ($\bar{x}$=1.02) and were all ranked 14th, 15th and 16th respectively while knowledge about it having low moisture and non-lodging was ranked least (17th) with a mean score of 1.01. This result is an indication that the respondents still have inadequacies in knowledge on some attributes about bio-fortified cassava. This result implies that extension agents and other stakeholders involved in the bio-fortified cassava project still have services to render to enable the farmers to have a well-rounded knowledge about the cassava variety. Generally, the result implies that cassava farmers in the study area are informed about bio-fortified cassava variety and them being informed is a major factor that influenced the cultivation of the cassava variety in the study area. Also, it is worthy to note that innovations in agriculture can only be successful if it is transmitted by the researchers and research agency to the extension services to aid the dissemination of such innovation to the consumers who are the farmers. In lieu of the responses gotten from the farmers, the extension agents and agency are also implored to consolidate in the use of appropriate teaching methods as this will enhance the knowledge level of their target audience. This result is in consonance with the findings of Anugwa *et al.,* (2021) where majority of the respondents had a high knowledge about bio-fortified cassava variety. Their knowledge about the bio-fortified cassava is linked to their experience in cassava farming which is an age-long practice in the cultivation of other cultivars of cassava.

Constraints associated with adoption of bio–fortified cassava

The result in Table 4 reveals the constraints associated with the adoption of bio-fortified cassava in the study area. The constraints were measured on 3-point rating scale of severe, mild and not a constraint which were ranked 2, 1 and 0 respectively. Based on the Weighted Mean Score (WMS), high moisture content, lack of ready market for sales and socio-cultural restrictions were ranked 1st, 2nd and 3rd with WMS of 1.98, 1.96 and 1.95 respectively.

Table 3: Distribution of respondents according to farmers' knowledge on attributes of bio–fortified cassava varieties, n=138

Knowledge	True	False	I don't know	WMS	Rank
Bio fortified cassava has low level of cyanide acid	133 (96.4)	0 (0.0)	5 (3.6)	1.93	2nd
Thrives in all weather conditions	128 (92.8)	10 (7.2)	0 (0.0)	1.93	2nd
Planting can be done at any season in the year	55 (39.9)	79 (57.2)	4 (2.9)	1.37	9th
It is more nutritious	134 (97.1)	0 (0.0)	49 (2.9)	1.94	1st
Bio fortified cassava does not need nutrient rich soil or extensive land preparation	52 (37.7)	82 (59.4)	4 (2.9)	1.35	10th
It reduces the need for fertilizer usage	86 (62.3)	52 (37.7)	0 (0.0)	1.62	6th
The bio fortified variety gives more yield than the local variety	122 (88.4)	12 (8.7)	4 (2.9)	1.86	5th
It has high dry matter content compared to local varieties	15 (10.9)	119 (86.2)	4 (2.9)	1.08	11th
It tastes better	52 (37.7)	86 (62.3)	0 (0.0)	1.38	8th
It is early maturing	55 (39.9)	83 (60.1)	0 (0.0)	1.40	7th
There is high market demand for bio fortified produce	9 (6.5)	125 (90.6)	4 (2.9)	1.04	12th
The biofortified cassava attracts premium price compared to other verities	125 (90.6)	9 (6.5)	4 (2.9)	1.88	4th
It is resistant to diseases and pests	128 (92.8)	10 (7.2)	0 (0.0)	1.93	2nd
It contains low moisture and non-lodging	6 (4.3)	128 (92.8)	4 (2.9)	1.01	14th
It has high nutritional content and a potential for food security	132 (95.7)	2 (1.4)	4 (2.9)	1.01	2nd
It requires less irrigation and water saving	122 (88.4)	16 (11.6)	0 (0.0)	1.88	4th
Bio fortified can stored for a long time compared to local verities	7 (5.1)	127 (92.0)	4 (2.9)	1.02	13th

Source: Field survey, 2024
WMS: Weighted mean score

This implies that the perishability nature is such unforeseen circumstance and severest of the constraints facing the adoption of the bio – fortified cassava varieties in the study area. It is however a technical and laboratory problem that has to do with the genetic composition, and it is an undesirable trait among other undesirable traits known with the bio-fortified cassava varieties as asserted by Onyeneke *et al.,* (2019). Equally, lack of market or demand for the produce threatens the adoption of bio - fortified innovation in the study area and farmers consider acceptability of the produce as a major factor before adoption of innovation. Adoption of an innovation is fast when there is available market as well as demand for the product. In a similar way, socio-cultural norms place threat to many innovations by restricting access to information about the innovation and in extreme cases, forbid members of the society from adopting the technology. The hierarchical structure in the rural area is a major factor that aids adoption and non-adoption of innovation in the rural area as they play a major in getting their members convinced, hence innovation should be done in accordance with the culture of the to be users of the innovation. Also, lack of post-harvest technology for processing, high cost of acquiring stem cuttings, high degradation and discoloration, unavailability of stem cuttings for planting and unavailability/high cost of labour were ranked 4th, 5th, 6th, 7th and 8th with WMS of 1.84,

1.62, 1.61, 1.60 and 1.30 respectively. This result is an indication that the cultivation of bio-fortified cassava requires financial investment which is more than what is needed to cultivate the existing cassava variety. The high cost of acquiring stem cuttings limits the adoption of the technology in the study area since farmers in most cases may have to travel wide to research institutes just to get bio- fortified stem cuttings. Availability of planting materials makes the usage of the materials easy and hence facilitates adoption. Furthermore, the result reveals that root start decaying immediately after maturation (WMS=1.05); lack of extension training to improve production skills (WMS=0.65); unpleasant taste (WMS=0.62); low stems viability with WMS of 0.46 were ranked 9th, 10th, 11th and 12th respectively. This result implies that extension services, viability of the innovation, taste and viability of the stems poses lesser constraints to the adoption of bio-fortified cassava in the study area, an indication that extension services and research work done on the cassava variety is satisfying to an extent. Lastly, close weeding intervals and problem of pests and diseases were ranked 13th and 14th with weighted mean score of 0.28 and 0.25 respectively. This result is an indication that the modification done to the cassava variety gives little or no room for the growth of weeds and infestation of the cassava tubers. Generally, this result implies that despite the adoption of bio-fortified cassava variety and

obvious benefits been derived from the cultivation, farmers in the study area still encounters constraints in the cultivation of the cassava variety though on a varied level of severity. The study is consistent with the findings of Olaosebikan et al., (2019) which states that high cost of inputs is a serious constrain to bio-fortified cassava production. In addition, Uwandu, Amadi and Igwe (2019), and Onyeneke et al., (2020) confirmed that high cost of cassava stems is responsible for lack adoption of bio-fortified pro-vitamin A cassava varieties.

Table 4: Distribution of respondents according to the constraints associated with adoption of bio fortified cassava

Constraints	Severe	Mild	Not a constraint	WMS	Rank
Low soil fertility	3 (2.2)	9 (6.5)	126 (91.3)	0.11	15th
Unavailability of stem cuttings for planting	107 (77.5)	7 (5.1)	24 (17.4)	1.60	7th
High cost of acquiring stem cuttings	111 (80.4)	2 (1.4)	25 (18.1)	1.62	5th
Close weeding intervals	4 (2.9)	31 (22.5)	103 (74.6)	0.28	13th
Root start decaying immediately after maturation	61 (44.2)	23 (16.7)	54 (39.1)	1.05	9th
Unavailability/high cost of labour	62 (44.9)	55 (39.9)	21 (15.2)	1.30	8th
Lack of post-harvest technology for processing	116 (84.1)	22 (15.9)	0 (0.0)	1.84	4th
High moisture content	135 (97.8)	3 (2.2)	0 (0.0)	1.98	1st
High degradation and discoloration	86 (62.3)	50 (36.2)	2 (1.4)	1.61	6th
Lack of extension training to improve production skill	5 (3.6)	80 (58.0)	53 (38.4)	0.65	10th
Unpleasant taste	2 (1.4)	81 (58.7)	55 (39.9)	0.62	11th
Lack of ready market for sales	133 (96.4)	4 (2.9)	1 (0.7)	1.96	2nd
Socio-cultural restrictions	133 (96.4)	3 (2.2)	2 (1.4)	1.95	3rd
Problems of pests and diseases	4 (2.9)	27 (19.6)	107 (77.5)	0.25	14th
Low stems viability	0 (0.0)	64 (46.4)	74 (53.6)	0.46	12th

Source: Field survey, 2024
WMS: Weighted mean score

Test of hypothesis

Pearson's Product Moment Correlation analysis revealed that there is a positive and significant relationship between socio economic characteristics of the bio-fortified cassava farmers such as age (r=0.269**, p=0.000) and years of experience in cassava production (r=0.266**, p=0.000) and the level of adoption of bio-fortified cassava varieties. This result implies that as the age of the cassava farmers increases the more experienced and courageous, they are to adopt innovations introduced to them, knowing fully that innovations are aimed to improve the production level of farmers. Economically active and matured farmers are liable to take more risks in agricultural production due to the anxiety to accumulate more wealth in their chosen enterprise. The reason for this might be that the expertise and resources of the older farmers may provide them with greater opportunities to experiment the bio-fortified cassava varieties. Other the other hand, younger farmers are more inclined to accept new technologies than older farmers since they have received more education than older group (Rajendran et al. 2016). This result is consistent with the findings of Singh and Park (2018), who reported that the older the farmer is, the less likely he is to adopt new technology. In addition, years of experience in cassava production and experience in the cultivation of bio-fortified cassava varieties significant relationship on the level of adoption of bio-fortified cassava varieties might be attributed to the level of knowledge accumulated hence; the more experienced they are, the more the probability they adopt new cassava varieties so as to optimally have an increased output on the cassava farm. This is in conformity with Mittal and Mehar (2016), who asserted that knowledge which might be in form of experiences gained, influences the behaviour of farmers to adopt innovation, resulting from better understanding and appreciation of benefits of innovations, and increased accessibility to information that will enable adoption.

Table 5: PPMC analysis showing relationship between socio economic characteristic and adoption of bio-fortified cassava varieties

Socio-economic characteristics	Correlation coefficient	p- value	Remark
Age	0.269**	0.000	Significant
Household size	0.152	0.076	Not Significant
Years spent in school	0.099	0.247	Not significant
Farm size	0.164	0.054	Not Significant
Years of Experience in cassava production	0.266**	0.000	Significant

Source: Computed Data, 2023

**: Correlation is significant at 0.05 level {2-tailed}

CONCLUSION AND RECOMMENDATIONS

The study found that most of the respondents were young, active and married with large household size. The study also found out that most of the cassava farmers had low knowledge on the attributes of the bio – fortified cassava varieties. The benefits derived from the bio –fortified cassava varieties among the farmers also turned out to be low. Only three out of the bio –fortified cassava varieties were adopted by the farmer, while two of the three adopted varieties were cultivated by the farmers. It is worthy of note that the level of use of the adopted varieties was high. In line with hypotheses, the study established that significant relationship exists between selected socioeconomic characteristics such as (age, years of experience in cassava production and educational level) and the adoption of bio-fortified cassava varieties. Also, the PPMC results established that significant relationship exists between farmers' knowledge on the attributes of cassava production practices and adoption of bio-fortified cassava varieties. Thus, more awareness on the benefits and good attributes of biofortified cassava varieties be created among the cassava farmers.

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Effect of the home-grown school feeding programme on the welfare status of participating fish farmers in Osun state

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Abstract - Despite the increasing emphasis on agricultural value chains in the school feeding programmes, there is limited evidence on how participation affects fish farmers' welfare status. This study addresses the gap by examining the effect of the Home-Grown School Feeding Programme (HGSFP) on the welfare status of participating fish farmers in Osun state, comparing participating and non-participating farmers to assess improvements in welfare. The result obtained from Per Capital Expenditure (PCE), a metric employed in determining welfare status indicated that participating fish farmers had higher PCE values across all the three categories of welfare status that was examined than the non-participating fish farmers. Test of hypothesis with t-test revealed that participating fish farmers had significantly higher welfare status (mean = ₦64,929.17) than non-participating fish farmers (mean= ₦47,066.74, $p<0.001$), highlighting the programme's positive impact on welfare. The study concluded that HGSFP participating fish farmers had higher PCE values when compared to the non-participating fish farmers across all the three welfare categories studied. It is recommended that participating fish farmers should form cooperatives to improve access to credit and resources. Again, Non-Governmental Organizations (NGOs) and relevant private stakeholders should provide training and capacity building initiatives for fish farmers participating under the programme to ensure sustainable improvements in their welfare status.
Keywords: Home Grown School Feeding Programme, Welfare Status, Social Intervention Programme, Agricultural Development, Fish farmers.

INTRODUCTION

School feeding programmes are generally considered to be education interventions aimed at facilitating access to education, increased attendance and retention rates, while improving the nutrition of school children (New Partnership for Africa's Development [NEPAD], 2013), while at the same time stimulating local agriculture and economies through the procurement of food from local, smallscale producers. (Food and Agriculture Organizations [FAO] and World Food Programme [WFP], 2018). Countries are increasingly recognizing that social protection measures, including school feeding, are needed to reduce and/or prevent poverty and hunger, and that connecting programmes to agriculture through institutional procurement can further increase benefits, particularly for family farmers who are the backbone of agriculture in low- and middle income countries but, nevertheless, are often poor and work on a small scale, (Nkang and Ereh, 2021).

According to Okumu and Muhingi (2020), the Home-Grown School Feeding (HGSF) is an approach that was identified by the Millennium Hunger Task Force as a quick win in the fight against poverty and hunger. In Africa, its genesis dates back to 2003, when African governments included locally sourced school feeding programmes in Pillar 3 of the Comprehensive Africa Agriculture Development Programme (CAADP), which is part of the New Partnership for Africa's Development and World Food Programme (WFP, 2018). As opined by WFP (2020), the Home-Grown School Feeding Programmes (HGSFP) can significantly contribute

to the achievement of the sustainable Development Goals (SDGs), particularly SDG 2 (on ending hunger, achieving food security and improved nutrition, and promoting sustainable agriculture) and SDG 4 (on quality education).

In Nigeria, the Home Grown School Feeding Programme is a component of the National Social Investment Programme (NSIP) which was launched by the federal government in collaboration with the Imperial College Partnership for Child Development (PCD), the Bill and Melinda Gates Foundation (BMGF), the World Bank Group (WBG), and the Vitol Foundation (VF) to address primary school enrolment and retention issues (National Home Grown School Feeding Programme [NHGSFP], 2016). The Nigerian Government in the year 2004 piloted the implementation of Home-Grown School Feeding beginning with twelve (12) States selected from the six geo-political zone of the country (Ogun State Home Grown School Feeding Programme (OSHGSFP), 2018). The initiative, officially known as Home Grown School Feeding Programme insisted on buying the food stuffs from the local farmers which reduced the rate of malnutrition while it also provided the local farmers the opportunity to sell their produce to participating schools as Masset and Gelli (2013) posited that the Home Grown School Feeding Programme (HGSFP) has the capacity to enhance farmers' livelihoods and incomes. However, despite the good intentions of these commitments, the programme may be chronically under-financed with little known evidence of the inclusion of locally procured fish in

School Feeding Programmes (SFPs), (Ahern *et al.,* 2021).

Although, HGSFP has been found to have positive impacts on child nutrition and as well creating new markets for farmers (Di-Prima *et al.,* 2022). However, scarcity of empirical evidence still exists regarding its effect on the welfare status of the participating fish farmers, and it remains a subject that has not been sufficiently studied and documented. In light of the foregoing, this study therefore aims to examine the effect of the Home-Grown School Feeding Program on the welfare status of participating fish farmers in Osun State.

Objectives of the study are to:
1. Describe the socioeconomic characteristics of HGSFP participating fish farmers and non-participating fish farmers.
2. Determine the welfare status of HGSFP participating fish farmers and non-participating fish farmers

The study hypothesised that there is no significant difference in the welfare status of HGSFP participating fish farmers and non-participating fish farmers.

METHODOLOGY

The study was carried out in Osun state which is an inland State in south-western Nigeria, having Osogbo as the state capital. The main occupation and economic activities of the people centers around farming, agro allied productions, trading, and artisanship (OSSADEP, 2004) however, fish farming is the most efficient husbandry for animal protein production than all other forms of livestock husbandry in the State (Adelakun *et al.*, 2015) because Osun State is landlocked with many perennial rivers, riverlets, streams, springs sources and wetlands that are suitable for fish farming (Fregene and Tejiri, 2008). The population of the study consists of all participating fish farmers under the Home-Grown School Feeding Programme (HGSFP) and the non- participating fish farmers in the study area. A multistage sampling technique was used in selecting the sample size for the participating fish farmers. In the first stage, 40% of the LGAs were randomly selected from the 30 LGAs in Osun state, yielding 12 LGAs from which 70% of the registered fish farmers were randomly selected, totaling 103 respondents. For the non- participating fish farmers, purposive sampling was applied in selecting Ede and Ikirun which are notable fishery zones in the state. Four villages in each of these two zones were purposively selected and lastly, 40% of the fish farmers in each of the selected villages from these zones were randomly selected thus giving a total of 108 respondents. Overall, 211 respondents were sampled for this study. Validated interview schedule was adopted for the study and the data collected were described with percentages, mean and frequency counts while t-test was used in making inference and testing the stated hypothesis. The dependent variable of this study, which is the welfare status of fish farmers participating and non-participating fish farmers was measured using the Per Capita Expenditure (PCE). Welfare status of both groups of fish farmers was categorized into three (3) as categorized by Olajide and Aderolu, (2017); core poor, poor and non-poor. Both participating and non-participating fish farmers whose PCE values fell within the range of ⅓ mean PCE and minimum PCE value were accorded core poor welfare status. Fish farmers whose PCE fell between ⅓ mean PCE to ⅔ mean PCE were accorded poor welfare status while fish farmers whose PCE fell within the range of ⅔ mean PCE to the maximum PCE value were accorded non-poor welfare status.

RESULT AND DISCUSSION
Socioeconomic characteristics

The results of analysis as shown in Table 1 below, revealed that fish farming is predominantly a male-dominated activity as 89.3% of the participating fish farmers and 82.4% of the non-participating fish farmers were males. The low participation of females (10.7%) for participating and 17.6% for non-participating fish farmers may be attributed to the physical demands of fish farming which males were better suited to handle than females. This finding aligns with the reports of Ayodeji (2022), Alawode *et al.*, (2016), and Ogunlade (2007) who noted the tedious nature of fish farming as a reason for its male dominance. The age distribution in Table 1 suggests that most fish farmers were in their active years. The mean age was 45 years for participating fish farmers and in contrast 39 years was the mean age for the non-participating farmers. Although majority (66.1%) of the participating fish farmers fell within the age group of 40-49 years and the majority of the non-participating fish farmers (52.7%) were aged 31-39 years. These findings are consistent with Adebayo and Daramola (2013), who reported that most catfish farmers were within the active age range of 31-49 years. Results also revealed that majority of fish farmers in the study area were married as 77.7% of the participating and 81.5% of the non-participating fish farmers fell into this category. This implies more married people were involved in fish farming as family members can serve as source of labour on the fish farm. This finding is corroborated by the report of Idris-Adeniyi *et al.,* (2018) and Omitoyin and Sanda (2010), who all noted that married individuals were more engaged in fish farming. Fish farming is an acceptable farming activity across the various religious groups in the study area as 65% of the participating farmers and 40.7% of the non-participating farmers were

Christians, while Muslims made up 33% and 53%, respectively. Adelakun *et al.,* (2015) noted the lack of religious restrictions in fish farming in Osun State which is in tandem with this result. Moreover, majority of the respondents in the study had household sizes of 1-5 members with 82.6% participating and 80.5% non-participating fish farmers within this range of household size. This aligns with the findings of Idris-Adeniyi *et al.,* (2018), who observed that most fish farmers had relatively small households. Also, most of the fish

farmers owned 1-5 ponds, with an average of three ponds for participating fish farmers and two ponds for non-participating fish farmers. This result is consistent with the report of Adeosun *et al.,* (2019), who noted a similar distribution in Enugu State while the mean years of experience in fish farming was six for both groups of farmers which suggests that most of the fish farmers entered the profession relatively recently probably as an alternative vocation after school or due to unemployment, as reported by Idris-Adeniyi *et al.,* (2018).

Table 1: Distribution of respondents by socio-economic characteristics of HGSFP participating fish farmers and non- participating fish farmers.

HGSFP variables	Participating fish farmers		Non-participating fish farmers	
Sex	Frequencies	Percent	Frequencies	Percent
Male	92	89.3	89	82.4
Female	11	10.7	19	17.6
Age	45		39	
≤30	6	5.5		
31-39	15	13.0	57	52.7
40-49	68	66.1	30	27.8
50-59	20	19.4	15	11.0
Marital Status				
Single	10	9.7	17	15.7
Married	80	77.7	88	81.5
Divorced	7	6.8	1	0.9
Widowed	6	5.8	2	1.9
Years spent receiving formal education	16		12	
1-6	1	1.0	22	20.4
7-12	4	3.9	21	19.4
12 years and above	98	95.1	65	60.3
Religion				
Christian	67	65.0	44	40.7
Islam	34	33.0	59	53.0
Traditional	2	1.9	5	3.0
Household size	5		4	
1-5	85	82.6	87	80.5
6-10	17	16.5	21	19.4
10 members and above	1	1.0	0	0.0
Number of fish ponds	3		2	
1-5	101	98.1	105	97.2
6-10	1	1.0	3	2.8
10 and above	1	1.0	0	0.0
Years of fish farming experience	6		6	
1-5	66	61.0	70	39.8
6-10	34	33.1	28	41.8
10 years and above	3	2.9	10	18.5

Source: Field Survey, 2024

Welfare status of participating and non-participating fish farmers.

The result of analysis in Table 2 revealed that HGSFP participating fish farmers had higher mean PCE of ₦64,929.2. For this group of farmers, the minimum and maximum values of PCE were ₦22,160.0 and ₦287,500.0 which were all higher than the PCE values of the non-participating fish farmers across all thresholds. Specifically, 0.9% of

the participating fish farmers were core poor (₦21,643.1 - ₦22,160.0), and 24.3% were poor, i.e., ₦21,643.1 - ₦43,286.1, while 74.8% of the participating fish farmers were non-poor (₦43,286.1 - ₦287,500.0). This result therefore reveals that participation in the HGSFP is positively related to increased financial stability and better livelihood. The higher PCE thresholds observed among participating fish farmers across all the welfare

categories examined therefore suggest that participation in HGSFP is a key factor in raising the welfare status of fish farmers.

In contrast, the result of analysis in Table 2 revealed that non-participating fish farmers have a lower mean PCE, which is ₦47,066.7, and a PCE value of ₦20,083.3 being the minimum and likewise, ₦142,500.0, which is the maximum PCE. Specifically, 0.9% of the participating fish farmers saw no improvement in their welfare status, while 23.1% (₦15,688.9 - ₦31,377.8) were poor, and 75.9% of the non-participating fish farmers (₦31,377.8 - ₦142,500.0) were analysed to non-poor.

Table 2. Categorisation of participating and non-participating fish farmers according to their welfare status

HGSFP	Participating fish farmers		Non-participating fish farmers	
Welfare status	PCE Range	Percent	PCE Range	Percent
Core Poor	₦21,643.1- ₦22,160.0	0.9	₦15,688.9-₦20,083.3	0.9
Poor	₦21,643.1- ₦43,286.1	24.3	₦15,688.9- ₦31,377.8	23.1
Non-Poor	₦43,286.1- ₦287,500.0	74.8	₦31,377.8- ₦142,500.0	75.9
	Participating fish farmers		**Non-participating fish farmers**	
Max. PCE	₦287,500.0		₦142,500.0	
Min. PCE	₦22,160.0		₦20,083.3	
Mean PCE	₦64,929.2		=₦47,066.7	

Source: Field Survey, 2024

Test of difference welfare status between HGSFP participating fish farmers and non-participating fish farmers

The results in Table 3 show the analysis of welfare between participating and non-participating fish farmers. The results obtained showed that the welfare status of participating fish farmers is significantly higher than the welfare status of non-participating fish farmers. The analysis revealed that the mean PCE for participating fish farmers was ₦64,929.17 while the non-participating fish farmers had ₦47,066.74 as the mean PCE. Consequently, the improvement of income generated from the stable market structure offered HGSFP translated into better welfare status for participating fish farmers. Also, the support given within HGSFP could have reduced the stress and the struggles that is associated with fish marketing, thus enabling the participating fish farmers to pay closer attention to enhancing their household conditions and the pursuit of satisfying basic needs and likewise investment in personal and professional development.

In contrast, the non-participating farmers do not have the opportunity to have similar benefits as they are not under HGSFP, hence their capacity to realize similar welfare outcomes is relatively limited. Consequently, the lower and unstable levels of incomes earned by non-participating fish farmers are likely to bring an undesirable impact on their welfare status as they have limited ability in self-support and investment in professional development.

Table 3: Test of difference in welfare status between participating fish farmers and non-participating fish farmers

Group	N	Mean	SD	t-value	df	*p*-value
Participating fish farmers	103	64,929.17	37,298.41	4.196	209	<0.001***
Non-participating fish farmers	108	47,066.74	23,230.90			

Source: Field Survey, 2024
***Significant at 0.001 level (2- tailed)

CONCLUSION AND RECOMMENDATION

The study concluded that there were higher Per Capita Expenditure thresholds across all the three welfare categories among participating fish farmers which therefore indicates improved welfare state in contrast to the PCE values of non-participating fish farmers that was significantly lower. The structured market and income stability the participating fish farmers enjoy from the programme emerged as a strong driver for welfare improvement among the participating fish farmers which overshadowed the influence of individual socioeconomic characteristics. To further enhance welfare improvement, HGSFP participating fish farmers should prioritize forming cooperatives to pool resources for fish farming and access credit facilities with better repayment plans to enhance fish production. Besides, it is imperative to create more awareness about the programme in order to expand the HGSFP's coverage to a greater number of fish farmers in the study area to reduce income disparities and build an economically inclusive path for more fish farmers in the study area. Capacity-building initiatives by Non- Governmental Organizations (NGOs) and private stakeholders is likewise vital and needs to focus on the special needs of participating fish farmers in areas that would enhance productivity, self-reliance and resilience.

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Knowledge level of extension agents on smart farming technologies in southwest Nigeria

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Abstract - This study assessed knowledge level of extension agents on smart farming technologies (SFT) in Southwest, Nigeria. Sampling of respondents was carried out in two stages to elicit data from 188 change agents in Southwestern Nigeria with the aid of a structured questionnaire. The statistical analytical tools employed in the study included both descriptive statistics (frequency counts, percentages and mean) and inferential statistics which was Logistic Regression Analysis. Findings showed that the extension agents were still in their active years with mean age of 44.2±7.6 years. The mean year spent in school was 17.2±3.4 years while the mean of years of working experience was 12.9±7.7 years. The available and mostly used SFT was precision farming technology. The respondents were most knowledgeable on smart greenhouse with a high knowledge score. The result of Logistic regression revealed age (p=0.035) and years of experience (p=0.057) as socio-economic factors that influence knowledge levels of extension agents on smart farming technologies. Conclusively, it was observed that precision farming technology was the available and most utilised smart farming technology, majority of the respondents were most knowledgeable on smart greenhouse while it was therefore recommended that Governments, private sectors, and non-governmental organizations should organise continuous training programs to focus on enhancing extension agents' knowledge and practical skills in underutilised technologies such as artificial intelligence (AI), robotics and drones, while also strengthening competencies in widely recognized technologies like precision farming and internet of things (IoTs).

Keywords: Socio-economic characteristics, smart farming technologies, extension agents, knowledge level.

INTRODUCTION

In developing countries, the agriculture industry continues to be one of the most significant drivers of national income and job development. As a result, enhancing the agricultural sector with new technologies is crucial for bolstering the national economies of those nations, Nigeria inclusive (Nyaga *et al*., 2021). Agricultural production includes the production of food for humans and livestock, in addition to the raw materials needed for industrial processes. Food availability is a prerequisite to human beings' existence and quality of individual's life in particular (Sejabaledi, 2017).

Globally, agricultural extension services are vital components of agricultural development processes, encompassing the dissemination of information, technology transfer, and capacity-building to end users by enhancing their productivity and livelihoods (Rahman and Pal, 2021; Sahoo *et al.,* 2023). Agricultural extension is a fundamental medium of providing farmers with essential knowledge, skills, and information to improve their agricultural practices, increase productivity, and enhance their socio-economic well-being. This acts as a bridge/link between researchers, agricultural information experts and farmers, thus facilitating adoption of best agricultural practices and incorporation of cutting-edge technologies in the agricultural sector (Pallavi *et al*., 2023).

The integration of agricultural extension services with smart agriculture technologies creates a powerful synergy that enhances the dissemination and adoption of innovative farming practices. Smart agriculture addresses many issues related to crop production as it allows monitoring of the changes of climate factors, soil characteristics, soil moisture, etc. Robots, ground sensors, and drones can all be connected to the internet via the Internet of Things (IoT) technology, which enables objects to be linked together and controlled automatically (AlMetwally *et al*., 2020; Jui-Hsiung *et al.,* 2020). Precision agriculture focuses on optimizing spatial management techniques to boost crop yields while preventing the overuse of pesticides and fertilizers (Mohamed *et al*.,2021). In addition, the serious dearth of knowledge on smart technology information gathering among extension agents is quite massive and expensive. The antidote requires enormous investment in high data management skills, training and infrastructures. The direct linkage between adoption/advancement of any technologies and knowledge base among extension agents is widen by these notable deficiencies (Kwaghtyo and Eke, 2022; Kumar and Ilango, 2018).

Also, according to Njenga *et al*., (2021) inadequate knowledge of smart technologies among the major players is rampant especially in developing economy and this negatively impact the adoption and implementation of new agricultural technologies. Therefore, there is need to investigate the knowledge level of extension agents about the opportunities and benefits of smart farming technologies, thus promoting the adoption rates and enhancing sustainability in food production within our immediate communities. Against these backdrops, the study is therefore described the socio-economic characteristics of the respondents in the study area, identified the smart farming agricultural technologies available and being used by the respondents and determined the knowledge level of Agricultural Extension Agents on smart farming technologies in the Southwest, Nigeria.

The study hypothesised that there is no significant relationship between socio-economic characteristics of the respondents and their knowledge of smart farming technologies.

METHODOLOGY

The study was carried out in Southwestern Nigeria, which comprises of six states namely, Lagos, Osun, Oyo, Ogun, Ondo and Ekiti States. The zone lies between Latitude 60 to the North and 40 to the South and longitude 40 to the West and 60 to the East. Southwestern Nigeria is bounded in the South by the Atlantic Ocean, in the East by Edo and Delta states, in the West by the Republic of Benin and in the North by Kwara and Kogi States. The area covers about 114,271km^2 which is approximately 12% of Nigerians total land area (National Agricultural Research Programme, 2016). Agricultural sector forms the basis of all the overall development thrust of the zone. It has a population of 33,045,477 constituting approximately 20 percent per annum.

Sampling of respondents was carried out in two stages. The first stage involved a random selection of 60% of the states in Southwest Nigeria. Therefore, four (4) states were selected, namely, Oyo, Osun, Ekiti and Ogun. The second stage involved a random selection of 80% extension agents in the selected states. This implies 45, 16, 53 and 74 extension agents were selected in Oyo, Osun, Ekiti and Ogun respectively. Therefore, a total of one-hundred and eighty-eight (188) extension agents were used as the sample size for this study

with the aid of a structured questionnaire. A total of 32 items (cutting across eight categories) relating to smart farming technologies knowledge statements that extension agents were supposed to be knowledgeable about were presented to the respondents. They were asked to indicate whether these statements were correct (true) coded 2 or incorrect (false) coded 1 at nominal level. This was used to recategorize their scores into whether they have a high knowledge on SFT for those above the mean score or a low knowledge for those below the mean score.

RESULTS AND DISCUSSION
Socio economics characteristics

From Table 1, 65.4% of the respondents were male while 34.6% were female. This result go in line with that of Olaniyi et al., (2020) where male was dominant among the extension agent. The distribution of respondents by their age revealed that 44.7% of the respondents were between the ages of 41-50 years of age, 32.9% were between 31-40 years of age, 21.3% were between 51-60 years of age while 1.1% of the respondents were within the age range of ≤30years of age with the mean age to be 44.2 years. This result implies that the extension agents are in their active age and would need training to ensure continued use of smart farming technology. This result is in line with the findings of Olorunfemi et al. (2020) which support the idea that age is expected to enhance their capacity to effectively communicate climate smart agricultural initiatives to farmers.

Table 1: Distribution of respondents based on socio-economic characteristics

Variables	Response options	Frequency	Percentage	Mean
Sex	Male	123	65.5	
	Female	65	34.6	
Age (years)	≤30	2	1.1	
	31-40	62	32.9	44.2
	41-50	84	44.7	
	51-60	40	21.3	
Years spent in school	5-10	9	4.8	
	11-16	58	30.9	17.5
	17-22	112	59.6	
	≥ 22	9	4.8	
Years of working experience	1-10	91	48.4	
	11-20	61	32.5	12.9
	21-30	33	17.6	
	31-40	3	1.5	
Training received	Yes	126	67.0	
	No	62	33.0	

Source: Field survey, 2024

More than half (59.6%) of the respondents spent between 17-22 years schooling, 30.9% spent 11-16 years, while 5-10 years and above 22 years in school were 4.8% respectively with the mean of 17

years schooling. This implies that majority of the extension agents were highly educated. The mean years of working experience was 12.9 years and it implies that the extension agents had spent a good

considerable number of years in extension service thereby improving extension services and deriving enough benefits on various technologies including SFTs. This finding collaborates the finding of Uzoechi *et al.,* (2022) who reported average working experience of 5-15 years among extension agents in Southeast Nigeria. Source of training received, 41.0% of extension agents received training on SFT from ADP, 14.9% received from research institute and NGOs (11.2%) also provided training on SFT. Few (6.9%) received training from ministry of agriculture while 0.5% received training from world bank. This implies that many of the extension agents were still lacking comprehensive and high-quality training on SFTs. This finding collaborates with the finding of Ogunleye, (2014) who reported that training should be organized on the poorly used ICTs so that the respondents can benefit from them.

Smart farming technologies available and being used

The result in Table 2 shows that the majority (73.9%) of the respondents indicated precision farming technology available for use in their area, indicating a high level of knowledge of this SFT. A significant proportion of extension agents, 53.7%, reported having internet of things (IoTs) technology available, highlighting the potential for data-driven decision making in agriculture. The relatively low availability of artificial intelligence (AI) (13.8%) and robotics and drones (5.3%) suggest a need for increased investment in these areas to enhance agricultural productivity. The availability of smart irrigation systems 32.4% and smart greenhouses 33.5% indicates a growing trend towards precision agriculture and climate-smart agriculture in the region. However, the mere availability of these technologies does not automatically translate into widespread usage. These findings underscore the importance of providing extension agents with training and support on SFT to enhance their knowledge more on the available technologies.

Table 2: Distribution of respondents by types of SFT available

SFT available	Frequency*	Percentage (%)
Precision farming	139	73.9
Remote sensing	45	23.9
Internet of Things	121	53.7
Artificial Intelligence	26	13.8
Cloud computing	56	29.8
Robotics and Drones	10	5.3
Smart Irrigation system	61	32.4
Smart Greenhouse	63	33.5

Source: Field Survey, 2024
*Multiple responses

Level of use of smart farming technologies in work environment

Table 3 shows the level of use of smart farming technologies by the respondents in the study area. Based on the findings, any mean score greater or equal to 1.50 was categorized as high use and any mean score less than 1.50 was categorized as low use. Precision farming ($\bar{x} = 1.57$) ranked 1st as the SFT used. This was followed by internet of things ($\bar{x} = 1.39$) which ranked 2nd, and irrigation system ($\bar{x} = 1.20$) ranked 3rd. This suggests that precision farming had the highest level of use among the respondents surveyed. Also, artificial intelligence ($\bar{x} = 0.98$) ranked 4th subsequently followed by smart greenhouse ($\bar{x} = 0.96$) which ranked 5th, cloud computing ($\bar{x} = 0.92$) ranked 6th. Furthermore, remote sensing ($\bar{x} = 0.91$) ranked 7th while robotic and drones ($\bar{x} = 0.61$) ranked 8th among the extension agents in the study area.

Table 3: Distribution of respondents by the level of use of SFT

SN Types of SFT	High	Moderate	Low	Not Use	WMS	Rank
1 Precision farming	23 (12.2)	90 (47.9)	46 (24.5)	29 (15.4)	1.57	1st
2 Remote sensing	7 (3.7)	30 (16.0)	91 (48.4)	60 (31.9)	0.91	7th
3 Internet of Things	9 (4.8)	88 (46.8)	58 (30.9)	33 (17.6)	1.39	2nd
4 Artificial Intelligence	4 (2.1)	47 (25.0)	79 (42.0)	58 (30.9)	0.98	4th
5 Cloud computing	3 (1.6)	46 (24.5)	72 (38.3)	67 (35.6)	0.92	6th
6 Robotics and Drones	0 (0.0)	6 (3.2)	102 (54.3)	80 (42.6)	0.61	8th
7 Smart Irrigation system	13 (6.9)	44 (23.4)	99 (52.7)	32 (17.0)	1.20	3rd
8 Smart Greenhouse	5 (2.7)	36 (19.1)	93 (49.5)	54 (28.7)	0.96	5th

Source: Field Survey, 2024

The result implies that precision farming is a more established technology compared to some of the other SFTs which have shown significant benefits for crop yields and resource management. This is in alignment with Abdulsalam, (2019), who opined that the benefit of precision farming helps to reduce both the cost of producing crops and the risk of environmental pollution.

Knowledge level of extension agents on Smart Farming Technologies.

Table 4 shows that the extension agents were knowledgeable on internet of things (IoTs) such as its role in tracking and monitoring of farm produce to reduce wastage (75.5%), its facilitation of farming automation (67.6%), internet connectivity for agricultural technologies (66.5%), and 53.2% saw IoTs investment as profitable in farming. However, low knowledge was identified that traditional farming practices is unnecessary with SF (41%) and 21.8% indicated that conventional methods could efficiently handle irrigation and climate forecasting. This implies that the extension agents in Southwest Nigeria need more training on the potential benefits of IoTs. The findings of this study agree with Olorunfemi *et al.* (2021) cited by Ojo *et al.,* (2023) who discovered low knowledge of the use of ICT for transferring information to farmers among the extension agents.

On precision farming, most of the extension agents were knowledgeable on minimization of fertilizer or pesticides waste (85.6%), right dosage delivery (77.7%), other inputs are incompatible with precision farming (58.5%), and 51.6% had low knowledge on optimization of spatial management is not possible in precision farming. The high level of knowledge exhibited by the extension agents on precision farming gives an indication of a good understanding of the benefits of precision agriculture in reducing the environmental impact of farming practices. They recognize the importance of minimizing wastage and preventing overuse of inputs, which agrees with the principles of precision agriculture (Kalischuk *et al.,* 2019).

The extension agents had a wide range of knowledge on robotics and drones, as presented in the table reveals that majority (67.6%), agreed with the fact that field monitoring/surveillance are easier with the aids of drones, efficient work rate (64.9%), reduction in labour cost (65.4%), and all farming operation cannot use robots and drones (55.9%). This implies that extension agents recognize the advantages of using drones for monitoring and surveillance, especially in challenging terrain. This agrees with Vinodhini, (2024) who opined that, a type of drone utilises laser beams to measure distances and creates detailed, three-dimensional maps of the terrain, assisting in topographic mapping and crop elevation analysis.

The results from Table 4 show that extension agents demonstrated high level of knowledge on remote monitoring helps farmers detect issues early and improve overall farm management (89.4%), using sensors to collect real-time weather data (81.9%), and sensors can be used to monitor or collect soil parameters (80.3%). On the other hand, a low knowledge response to forecasting is not reliable by sensors (60.1%). This indicates that extension agents have a good understanding of the benefits of smart farming technologies, particularly in terms of remote monitoring and sensor applications. However, the low knowledge exhibited on some of the identified responses needs urgent upgrade via training for them to be able to make the expected impact. This agrees with the findings of Ale *et al.* (2016) that extension agents in the Southwest zone of Nigeria needed to be more knowledgeable on diversification practices in crop enterprise for adequate dissemination to the farmers.

The result reveals that the respondents were mostly (73.4%) knowledgeable of the ability of AI in making decision efficiently while (51.1%) had low knowledge in precise and reliable with AI enabled farming. The result indicates that extension agents have a high level of knowledge and appreciation for the capabilities of AI in farming operations. This agrees with Zhang *et al.,* (2020) who opined that, it will enhance the accuracy and effectiveness of extension services, leading to optimized resource management and increased productivity.

Furthermore, majority (78.2%) of the respondents demonstrated a high level of knowledge on high cost of subscription and services, followed by effective data storage management systems (73.4%) while they had low knowledge in efficient management on physical data facilities (29.8%). This implies that extension agents were concerned with the high cost of cloud computing services. However, Maston *et al.,* (2011) argues that the benefits of cloud computing, including reduced capital expenditure and increased agility, may outweigh the costs for many organizations.

The result revealed that (88.8%) of the respondents had high knowledge on installation of pumps for easy water transportation, automated drip irrigation can be employed using soil moisture sensors to eliminate water wastage (79.3%), irrigation coupled with fertilizer application is possible with precise-to-point delivery system (75.5%). However, low knowledge was recorded for surface or sprinkler irrigation system is best practiced (25.0%) and water distribution is tailored towards precipitation (20.2%). This implies that extension agents recognize the critical role of pumps in ensuring water availability and efficient transport. This aligns with the study by Ramli and Jabbar (2022), which emphasized that the use of pumps in

irrigation systems can greatly improve water distribution, even during dry periods.

Table 4: Distribution of respondents' knowledge levels on smart farming technologies.

Smart Farming Technologies	(%)
Internet of Things (IoT)	
Internet connectivity of robots, ground sensors, cameras and drones are possible and essential to agricultural productivity.	66.5
Internet of things enables easy coordination and automation of farming operations.	67.6
It enables efficient tracking and monitoring of farm produce, thereby minimizing wastage.	75.5
The progression and integration of smart technologies with traditional farming practices is unnecessary.	41
The investment in IoTs is massive and practically profitable in farming.	53.2
Operations such as irrigation, fertilization, harvesting, and climate forecasting are efficiently productive with conventional farming.	21.8
Precision agriculture	
Chemical and other inputs are incompatible with precision agriculture	58.5
Precision agriculture prevents the overuse of pesticides and fertilizers	77.7
Precision agriculture minimizes wastage of pesticides and fertilizers	85.6
Optimization of spatial management is not possible in precision farming	51.6
Robotics and Drones (Unmanned Aerial Vehicles)	
Robots and drones can work tirelessly and efficiently, reducing labour costs and improving overall productivity.	64.9
Image/ data capturing, object detection and field monitoring/ surveillance are easier with the aids of drones especially in difficult terrain.	67.6
Robots and drones cannot be deployed to all farming operations	65.4
Semi-automated or autonomous tractors are fabricated to couple with drones or robots in order to ease operation.	55.9
Farming operations are more predictable, reliable or less susceptible to damages with direct human involvement.	32.4
Remote sensing	
Sensors can be used to collect real-time weather data, such as temperature, humidity, wind speed, and precipitation	81.9
Sensors can be used to monitor or collect soil parameters and detect deficiencies or excesses	80.3
Remote monitoring also helps farmers detect issues early and take prompt action, in the process minimizing losses and improving overall farm management.	89.4
Sensor predictions are not reliable or dependable in forecasting	39.9
Artificial Intelligence	
AI enables machine decision in par with human intelligence in farming operations.	73.4
Precision and reliability are not correct with AI enabled farming.	51.1
Cloud computing	
Effective data storage management systems, algorithms and computation are virtually handled and supported	73.4
Physical data facilities are enough for efficient management	29.8
The cost of subscription and services are at the high end	78.2
Smart Irrigation system	
The surface or sprinkler irrigation system is best practiced and insufficient for production	25.0
Automated drip irrigation can be employed using soil moisture sensors to eliminate water wastage	79.3
Irrigation coupled with fertilizer or chemical pesticides application is possible with precise-to-point delivery system.	75.5
Water availability and transport system is enabled with installation of pumps.	88.8
Water availability and distribution is tailored towards precipitation.	20.2
Smart greenhouse	
The use of protected/ covered environment limits pest problem and other external factors.	86.7
Production is maximized through efficient use of space	86.7
Open field farming is still obtainable and should be generally practiced.	19.7

Source: Field Survey, 2024

The extension agents however had high knowledge on smart greenhouse on the use of protected/covered environment limits pest problem and other external factors, efficient use of space is maximised (86.7%) respectively while the extension agents had low knowledge on open field farming should be generally practiced (19.7%). This implies that the high percentages of responses indicate that extension agents recognize the advantages of using smart greenhouse to control pest problems and mitigate external environmental factors. This is supported by the study of Gruda *et al.,* (2021), which highlighted protected environments, such as greenhouses, can significantly reduce pest infestations and provide a stable microclimate for crops.

Knowledge scores of the extension agents on each of the SFTs

Table 5 shows that, majority (87.2%) of the extension agents had high knowledge score of percentages above the mean in smart greenhouse, this indicate that extension agents' strong understanding of smart greenhouses positions them as critical intermediaries in advancing controlled environment agriculture. This is supported by Kumar *et al., (*2023), which highlighted that extension agents' knowledge on smart greenhouse enables them to guide farmers in reducing resource wastage, and increasing yields through technologies such as automated climate control and real-time monitoring systems. Majority (81.4%) of the respondents also had high knowledge score on precision agriculture. This implies that, high knowledge score exhibited by the extension agents on precision farming gives an indication of a good understanding of the benefits of precision agriculture in reducing the environmental impact of farming practices. They recognize the importance of minimizing wastage and preventing overuse of inputs, which is in line with the principles of precision agriculture (Kalischuk *et al.,* 2019).

The results from Table 5 shows that (79.3%) of the respondents had high knowledge of smart irrigation. This implies that the extension agents have in-depth knowledge about efficient resources management such as water, fertilizer and pesticides application, a critical issue in agriculture. This aligns with Organisation for Economic Co-operation and Development (OECD), 2019 submission, to imply increased efficiency and waste reduction.

Table 5: Distribution of knowledge scores of the extension agents on SFTs

Knowledge Score	Percentage %	Mean (SD)
Internet of Things (IoT)		
6- 9 (Low)	66.5	9.23 (1.22)
10- 12 (High)	33.5	
Precision farming		
4- 6 (Low)	18.6	6.98 (1.03)
7- 8 (High)	81.4	
Robotics and Drones (UAV)		
5- 7.5 (Low)	43.6	7.48 (1.35)
7.6- 10 (High)	56.4	
Remote sensing		
4- 6 (Low)	42.0	6.53 (1.16)
7- 8 (High)	58.0	
Artificial intelligence		
2- 2.9 (Low)	74.5	3.21 (0.50)
3- 4 (High)	25.5	
Cloud computing		
3- 3.9 (Low)	47.3	4.65 (0.72)
4- 6 (High)	52.7	
Smart Irrigation system		
5- 7.5 (Low)	20.7	7.96 (0.83)
7.6- 10 (High)	79.3	
Smart greenhouse		
3- 3.9 (Low)	12.8	4.96 (0.56)
4- 6 (High)	87.2	
Overall knowledge score		
Low	**49.5**	**50.61(4.32)**
High	**50.5**	

Source: Field survey, 2024

However, the high knowledge score of 58.0% among extension workers in the application of remote sensing technologies in farming activities and operations suggest they had information of better and improved production methods in monitoring pest and diseases spread. This is partly supported by the result of Ibrahim *et al.,* 2024 which highlighted the higher prediction rate in monitoring potato diseases aided with remote sensing-based climate data.

Furthermore, the 56.4% high knowledge score of extension agents regarding robotic and drones is a promising indicator for the future of agriculture, thus expertise lean towards significant advancements in productivity, sustainability, and data utilisation in farming. In general, the push towards agricultural productivity is greatly incentivized by engagement of relevant stakeholders such as extension services, investors and IT experts (Falana *et al.,* 2024). About 52.7% of extension agents indicated high knowledge level on the benefits and utilisation of cloud computing incorporated farming techniques, which encourages better service delivery in agriculture as supported by Paul *et al.,* (2020). Many extension workers reported low knowledge score of 33.5% in IoT-incorporated farming, the evident lack of robust infrastructures, connectivity and limited electricity access poses this major constraint in extending operations to include necessary IoTs- supported knowledge advancement and trainings (Agballa *et al.,* 2024).

Lastly, extension agents in general had low knowledge level with scores below the average benchmark in AI (25.5%), as contrary to the findings of Omole and Fasina (2024); which suggested high usage of AI-enabled technologies among agripreneurs in Ondo State, Nigeria. Meanwhile, the overall knowledge score (50.5%) of the respondents indicates that about half of the extension agents possess high level of SFTs, while (49.5%) of the respondents indicate a little below half had low level of knowledge in SFT implying that significant portion still lacks adequate knowledge of the use of SFTs.

Relationship between selected socio-economic characteristics of the respondents and the level of their knowledge on smart farming technologies.

The result of Logistic regression revealed a significant relationship between age (p=0.036) and years of experience (p=0.057) and socio-economic factors that influenced the knowledge level of the extension agents on smart farming technologies. Age (β= -0.072; p=0.036) had a negative significant relationship with their knowledge level of smart farming technologies at 5% level of significance. This indicates that as extension agents grow older, the knowledge level of the extension agents on SFTs decreases. This could be attributed to the fact that: older agents may have been used to traditional farming practices and may find it challenging to adapt to newer, smart farming technologies. Also, the rapid evolution of SFT practices, which includes the adoption of modern technologies and innovative farming strategies, might be more easily embraced by younger agents who are typically more open to new methods and lastly older agents may have fewer opportunities for continuous professional development, which might make them to miss out on the latest advancements in smart farming technologies. This finding corroborates Mubiru *et al.* (2018) that older farmers and extension agents often face challenges in adapting to smart farming technologies practices, as they tend to favour conventional methods. The fast-paced development of SFTs may pose a barrier for older individuals who may not have the necessary digital literacy or comfort with new practices.

Table 6: Logistic Regression Model showing relationship between selected socioeconomic characteristics of the extension Agents and knowledge level of smart farming technologies

Variables	Coefficient	Standard Error	z	P>|z|
Sex	0.0155944	0.3244366	0.05	0.962
Marital status	0.298822	0.3270356	-0.91	0.361
Age	-0.0721321	0.0343708	-2.10	0.036**
Years of education	0.0415218	0.0465151	0.89	0.372
Training received	0.4863754	0.3201153	1.52	0.129
Years of experience	0.0620787	0.0325789	1.91	0.057*
Constant	1.943194	1.365553	1.42	0.155

Source: Computed Data, 2024
* Significant at 10%, ** Significant at 5%
Number of obs. = 188
LR Chi-Squ. (6)= 9.16
Prob > Chi-Squ.= 0.1647
Log likelihood = -125.72049
Pseudo R^2 = 0.0352

Years of experience (β= 0.062; p=0.057) showed a positive and significant relationship with knowledge level of the extension agents on SFTs at 10% level. This implies that more experienced extension agents tend to have better knowledge of SFTs. Also, as extension agents with more years of experience, may have encountered a wider range and have a deeper understanding of farming systems, including technological impact on agriculture. This work's finding aligns with the opinion of Owen (2004) as cited in Uzoechi *et al.,* (2022) who in their study suggested a long-term specialized development plan for extension agents towards their evaluation in their early years of service, to ensure development of their desired sub competencies to aid the usage of smart farming technologies.

CONCLUSION AND RECOMMENDATIONS

The study concludes that the extension agents were in their active years and would need training to ensure continued use of SFTs. Precision farming technology was the most available and utilised smart farming technology, majority of the respondents were most knowledgeable on smart greenhouse which limits pest problem and other external factors through the use of protected/covered environment in agriculture enables controlled growing conditions, optimizing factors such as temperature, humidity, and light to enhance crop yield and quality. Overall knowledge score indicated that about half of the extension agents possess high level of SFTs, while little below half had low level of knowledge in SFTs implying that significant portion still lacks adequate knowledge. Based on the findings, it is recommended that; there should be continuous and intensive training programs tailored to equip extension agents with the necessary technical know-how and hands-on experience in using smart farming technologies.

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Utilisation of herbs for health treatment among rural dwellers in Oyo and Osun states, Nigeria

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Abstract - There has been a lot of criticism and attack against the use of herbal medicine, that it is fetish, the dosage is not measurable and that the practitioners are illiterate. This study therefore examined the level of utilisation of herbs for health treatment among rural dwellers in Oyo and Osun state, Nigeria. Multistage sampling technique was used to select 164 respondents in the study area. Purposive selection of three local government areas (LGAs) from Ogbomoso agricultural zone of Oyo state, while two local Government Areas were purposive selected from Iwo agricultural zone of Osun State. Data for the research was collected using structured interview schedule. Descriptive statistical tools such as frequency counts, percentages, Weighted Mean Scores (WMS), rankings and standard deviation were used to describe the socio-economic characteristics while Chi square and Pearson Product Moment Correlation (PPMC) were employed as the inferential statistical tool to determine relationship between the variables examined at 5% significance level. The study revealed that mean age of the respondents was found to be 51 years. The mean year spent in school was 10 years, while the mean year of herb experience was 25 years. The constraints associated with the utilisation of herbs were Irregular dosage and measurement (WMS=1.44) were ranked 1st, while taste with (WMS=0.97) was ranked least (9th). The result of the Chi-Square revealed that there is significant relationship between the selected socio-economic characteristics of respondents and the level of herbs utilisation for health treatment which include, Religion (x = 47.262, p = 0.000), Marital Status (x = 292.625, p = 0.000). Conclusively, it was observed that malaria was the most common disease treated by the respondent therefore, there must be a policy regulating the dosage of herbs to be used for each ailment and age grade of patient. Herb producers should endeavor to process herbs in an attractive environment and acceptable form for the end users.

Keywords: Utilisation, herbs, health, rural dwellers.

INTRODUCTION

Herbal medicine, also known as botanical medicine, a phytotherapy, is the use of plants extracts for medicinal purposes. It has been used for thousands of years in various cultures around the world, many modern medicines have their roots in herbal medicine (Yuan, 2016). Herbal medicines can be prepared in different forms, such as teas, tincture, capsules or creams. They are often used to treat a wide range of ailments/diseases such as malaria, cough, heart disease and many more. Some herbs may also have anti-inflammatory, antimicrobial or antioxidant properties (Wachtel-Galor and Benzie, 2011).

It is worthy of note that, herbal medicine has been defined differently by various people. According to Lucas (2010) herbal medicine is the use of plant products to treat or prevent ailment. Nsowah-Nuamah *et al.,* (2010) suggests that the treatment of ailment using herbal usually takes the form of herbs, and plant preparations. The World Health Organization (WHO) likewise defined herbal medicine as a plant-derived material or preparation with therapeutic or other human health benefits which contain either raw or processed ingredients from one or more plants (WHO, 2010).

Plant resources have remained an integral part of human society throughout history. Herbal medicine is generally considered highly available and accessible to people in developing countries (Ariyo, 2018). This high use of herbal medicines may be due to accessibility, affordability, availability and acceptability of traditional medicines by a majority of the populace in developing countries (Elvin-Lewis, 2000). Consequently, poor and marginalized people are commonly assumed to be most reliant on traditional medicine for their healthcare (Cunningham *et al.,*2008). Long time ago, in traditional societies, herbalism was a way of life rather than a trade as it later turned out to be. If a person fell sick, the other person who knew just what to use went to the nearby bush and brought back herbs that gave relief to the sick (Ogunkunle and Ashiru, 2011). There has been a lot of criticism and attack against the use of herbal medicine, that it is fetish, the dosage is not measurable and that the practitioners are illiterate, the main purpose of this study was to assess the utilisation of herbs for the treatment of ailment among the rural dwellers in Oyo and Osun State.

The specific objectives are to:
1. Described the socio-economic characteristics of rural dwellers on utilisation of herbal medicine
2. Examined the level of uses of herbal medicine for health treatment
3. Identified the types of herbs used for different diseases treatment in study area.

METHODOLOGY

The study was carried out in two states Oyo and Osun State of Nigeria. Oyo state was created on February 3, 1976, which is located between latitudes 20381 and 40351 east of the Greenwich meridian. The State covers an area of 28,454 square kilometers

(FOS, 1996). According to NPC (2006), Oyo State had a population of 5,591,585 people. The State has two distinct ecological zones – the western moist forest to the south and the intermediate savannah to the north. The State shares border with the people Republic of Benin in the west, Kwara State in the north, Osun state in the east and Ogun State in the south. The State is divided into four agricultural zones. These are Ibadan/Ibarapa, Oyo, Ogbomoso and Saki agricultural zones. Agriculture is the main occupation of the people and small-scale traditional farming system predominates in the area. The major cash crops cultivated in the area are yam, cassava, cocoa and maize and many more, the major occupation of the people in the area is farming and they are Yoruba tribes. Wikipedia, (2024).

Also, Osun State was established on 27th day of August 1991 as a result of bifurcation of the former Oyo State. Osun State is located in the South-Western part of Nigeria. It covers an area of approximately 14,875 square kilometers and an estimated population of 4,137,627 (National Popolation Census). It also lies between longitude 04 0^0E and latitude 05 558^{0}N and is bounded by Ogun, Ekiti, Kwara, Oyo, and Ondo States in the South, North, West, and East respectively, (Osun State in brief 2007). The inhabitants are mostly Yorubas, though other tribes do co-exist in Osun State. The major occupation of these people is farming and crops cultivated include yam, cassava, cocoyam, cocoa, oranges, kolanut, plantain and other tree crops which are typical of rain forest zones. Osun State is largely agrarian, and agriculture is the mainstay of the state economy. It employs 75% of the state working population. The State is the one of largest producers of Rice, Kolanut, Oil palm, and Cocoa in the country. Wikipedia, (2024).

The data for this study was obtained from primary source through the administration of a well-structured interview schedule. The schedule is divided into sections which are designed in line with the objectives of the study.

Multistage sampling technique was used to select 164 respondents in the study area. Purposive selection of three local government areas (LGAs) from Ogbomoso agricultural zone of Oyo state, while two local Government Areas Were Purposive selected from Iwo agricultural zone of Osun State.

RESULT AND DISCUSSION
Socioeconomic characteristics
Age - The result of the analysis of the age of household members presented in Table 1 shows that 48.5% of the respondents were above 51 years of age, while 7.0% of the respondents were less than or equal to 30 years of age. The mean age of the respondents was revealed to be 51.1 years. The mean age of the respondents in the two states was to be middle aged is an indication that rural dwellers that utilise herbal medicine in the study areas are in their active age and can utilise herbal medicine exploited optimally. This result agrees with the findings of Nzeh *et al,* (2008) and Akanni, (2013) who cited in their study that those using herbal medicine were middle-aged people who have various family responsibilities.

Table 1: Distribution of respondents according to their age

Age (Years)	Frequency	Percent	WMS
≤ 40	46	22.0	
41-50	29	23.3	51.09
51-60	36	48.5	
61-70	36	48.5	
71-80	17	22.0	
Total	164	100	

Source; Field survey, 2024
WMS: Weighted mean score

Sex - The result on sex of rural households presented in table 2 shows that, slightly more than half 56.3% of the herbs users were males and 43.8% of them were females. This is an indication that both male and female were involved in the use of local herb, though it is dominated by males. This implies that both sex is health conscious and give regard to herb utilisation, and this could be attributed to the respective family custom they belong to.

This result is in line with the findings of Ayanwuyi (2013), where more than half (56.3%) of the forest users in which herb is one of the forest products were males. This result is also in line with Shehu and Mallam, (2007) who indicated that the utilisation of herbal medicine is not gender sensitive as health is the foundation of all other aspects of life and the ultimate aim of any medical service is to reduce mortality and morbidity of people regardless of their sex.

Table 2: Distribution of respondents according to their gender

Gender	Frequency	Percentage
Male	92	56.3
Female	72	43.7
Total	164	100

Source: Field survey, 2024

Marital status - The result on marital status of the households' size shows that 73.1% of the respondents were married, while 0.6% were separated. The findings therefore imply that majority of the respondents were married, which suggests that most of the respondents were responsible. Majority (73.1%) of them were married and they need to provide for the needs of their household which includes health care. According to Akinbile (2007), marriage confers responsibility therefore health case within the family setting is expected to be better as it provides opportunity for members to be their brothers' keepers because non-married individuals may not be sufficiently sensitive to their health needs. This result is an indication that respondents in the study area were responsible individuals who respect the culture and tradition of the social institution.

Table 3: Distribution of the respondents according to their marital status

Marital Status	Frequency	Percentage
Married	121	73.1
Single	12	7.5
Separated	1	0.6
Divorced	5	3.1
Widow	25	15.6
Total	**164**	**100**

Source; Field survey, 2024

Usage of herbs for health treatment - The result on the usage of herbs for health treatment on rural households presented in table 4 revealed that almost all (96.3%) the respondents are using herbs for treatment, while 3.7% of the respondents were not using herbs for treatment. The finding indicates that majority of the respondents are using herbs for treatment. Based on the responses obtained from the respondents, this work affirms the assertion of (Osemeobo *at el.,* 2005), that more than 90% of Nigerians in rural areas and over 40% in urban areas depend partly and wholly on traditional medicine. In addition to the fact that millions of people depend on medicinal plants for health treatments.

Table 4: Distribution of respondents according to usage of herbs for health treatment

Do you use herb to treat yourself	Frequency	Percentage
Yes	159	96.3
No	5	3.7
Total	164	100

Source; Field survey, 2024

Types of herbs used for difference diseases treatment in study area - It was revealed that almost all (99.6%) of respondents used neem tree and lemon tree for malaria treatment, 90.0% used bitter leaves for diarrhea treatment, 73.8% used pawpaw and lemon grass for typhoid treatment, 72.5% used miracle leave and honey for ulcers treatment, 70.6% used miracle leaf for asthma treatment, 68.1% used ackee apple and goat weed for headache treatment, 67.5% used blood leave, pap and spoilt plantain for body pain 66.9% used bitter kola for cough, 59.4% used bitter melon and spring onion for urinary infection treatment, 56.9% used miracle leave and scent leave for infertility treatment, 56.1% used spring onion and bitter lemon for gonorrhea treatment, 55.0% used brimstone and bitter lemon for pile treatment, 44.4% used jathropha leave and guinea pepper for hypertension treatment, 42.5% used stonebreaker and itakun for rheumatism treatment, 38.1% used tobacco for convulsion treatment. Medicinal plants are important for a number of reasons such as treatment of various diseases, collection and processing of medicinal plants which provide employment and income opportunities for a large number of people in rural areas (Marshall*, et al.,* 2003), also the importance of traditional medicinal plants in conservation of biological diversity also merits attention (Okoil, *et al.,*) and (Mensah 2007). Therefore, this finding is in line with the research work of Osunderu (2017), where Eeru, Oruwo, and Dongoyaro were listed as medicinal plants used in the treatment of disease. A large proportion of the

world's rural population depends on these plants for
their health care needs (Largo, 2014).

Table 5: Distribution of respondents based on types of herbs in the study area, n=164

Plant	Local name	Oyo F(%)	Osun F(%)	Pooled F(%)
Neem tree, lemon tree, tea tree	Dongoyaro, Oronbo, ewe tea	100(98.0)	59(95.2)	59(99.6)
Bitter kola	Orobo	68(57.8)	42(67.7)	90(66.9)
Miracle leaf	Ewe abamonda	59(57.8)	32(51.6)	91(70.6)
Brimstone, bitter lemon	Oruwo,	70(68.6)	47(75.8)	117(55.0)
Bitter leave	Ewuro	91(89.2)	56(90.3)	147(90.0)
Jatropha leave, guinea pepper	Lapalapa, ero awonka	47(46.1)	26(41.9)	73(44.4)
Pawpaw leave, lemon grass	Ewe ibepe, koriko oba	79(77.5)	43(69.4)	122(73.8)
Stone breaker, climb tree	Ewe eyin olobe, itakun	47(46.1)	24(38.7)	71(42.5)
Ackle apple, goat weed	Ewe isin, ewe imi-esu	66(64.7)	45(72.6)	111(68.1)
Bitter lemon	Ewe ejirin	64(62.7)	34(54.8)	98(59.4)
Scent leave, miracle leave	Efinrin, ewe abamonda	56(54.9)	39(62.9)	95(56.9)
Spring onion	Alubosa elewe	58(56.9)	29(46.8)	87(56.1)
Miracle leave	Ewe abamonda	74(72.5)	46(74.2)	120(72.5)
Tobacco leave	Ewe taba	41(40.2)	22(35.5)	63(38.1)
Blood leave, spoilt plantain	Ewe aje, Ogede rira	64(62.7)	46(74.2)	110(67.5)

Source: Field Survey, 2024

Level of uses of herbal medicine for health treatment

It was revealed that, malaria diseases (aarun iba) being treated with neem tree, tea tree, pineapple and mango leave and was ranked first based on the level of use of herbal medicine with weighted mean score(WMS=2.16), body pain (ara riro)treated with ewe aato, dog bone, eko tutu, spoilt plantain and ori was ranked second with (WMS=1.97), Other herbal medicine based on the level of use in their ranked order include pile(jedijedi) treated with efinrin,oruwo, asunwon and bara was ranked third with(WMS=1.92), diarrhea(igbe gbuuru) treated with ewuro and ewe laali was ranked fourth with (WMS=1.80), headache(ori fifo) treated with ewe isin and ewe imi esu was ranked fifth with(WMS=1.79), cough(iko) treated with igi ipeta,lime and eru awola was ranked 6th with(WMS=1.78), convulsion(ile tutu/giri) treated with ewe taba(dry and wet), black alum and ororo maalu(egunnugo) was ranked 7th with(WMS=1.63), typhoid(iba jedojedo) treated with ewe ibepe, koriko oba and lime was ranked 8th with(WMS=1.54), gonorrhea(atosi) treatd with ewe ipeta, alubosa elewe, lime and bara epa ikun was ranked 9th with(WMS=1.52), ulcer(ogbe inu) treated with red lapalapa, white lapalapa, ewe owu and honey, and infertility(airomobi) was ranked 10th respectively with(WMS=1.48), hypertension(eje riru) treated with lapalapa, ewe laa and eru awola was ranked 11th with(WMS=1.46), asthma treated with ewe abamonda and lime was ranked 12th

with(WMS=1.44), rheumatism treated with ewe eyun and itakun was rank 13th with(WMS=1.43), hernia(ipake) treated with itagiri, ewe aji ewu, pandoro and lime was ranked 14th with(WMS=1.40), toothache(eyin riro) treated with coconut bark and urinary infection(ito akoran) treated with ewe owu, imo ope, bara and alubosa elewe ranked 15th respectively with (WMS=1.39), while epilepsy (warapa) treated with dry taba, lizard and urine ranked least with(WMS=.1.26). This implies that malaria is the most common disease treated with traditional medicine by the rural dwellers and corroborates the findings of WHO (2012), that Nigeria is one of the six highest malaria burdened countries in Africa which account for an estimated 47% of malaria cases globally and also Chan (2008) which states that 60% of young children in some African countries suffering from high fever, presumably caused by malaria, are treated at home with herbal remedies which are the most common type of traditional medicine. The high incidence of malaria in the community may also be indicative of the fact that majority of the respondents are farmers and the proximity of villages to fields and water sources are some characteristics of agricultural production systems that can create conditions that favor parasitic vectors and facilitate the disease's transmission. This explains why the WHO (2007) stated that most people living in Africa use herbal medicines for the management or prevention of diseases.

Table 6: Distribution of respondents based on level of uses of herbal medicine in Oyo and Osun states

Ailments	Very often F(%)	Often F(%)	Rarely F(%)	Never F(%)	WMS	R	Pooled WMS	R
Malaria (aarun iba)	48(47.1)	35(34.3)	11(10.8)	8(7.8)	2.21	1st	2.16	1st
Cough (iko)	20(19.6)	51(50.0)	29(28.4)	2(2.0)	1.87	4th	1.78	6th
Asthma (iko-fee)	26(25.5)	28(27.5)	27(26.5)	21(20.6)	1.58	10th	1.44	13th
Pile (jedijedi)	33(32.4)	40(39.2)	18(17.6)	11(10.8)	1.93	2nd	1.92	3rd
Diarrhea (igbe-gbuuru)	29(28.4)	38(37.3)	30(29.4)	5(4.9)	1.89	3rd	1.80	4th
Hypertension (eje riru)	21(20.6)	33(32.4)	25(24.5)	23(22.5)	1.51	12th	1.46	12th
Typhoid (iba jedojedo)	34(33.3)	24(23.5)	19(18.6)	25(24.5)	1.66	8th	1.54	8th
Rheumatism(arunmolegun)	29(28.4)	16(15.7)	37(36.3)	20(19.6)	1.53	11th	1.43	14th
Headache (ori fifo)	27(26.5)	38(37.3)	28(27.5)	9(8.8)	1.81	6th	1.79	5th
Toothache (eyin riro)	22(21.6)	26(25.5)	33(32.4)	21(20.6)	1.48	14th	1.39	16th
Urinary infection (ito akoran)	28(27.5)	21(20.6)	27(26.5)	26(25.5)	1.50	13th	1.39	16th
Infertility (airomobi)	27(25.5)	28(27.5)	29(28.4)	18(17.6)	1.63	9th	1.48	10th
Gonorrhea (atosi)	31(30.4)	21(20.6)	26(25.5)	24(23.5)	1.58	10th	1.52	9th
Hernia (ipake)	22(21.6)	25(24.5)	37(36.3)	18(17.6)	1.50	13th	1.40	15th
Epilepsy(warapa)	18(17.6)	32(31.4)	22(21.6)	30(29.4)	1.37	15th	1.26	18th
Ulcers (ogbe inu)	19(18.6)	31(30.4)	34(33.3)	18(17.6)	1.50	13th	1.48	10th
Convulsion (ile tutu/giri)	33(32.4)	31(30.4)	18(17.6)	20(19.6)	1.75	7th	1.63	7th
Body pain (ara riro)	30(29.4)	40(39.2)	21(20.6))	11(10.8)	1.87	5th	1.97	2nd

Source: Field Survey, 2024
F=Frequency
%=Percentage
WMS= Weighted Mean Score
R= Rank

Test of hypothesis

H_{01}: There is no significant relationship between some selected socio-economic characteristics of rural dwellers and level of herbs utilisation for health treatment

The result of the Chi-Square in the table revealed that there is significant relationship exists between the selected socio-economic characteristics of respondents and the level of herbs utilisation for health treatment which include, Religion (x = 47.262, p = 0.000), the finding therefore indicates that Christians, Muslims and traditional worshipers involved in utilisation of herbs and an implication that the respondents do not have bias towards traditional medicine for health purpose, Marital Status (x = 292.625, p = 0.000), the findings therefore implies that majority of the respondents were married, which suggest that most of the respondents were responsible, According to Akinbile, (2007) marriage confers responsibility therefore health case within the family setting is expected to be better as it provides opportunity for members to be their brothers' keepers, because non-married individuals may not be sufficiently sensitive to their health needs, primary Occupation (x = 51.250, p = 0.000), this result affirms that agricultural production is a dominant occupation in the study area.

Agriculture be of the major occupation of the respondents, is a likelihood that they might have knowledge about forest resources and better utilisation of forest resources for health purpose, this finding corroborates Adebayo and Adewumi, (2024) which opined that majority of the rural populace engages in farming activities as their major source of livelihood, Secondary Occupation (x = 83.625, p = 0.000), this result affirms that agricultural production is a dominant occupation in the study area, this result also corroborates the findings of Ajani, (2013) who reported that people living in rural area diversify their sources of income in other to empower themselves economically to meet the family responsibilities, Members of Social Organization (x = 101.450, p = 0.000), the finding indicates that majority of the respondents are members of social organization, this results conforms with that of Akintonde *et al*. (2021) whose study find out that majority of the respondents belong to social organization and Usage of Herb to treat yourself (x = 285.162, p = 0.000), the finding indicates that majority of the respondents are using herb for health treatment, based on the responses obtained from the respondents, this work affirms the assertion of Akunyili (2003), cited in Mbani, (2015) that there has been a noticeable shift from orthodox 'western' medicine to greater use of traditional (herbal) medicines in many countries and indeed worldwide, had a negative but significant relationship to the level of herbs utilisation for health treatment. This implies that rural dwellers use herbs for treatment because they have access to herbal materials which gives them many advantages

of using herbs for health treatment in the study area. This explains why the WHO, (2007) stated that most people living in Africa use herbal medicines for the management or prevention of diseases.

Since the relationship is significant, null hypothesis is rejected while the alternative hypothesis is accepted as there is significant relationship between selected socio-economic characteristics and level of herbs utilisation in the study areas.

Table 7: Summary of chi-square analysis showing the relationship between some selected socio-economic characteristics and usage level

Socioeconomic characteristics variables	Chi-Square Value (χ)	df	p-value	Remark
Religion	47.262	2	0.000	Significant
Marital Status	292.625	4	0.000	Significant
Primary Occupation	51.250	4	0.000	Significant
Secondary Occupation	83.625	4	0.000	Significant
Members of Social Organization	101.450	2	0.000	Significant
Usage of Herb to treat yourself	285.162	2	0.000	Significant

Source: Computed Data, 2024
**Correlation is significant at the 0.01 level

CONCLUSION AND RECOMMENDATION

The result of this study revealed the constraints encountered by the respondents on the use of herbal medicine were Irregular dosage and measurement, increased rate of unqualified/uncertified practitioners (by no specific prescription measurement), poor hygiene during preparation, not officially approved by government for health treatment. Therefore, everybody must have the knowledge on how to process herbs for ailments treatment, there must be a policy regulating the dosage of herbs to be used for each ailment and age grade of patient, herb producers should endeavor to process herbs in an attractive environment and acceptable form for the end users. It is highly imperative for government to issue licenses to herbal medicine producers which must be renewed periodically for authenticity's sake.

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Comparative analysis of information and communication technology usage for accessing agricultural information among cassava value chain actors in Oyo and Ogun states, Nigeria

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Abstract - This study investigated the comparative analysis of information and communication technology (ICT) usage among selected cassava value chain actors (CVCAs) in Oyo and Ogun States, Nigeria. Multistage sampling techniques was employed in the selection of 187 respondents in Oyo State and 168 respondents in Ogun State. Data were collected through a validated structured interview schedule and were analyzed through descriptive and inferential statistical tools. The results indicated that the basic ICT tools like radio (100%), mobile phones (100%), and social media (98.9% and 98.8%) were commonly used by the respondents; however, advanced technologies such as GPS and aerial drones have low adoption in the two states. The major identified constraints to ICT usage include erratic power supply, inadequate digital training and illiteracy, significantly impacting the use of ICT in accessing cassava value chain information. The result of the T-test revealed that there was no significant difference in the level of ICT (t-value= 0.650) usage between the two states. The study concluded that radio, mobile phones, and social media are the most commonly available and used ICT tools among CVCAs in both Oyo and Ogun States, with limited adoption of advanced technologies such as GPS and aerial drones, while the level of ICT usage remains relatively low across both states. The study recommends increasing ICT training opportunities for CVCAs to enhance improved ICT usage, and improvement in rural infrastructural facilities for accessibility of ICT tools and boost productivity within the cassava value chain.

Keywords: Cassava, Communication, Information, Technology, Value Chain

INTRODUCTION

Agriculture plays a pivotal role in Nigeria's economy, serving as the primary source of livelihood for most citizens Olaniyi et al. (2022). Its development is significantly influenced by the availability and timely dissemination of relevant information to farmers. In 2020, global cassava production was estimated at 291 million metric tonnes, with Africa contributing over 62% of this output (FAO 2022). Nigeria emerged as one of the leading producers worldwide, accounting for approximately 59.5 million metric tonnes, which represents about 21% of global production (Olaniyi et al., 2022; PWC, 2020). Notably, cassava farmers, cultivating between 0.5 and 5 hectares, are responsible for the majority of Nigeria's cassava production (Angba and Iton, 2020).

Cassava has gained increased prominence due to its diverse industrial, economic, and nutritional applications, primarily attributed to its starch-rich roots. Beyond its role as a staple food, cassava has transitioned into a significant source of income, with the potential to become a major foreign exchange earner, thereby positively impacting Nigeria's economic trajectory. Despite its economic potential, cassava remains predominantly used for human consumption, particularly in forms such as *Garri*, cassava flower, and *fufu*.

A value chain refers to a series of activities that an organization undertakes to produce and deliver a valuable product or service to the market (Olaniyi and Enwelu, 2021). Throughout this chain, value is incrementally added, enhancing the product's competitive edge in terms of quality and market price. Essentially, a value chain encompasses a sequence of processes aimed at creating and enhancing the value of a product, while analyzing the opportunity costs associated with this progression (Lee et al., 2018). It represents the advancement of a product from production to the final consumer, with value being added at each stage (Wen-Lung et al., 2018). Cassava exemplifies such a value chain, as it can be processed into various products, ranging from traditional and innovative food items to livestock feed while the main actors within the cassava value chain include farmers/producers, processors, and marketers.

The Cassava Value Chain (CVC) plays a critical role in Nigeria's agricultural economy, contributing significantly to food security and serving as a primary income source for millions of rural households. Despite this dominance, the sector grapples with low productivity, limited market access, and inefficiencies along the value chain (Adeniran et al., 2024). Information and Communication Technology (ICT) is increasingly recognized as a transformative tool to address these challenges, offering innovative solutions that enhance productivity, improve market connectivity, and provide critical agricultural information (Okadi et al., 2024).

ICT applications in agriculture have rapidly evolved, offering benefits such as real-time weather updates, market price information, and advanced farming techniques. For cassava value chain actors (CVCAs), ICT adoption can enhance production, processing, and marketing efficiency (Alfa., 2022). However, ICT adoption varies

significantly due to disparities in infrastructure, affordability, and digital literacy (Ebisike et al., 2021). Oyo and Ogun States are the leading cassava producers in southwestern Nigeria (FAO, 2022), there is a need to explore how ICT tools are being used differently in these states, the barriers faced by actors in using these technologies, and the impact on productivity and market access. This comparative analysis will shed light on differences in ICT utilisation and help identify targeted interventions that can promote broader ICT usage and improve cassava value chain efficiency. Based on the above background, the study investigated the comparative analysis of ICT usage among cassava value chain actors in Oyo and Ogun States. Specifically, it described the available and accessible ICT tools to CVCAs, the level of ICT usage and the constraints to ICT usage by CVCAs.

METHODOLOGY

The study was carried out in southwestern Nigeria, which comprises six (6) states, namely Oyo, Osun, Ogun, Ekiti, Ondo, and Lagos states. The zone lies in the equatorial rainforest belt, and the rainfall varies from 1500mm to 1800mm per annum. It is located between Longitude 30° and 7°E and Latitude4° and 9°N. The total land area is about 191,843 square kilometers. Oyo and Ogun States were purposively selected out of six constituent states in Southwest Nigeria. This selection was based on high cassava production data of the selected states in southwest Nigeria from the FAO database (FAO, 2022).

A multi-stage sampling procedure was adopted in the selection of the respondents for this study. The first stage involved the random selection of two agricultural zones out of the total agricultural zones in each of the selected states (Oyo and Ogun States). Second stage involved 50% of the total blocks in each of the selected agricultural zones, while three (3) blocks each were selected from Oyo and Ogbomoso agricultural zones in Oyo State respectively making six blocks in Oyo State. Also, five blocks were selected from Ijebu and Remo Agricultural Zones in Ogun state, Nigeria, making a total of eleven blocks selected. At the Third stage random sampling technique was used in the selection of one hundred and eighty-seven 187 (67 farmers, 60 processors, 60 marketers) CVCAs in Oyo state and one hundred and sixty-seven 167 (68 farmers, 50 processors and 50 marketers) cassava value chain actors in Ogun state respectively. Primary data were collected using a well-structured interview schedule; the data collected for this study were subjected to both descriptive and inferential statistical tools. The dependent variable of the study was the level of ICT usage among the Cassava value chain actors (CVCAs) across the states, and this was measured on a 4-point rating scale of always = 3, sometimes =2, rarely = 1, and never = 0, while the inferential statistic tool; T-test was used to test the slated hypothesis by checking the difference between the selected states

RESULTS AND DISCUSSION
Information and Communication Technology available to cassava value chain actors

The data on Information and Communication Technology (ICT) available to cassava value chain actors (CVCAs) in Oyo and Ogun States reveals that a wide range of technologies is available to the majority of actors, with radio, mobile phones, and social media being the most prevalent. The result in Oyo State shows that 100% of respondents reported having access to both radio and mobile phones, while 98.9% indicated the availability of social media. 93.0% had access to television, 89.3% to video, 85.0% to computers, and 80.7% to the internet. Sophisticated technologies such as Global Positioning System (GPS) (24.6%) and aerial drones (2.7%) recorded low in terms of its availability and access respectively. This implies that the range of ICT tools suggests that most CVCAs in Oyo have access to essential communication tools, as well as some advanced technologies. Furthermore, in Ogun State, all (100%) the respondents reported access to radio and mobile phones, with 98.8% having access to social media. Access to television, video, and computers was also high, with 92.3%, 85.7%, and 83.3% of respondents having these technologies available, respectively. The use of the internet was reported by 75.6% of respondents, while 25.0% and 3.0% had access to GPS and aerial drones, respectively. Generally, the widespread use of basic ICT tools such as mobile phones and radios shows their critical role in disseminating information to cassava value chain actors, providing updates on market prices, weather conditions, and agricultural techniques. Social media platforms are increasingly being used by CVCAs to enhance communication and networking; access to more advanced technologies, such as GPS and aerial drones, is still limited. This finding is in line with that of Yekinni et al., (2019) and Ebisike et al., (2021) they reported that Information and Communication Technology significantly improve access to agricultural information and retrieval of useful messages.

Table 2: Distribution of respondents by ICT tools available to CVCAs

ICT Tools Available	Oyo State F (%)	Ogun State F (%)
Radio	187(100)	168(100)
Television	174(93.0)	155(92.3)
Computer	159(85.0)	140(83.3)
Mobile phone	187(100)	168(100)
Internet	151(80.7)	127(75.6)
Social media	185(98.9)	166(98.8)
Global positioning system (GPS)	46(24.6)	42(25.0)
Aerial drone	5(2.7)	5(3.0)
Video	167(89.3)	144(85.7)

Source: Field survey, 2024

Level of ICT usage among Cassava Value Chain Actors (CVCAs)

The level of ICT usage among cassava value chain actors (CVCAs) in Oyo and Ogun states indicates a clear preference for basic communication technologies in the two states, while more advanced ICT tools remain underutilised. The result in Oyo State revealed that radio (WMS= 2.87), Mobile phones (WMS= 2.73) and social media (WMS= 2.55) were found to be the most frequently used ICT tools by the sampled respondents. This indicates the significant role these ICT tools play as primary source of information dissemination among CVCAs. However, other ICT tools like television (WMS=1.97) and the internet (WMS=1.88) were less frequently used, indicating limited access or preference for these mediums. Meanwhile, the use of computers, GPS, and aerial drones had the lowest usage scores; this implies that their availability, accessibility, and level of use are minimal among cassava value chain actors in Oyo State. Similarly, the result in Ogun State follows the same trends where radio (WMS=2.92), mobile phones (WMS=2.68) and social media (WMS=2.37) were the most used ICT tools by the respondents. On the other hand, ICT tools such as television (WMS=1.93), video (WMS=1.76), and the internet (WMS=1.71) also had relatively low usage levels. Advanced technologies like GPS and aerial drones were barely utilised, with WMS scores of 0.27 and 0.11 respectively. This indicates that while basic ICT tools such as radios, mobile phones, and social media are integral to the activities of cassava value chain actors, there is a significant gap in the usage of more advanced technologies. Generally, this implies that in both states, radios, mobile phones, and social media dominate the ICT landscape, providing cassava value chain actors CVCAs with vital and relevant information. However, the limited use of advanced ICT tools like GPS, aerial drones, and computers may be attributed to factors such as limited accessibility, affordability, and lack of awareness of these tools regarding their potential benefits. This finding is consistent with findings by Fawole et al. (2024), and Olaniyi and Enwelu (2021), who noted that the radio. Mobile phone and social media were the most used Information and Communication Technology among the value chain actors to disseminate and retrieve agricultural information.

Table 6: The Distribution of respondents by Level of ICT usage among Cassava Value Chain Actors (CVCAs) in Oyo and Ogun State

ICT level of Usage	OYO WMS	OGUN WMS
Radio	2.87	2.92
Television	1.93	1.93
Computer	1.28	1.36
Mobile phone	2.73	2.68
Internet	1.89	1.71
Social media	2.55	2.37
Global positioning system (GPS)	0.30	0.27
Aerial drone	0.13	0.11
Video	1.78	1.76

Source: Field survey, 2024

Categorisation of the respondents according to level of information and communication technology usage

The categorisation of respondents according to the level of Information and Communication Technology (ICT) usage among cassava value chain actors (CVCAs) in Oyo and Ogun states reveals a predominance of low ICT usage in both states. The data in Oyo State shows that the majority of CVCAs (56.7%) were classified as low-level users of ICT, 29.1% as moderate users, and only a few 13.9% as high-level users. This indicates that the overall level of ICT usage among cassava value chain actors in Oyo State is low, with more than half of the respondents exhibiting minimal engagement with these technologies. Similarly, in Ogun State, a larger percentage of CVCAs (61.9%) were categorized as low-level ICT users, while 27.4% fell into the moderate category,

and only a few 10.7% were high-level users of ICT. This finding implies that the level of ICT usage in both states is significantly low, with the majority of actors not fully utilising the potential of these technologies to enhance their operations. The low level of ICT usage among cassava value chain actors can have significant implications for agricultural productivity and efficiency, while limited use of ICT tools may hinder access to crucial agricultural information, reduce market linkages, and slow the adoption of new technologies that could enhance value chain processes.

The result corroborates the findings of Olaniyi and Enwelu 2021 and Nwobodo et al. 2023, who emphasized that low ICT usage among the cassava actors could limit their ability to access weather forecasts, market prices, and best agricultural practices, which are essential for making informed decisions.

Table 7: Categorisation of the Respondents According to Level of Information and Communication Technology Usage among the CVCAs

Category	n=187		n =168	
	Oyo State Range of score	F(%)	Ogun State Range of score	F(%)
Low	≤15	106(56.7)	≤15	108(61.9)
Moderate	15-18	55(29.1)	15-18	46(27.4)
High	>18	26(13.9)	>18	18(10.7)
Mean	15.47		15.11	
Std. Dev.	2.62		2.62	

Percentage % in parenthesis, WMS-Weighted Mean Score
Source: Field survey, 2024

Constraints to ICT usage by the CVC actors in Oyo and Ogun States.

The constraints to ICT usage among cassava value chain actors (CVCAs) in Oyo State reveal several significant barriers that hinder its effective usage for CVC activities. The identified constraints include erratic power supply (WMS = 2.82), the complexity of ICT tools (WMS = 2.77) and high cost of internet subscriptions (WMS = 2.76). Moreover, inadequate rain (WMS = 2.50), language barriers (WMS = 2.48), and poor network coverage (WMS = 2.41), indicate systemic problems related to infrastructure, education, and affordability. High illiteracy levels (WMS: 2.36), costs associated with acquiring ICT tools (WMS = 2.35), inadequate knowledge and skills (WMS = 2.19), and limited availability of ICT tools (WMS = 2.12) also contribute to the low levels of technology usage. These findings resonate with the findings of Ekanem and Aniebiet (2018), which reported similar constraints to the use of ICT tools such as infrastructure deficits, high costs, and low literacy as critical barriers to ICT usage among cassava value chain actors in rural agricultural sectors across Nigeria. The implications are profound: unless these

constraints are effectively addressed, the potential for ICT to enhance agricultural productivity, processing and improve market access will remain unrealized.

Similarly, the constraints identified by cassava value chain actors in Ogun State show that barriers such as erratic power supply (WMS = 2.77) and the complexity of using ICT tools (WMS = 2.73) significantly hinder technology usage, followed by the high cost of internet subscriptions (WMS = 2.64). Inadequate training on ICT (WMS = 2.46) and poor network coverage (WMS = 2.42) further compound the difficulties faced by these actors. Additional issues, including illiteracy among CVCAs (WMS = 2.27), high costs associated with acquiring ICT tools (WMS = 2.39), and language barriers (WMS = 2.39). Furthermore, inadequate knowledge and skills regarding ICT tools (WMS = 2.04) and inadequate availability of ICT tools (WMS = 2.07) present additional constraints. These challenges align with the findings of Obinna et al. (2023), who emphasized that unstable power supply, high costs of ICT, and low ICT literacy are significant impediments to ICT utilisation in the agricultural sector.

Generally, the constraint affecting the use of ICT in Oyo and Ogun state revealed that erratic power supply, complexity of using ICT tools, high cost of internet subscriptions, inadequate training on ICT and poor network coverage respectively. This is an indication the many factors have been militating the level of use of ICT among Cassava Value Chain actors in Oyo and Ogun state respectively. The result corroborates that of Naik et al., 2022, who worked on the constraints faced in the usage of ICT Tools by Farmers in Anantapur District of Andhra Pradesh.

Table 7: Distribution of respondents according to the constraints to ICT Usage by the CVC actors Oyo and Ogun State

Constraints to ICT usage by CVCAs in Oyo state	OYO WMS	OGUN WMS
Erratic power supply	2.82	2.77
Inadequate knowledge and skills on how to use ICT tools	2.19	2.04
Inadequate availability of ICT tools	2.12	2.07
Complexity in the use of ICT tools	2.77	2.73
Poor network coverage	2.41	2.42
Illiteracy level of the CVC actors	2.36	2.27
Inadequate training on ICT	2.50	2.46
High cost of acquiring ICT tools	2.35	2.39
High cost of internet subscription	2.76	2.64
Language barrier (as most of the text are in English language)	2.48	2.39

Source: Field survey, 2024   WMS-Weighted Mean Score

Test of hypothesis

There is no significant difference in the level of Information and Communication Technology (ICT) usage among CVCAs between Oyo and Ogun States. The result of the independent sample test analysis, as shown in Table 9, indicates that there is no significant difference in the level of ICT usage across the selected states (Oyo and Ogun). The mean scores for ICT usage were 15.47 for Oyo State and 15.11 for Ogun State, with a t-value of 0.650. When further subjected to T-test for equality of mean, the F-value of 0.206, was not significant at any level. This suggests that the level of ICT usage among Cassava value chain actors (CVCAs) in both Oyo and Ogun states does not differ statistically. The lack of significant difference may be attributed to the similarity in ICT usage patterns among the respondents across the two states. Therefore, the null hypothesis, which posits that there is no significant difference in the level of ICT usage across the selected states among the CVCAs, is accepted. This finding corroborates the work of Matthew et al., (2023), who reported similar patterns of ICT adoption and usage in rural agricultural communities across different Nigerian states, noting that infrastructural limitations and socioeconomic factors often result in comparable levels of ICT engagement, irrespective of geographic location. Furthermore, Olatunde et al. (2024) also reported that there was no significant regional variation in ICT usage among farmers in Southwestern Nigeria, further supporting the notion that ICT adoption barriers tend to be uniformly distributed across rural agricultural sectors in the region.

Table 9: Summary of Independent t – Test showing difference in level of information and communication technology usage among the cassava value chain actors between Oyo and Ogun State.

State	F	Mean	Standard deviation	Standard Error Mean
Oyo	187	15.47	2.620	0.192
Ogun	168	15.11	2.623	0.202

	Levene's test for Equality of variable					
	F	Sig	t-value	df	p-value	Mean Difference
Equal Variable Assumed	0.206	0.650	1.264	353	0.207	0.352
Equal variable Assumed			1.264	348.879	0.207	0.352

Source: Field Survey, 2023

CONCLUSION AND RECOMMENDATION

This study examined a comparative analysis of Information and Communication Technology (ICT) usage among cassava value chain actors (CVCAs) in Oyo and Ogun States, Nigeria. The findings reveal that while some ICT tools, such as radio, mobile phones, and social media, are accessible and utilised to some extent, the overall usage of advanced technologies like GPS and aerial drones remains limited. The major constraints affecting the level of ICT usage among CVCAs include erratic power supply, the complexity of ICT tools, high internet costs, inadequate training, and other systemic barriers such as high illiteracy rates and poor infrastructure. Categorisation of CVCAs in both states indicates that the majority have low levels of ICT usage and knowledge, with more than half of respondents falling into the low ICT usage category. Oyo State exhibited lower ICT knowledge levels compared to Ogun State, where knowledge levels were higher. Although the study revealed that there is no significant difference in the overall attitude towards ICT usage between the two states, the level of ICT usage showed notable variation, with Ogun State having relatively higher ICT engagement. It is recommended that stakeholders invest in rural electrification, telecommunication infrastructure, and ICT training programs. Moreover, policy interventions should subsidize ICT tools and services to improve affordability, while localised solutions and awareness campaigns should promote the benefits of ICT in agriculture, ultimately fostering sustainable development.

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Assessment of agricultural development stakeholders' use of social media for information sharing in Oyo State, Nigeria

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Abstract - The potentials of social media for sharing information among agricultural development stakeholders have not been fully harnessed. This study assessed agricultural development actors' use of social media in Oyo State, Nigeria. Data were collected from 255 respondents (farmers, researchers, and extension agents) using a multi-stage sampling procedure with the aid of a structured interview schedule and questionnaire. Frequency counts, percentages, PPMC, and ANOVA were used in the analysis of the data collected. The findings revealed that the majority (92.9%) of the respondents are male and married (96.1%), with a mean years of education of 15, and the mean age of the respondents was 46.1 years. The most available and accessible social media tools to the stakeholders were Facebook (100%), WhatsApp (100%), yahoo (98.8%), google Plus (98.4%), YouTube (96.1%), Instagram (95.7%), twitter (93.7%), messenger (90.6%), snapchat (17.3%), skype (13.7%), and LinkedIn (6.7%), while the most frequently used social media among the respondents were WhatsApp (WMS = 2.98), Facebook (WMS = 2.95), and Messenger (WMS = 2.64). The result of Pearson product-moment correlation (PPMC) revealed that years spent in school (r = 0.194, p≤ 0.05), income per annum (r = 0.182, p ≤ 0.05), knowledge of social media use (r = 0.274, p ≤ 0.05), and farm size (r = -0.132, p ≤ 0.05) were significantly related to the extent of social media usage among the development stakeholders in the study area. The study concluded that the extent of social media usage is still low among the stakeholders. It was recommended that the capacity of the stakeholders be built by both the government and NGOs on technical knowledge and skills on social media applications for effective information sharing.
Keywords: Agricultural Development Stakeholders, Information, Use, Social Media.

INTRODUCTION

Agriculture has historically been the cornerstone of Nigeria's economy, providing livelihoods for over 70% of the population, especially in rural areas (Gwarzo and Kamal, 2023). This sector contributes significantly to food security, employment, raw materials for the industries and foreign exchange earnings through exports of cash crops such as cocoa, palm oil, and groundnuts (Adejo and Opeyemi., 2019).

Despite the contribution to the economy, Nigeria's agricultural sector faces many challenges which impact on its productivity. These include poor land tenure system, low level of irrigation farming, climate change and land degradation. Others are low technology, high production cost and poor distribution of inputs, limited financing, inadequate extension personnel, poor dissemination of new innovation in agriculture, high post-harvest losses and poor access to markets and information (FAO, 2024). Despite the concerted efforts to modernize agriculture and implement technology-driven solutions aimed at enhancing productivity and sustainability, as pointed out by Gwarzo and Kamal (2023), Information and communication technology (ICT) continues to play a critical role. ICT is essential for facilitating effective networking and the timely delivery of critical information among key agricultural stakeholders in Nigeria. This is evident from the work of Nenna (2016), which underscores the importance of ICT in bridging communication gaps and promoting collaborative efforts within the agricultural sector. By leveraging ICT, stakeholders can access vital information, share best practices, and make informed decisions, ultimately contributing to the overall development and sustainability of agriculture in Nigeria. Social media, as part of the integral ICT, is becoming increasingly necessary among agricultural stakeholders as it enhances interaction, networking, and agricultural information delivery (Ayinde et al., 2020). The use of social media for disseminating agricultural information has the potential to bridge the gap created by the deficit in extension agents-farmer's ratio. Social media uniquely offers direct access to information and empowers users to maximize the data they gather (Van and Poell, 2013) and (Olaniyi et al. 2020). Social media facilitates real-time communication, providing farmers and other stakeholders with the opportunity to exchange ideas, disseminate new agricultural practices, and overcome geographical barriers to information dissemination (Akwiwu and Patrick, 2019). Social media platforms, such as Facebook, WhatsApp, Twitter, and Telegram, have emerged as valuable tools for enhancing communication and knowledge sharing among agricultural stakeholders such as farmers, extension personnel and researchers.

Social media encompasses internet-based digital tools that facilitate the sharing and discussion of information among individuals. It includes user-generated content such as opinions, videos, audio,

and multimedia shared across digital networks (Adejo and Opeyemi, 2019). Through platforms like Facebook, Twitter, YouTube, Instagram, Google, WhatsApp, blogs, and LinkedIn, social media supports activities such as blogging, tagging, discussions, and networking. These platforms have proven to be effective tools for disseminating agricultural information among stakeholders, including farmers, extension agents, and researchers. They play a vital role in rapidly distributing information, enabling farming communities, particularly in rural areas of developing countries, to make informed decisions regarding their agricultural practices (Adejo and Opeyemi, 2019). In Nigeria, the adoption of social media among agricultural stakeholders is gradually increasing. Social media facilitates connection and interaction, allowing individuals to communicate with many people simultaneously, regardless of geographical boundaries. Users engage in various activities on social media, such as downloading or uploading photographs, videos, and sharing information electronically (Ayinde et al., 2020). It mitigates the challenges of long-distance communication, providing people the ability to interact at any time (Engler, 2019). Moreover, social media serves as an invaluable resource for academia (Adejo and Opeyemi, 2019). It has enhanced collaboration between researchers and other agricultural stakeholders, such as farmers and extension agents, facilitating the dissemination and retrieval of information. Researchers leveraging social media have been reported to achieve higher results (Ayinde et al., 2020). By keeping researchers informed of contemporary issues, social media equips them to address potential challenges effectively. Additionally, it fosters stronger linkages among stakeholders, enhancing the impact and reach of their work.

The believed to have the potential to change the face of agriculture in Nigeria and improve information gathering and sharing among agricultural development stakeholders, because agricultural researchers, extension agents and farmers needed to be abreast of latest and updated agricultural information through social media usage (Kareem et al., 2020). This is particularly important in a country like Nigeria, where farmers, extension agents, and researchers often face difficulties in accessing timely and relevant information (Olorunniyi et al., 2022). The failure of the various extension delivery approaches to effectively engineer significant and sustainable agricultural development in Nigeria has become a major concern to all agricultural stakeholders (Agwu et al., 2023). However, agricultural research institutes are being challenged to deliver research outputs that will improve agriculture in Nigeria. One obstacle to the realization of information delivery to farmers in

particular, is that of an inadequate number of extension agents that lead to high extension-farmers' ratio. The ratio of extension agents to farmers is low which has a great effect on the dissemination of firsthand information to the end users (Alhassan et al 2022). Although, social media has demonstrated the potential to address this issue by enhancing connectivity and information dissemination. It has been noted that the adoption of social media remains low among the agricultural stakeholders due to low digital literacy, unreliable internet access, and dearth of knowledge to leverage social media tools effectively for agricultural information sharing purposes (Ramavhale et al., 2024). The recent literature search revealed limited empirical data on how major agricultural stakeholders use social media for agricultural information sharing and dissemination. Therefore, this study was intended to fill this gap by assessing the extent to which agricultural stakeholders use social media for agricultural information sharing in Oyo State. Specifically, the study described the socioeconomic characteristics of the respondents, identified the available social media platforms to the respondents, determined the frequency of social media usage for information dissemination and evaluated the extent of social media usage by the stakeholders in the study area.

METHODOLOGY

The study was carried out in Oyo State, Nigeria. The State falls within rainfall and Savannah agro-ecological zones of the country. It comprises of Thirty-three (33) Local Government Areas and four (4) agricultural zones. The State is located between Latitude 7º 3' and 9º 12' North of the equator and Longitudes 2º 47' and 4º 23' East of Greenwich meridian. The study area is bounded by Benin Republic in the West, while it is bounded in the North and East by Kwara and Osun State, and the south by Ogun state. The area covers a land mass of 27,000sq. Kilometers. For the selection of the agricultural development actors in Oyo State, respondents were drawn from agricultural extension institutions, research institutes and farmers respectively. There are four Agricultural zones in Oyo State Agricultural Development Programme namely Ibadan/ Ibarapa, Ogbomoso, Saki and Oyo agricultural zones. Also, there are four research institutes situated in Oyo state namely: International Institute for Tropical Agriculture (IITA), National Institute for Horticulture (NIHOT), Cocoa Research Institute of Nigeria (CRIN) and Forest Research Institute of Nigeria (FRIN). In addition, all registered farmers were included in this research work since farmers are important stakeholders and beneficiary of all agricultural information. The target population of the study comprised of all extension agents across the four (4) agricultural

zones in the State and all agricultural researchers in all research institutes under Agricultural Research Council of Nigeria (ARCN) in Oyo state. Nigeria and all registered farmers in Oyo State. Multistage sampling procedure was used in selection of farmers in the study area. First stage involved random selection of 50% of Agricultural zones out of four zones. The selected zones are Oyo Agricultural zone, and Ibadan/Ibarapa Agricultural zone and two (2) cells were randomly selected out of eight (8) cells from each zone respectively. Ona –Ara, Ibarapa East, Atiba and Afijio Local Government Area were selected. Third stage involved random selection of 30% of the entire cells from each block. Lastly, 30% of registered farmers were sampled to make a total of 74 farmers. Meanwhile, there are 48 extension personnel in Oyo state and 75% were randomly selected from all the four Agricultural zone of Oyo State to make a total of 36 Extension personnel, while there are five (5) research institute in Oyo sate they are NIHOT, CRIN, FRIN, IARandT and IITA and 60% research institute were randomly selected and they are NIHOT, CRIN and FRIN while 50% of the researcher were randomly selected which account to be 145 researchers, In all, a total of two hundred and fifty five (255) respondents were selected and form the sample size for the study. Primary data were collected using a well-structured interview schedule; the data collected for this study were subjected to both descriptive and inferential statistical tools. The dependent variable of the study was the extent of social media usage among Agricultural stakeholder, and this was measured on a 4-point rating scale of always = 3, sometimes =2, rarely = 1, and never = 0, while the inferential statistic tools; Pearson Product Moment Correlation (PPMC) and Analysis of Variance (ANOVA) was used to the test slated hypotheses by establishing the relationship and differences between the variables among the agricultural development stakeholders.

RESULTS AND DISCUSSION
Socioeconomic characteristics

Result in Table 1 revealed that 32.4% of the respondents were between the ages of 41 and 50 years, 29.7% were in the age range of 51-60 years of age, while 17.6% of the respondents were between the ages of 31 and 40,12.2% and 8.1% of the respondents were between the age range of 61-70and 21-30 years of age respectively with the mean age of the farmers was found to be 48.0 years. Meanwhile, the result of the analysis of the extension agent revealed that 47.2% were between the ages of 41-50 years of age, 17.2% were between 31-40 years of age, while 11.0% of the respondents were between the age range of 51-60 years of age with the mean age to be 43.3 years. The result on the age of researchers was revealed that 44.1% of the respondents were between the ages of 41 and 50

years, 35.2% were between 51 and 60 years, while 20.7% of the respondents were between the age range of 31-40 with the mean age of the researchers was found to be 47.0 years. The pooled result of the analysis revealed that 41.2% of the respondents were between the ages of 41 and 50 years, 30.2% were between 51 and 60, 22.4% of the respondents were between the age range of 51-60 years, while 3.5% and 2.7% of the respondents were between the age of 61-70 and 21-30 respectively. The mean age of the agricultural stakeholders was revealed to be 47 years. This implies that majority of agricultural stakeholders were young and still active and this may probably influence the extent of social media usage for sharing agricultural information. The sex of the farmers showed that majority (94.6%) of the respondents were male while only few 5.4% of the respondents were female, likewise the sex extension agent shows that majority (83.3%) of the respondents were male while 16.7% were female. Meanwhile the sex of the researchers revealed that majority (94.5%) of the respondents were male while 5.5% were female. The pooled result among the agricultural stakeholders shows that majority (92.9%) of the respondents were male while 9.1% were female. This result indicated that male was more dominant stakeholder in Agricultural production in the study area.

Furthermore, majority (91.9%) of farmers were married, 6.8% were single while only few 1.4% of the respondents were widowed. This result indicated that majority of the respondents had family responsibility to shoulder and an implication that they are responsible. The result agrees with that of Jiriko et al (2020) in a paper on constraints to the use of social media in accessing agricultural information among crop farmers in Benue State where the majority of the crop farmers were married, while it was revealed that majority (97.2%) of the extension workers were married with only few 2.8% were widowed an indication that marriage institution is established in the study area and this might have a positive influence on the extension agents.

Moreover, the results of the researchers indicated that majority (97.9%) of the respondents were married while only few 0.7% were single, divorced and widowed an indication that the researchers were responsible individuals who respect the culture and tradition of the social institution. The pooled result among agricultural stakeholders shows that majority (96.1%) of agricultural stakeholders were married, 2.4% were single, 1.2% indicated that they were divorced while only few (0.4%) indicated that they were widowed. This implies that the respondents value the social institution in the study area through their adherence to marriage institution.

The educational level of the farmers revealed that more than half (51.4%) of the farmers

had primary education, 29.7% secondary education, 10.8% had tertiary education while the rest (8.1%) had no former education. This implies that majority of the respondents were literate though with low educational background. The result is in line with that that of Jiriko et al., (2020) and Uy et al (2024) where majority of the respondents were educated but low level while social media still be used since they can read and write and improved based on the knowledge level. Likewise, extension agent shows that 97.2% of the extension workers had tertiary education while only few 2.8% had secondary education. This implies that majority of the respondents were education an indication that they will make use of social media effectively. Furthermore, research shows that majority (99.3%) of the respondents had tertiary education while only few 0.7 had secondary education. This is an indication that majority of the respondents were educated a means to inform wider audiences about their research work. While the pooled result of all the stakeholders shows that about 73.0% of the respondents had tertiary education, 15.3% had primary education, 9.0% had secondary education while only few 2.4% had no former education. It

could be deduced that the majority of the agricultural development stakeholders were educated as an indication that it may have great influence on the extent of social media usage. It is therefore expected that they were able to exploit all avenues including social media to bridge the gap between farmers, extension agents and the researchers. Table 1 also revealed that about (36.7%) of farmers had between 5-8 household size, 33.8% had between 9-12 household size, 21.4% and 8.1% had between 1-4% and 13-16 household size respectively with the mean to be 7 household size. For the extension majority (80.5%) of the respondents had between 5-8 household size, 16.7% had between 1-4 household size while only few 2.8% had between 9-12 household size respectively with the mean household size of the extension agent to be 6. Moreover, household size of the researcher shows that more than half (55.8%) of the researchers had between 5-8 household size, 32.4% had between 9-12 household size while 9.7% and 2.1% of the respondents had between 1-4 and above 12 household size, respondents had mean score to be 8 household size.

Table 1: Distribution of the Respondents According to Socioeconomic Characteristics

Variables	Farmers F (%)	Extension Agents F (%)	Researchers F (%)	Agricultural stakeholders (Pooled) F (%)
Age (Years)				
Less than 30	6 (8.1)	0(0)	0(0)	7 (2.7)
31-40	13 (17.6)	15 (41.7)	30 (20.7)	57 (22.4)
41-50	25 (32.4)	17 (47.2)	64 (44.1)	105 (41.2)
51-60	22 (29.7)	4 (11.0)	51 (35.2)	77 (30.2)
61 and above	9 (12.2)	0(0.0)	0(0.0)	9 (3.5)
Mean	**48.0**	**43.3**	**47.0**	**47.0**
Sex				
Male	70 (94.6)	30 (83.3)	137 (94.5)	237 (92.9)
Female	4 (5.4)	6 (16.7)	8 (5.5)	18 (9.1)
Marital status				
Single	5 (6.8)	0(0.0)	1 (0.7)	6 (2.4)
Married	68 (91.9)	35 (97.2)	142 (97.9)	245 (96.1)
Widowed	1 (1.4)	1 (2.8)	1 (0.7)	1 (0.4)
Divorced	0(0.0)	0(0.0)	1 (0.7)	2 (1.2)
Educational level				
No formal Education	6 (8.1)	0(0.0)	0(0.0)	6 (2.4)
Primary Education	38 (51.4)	0(0.0)	0(0.0)	39 (15.3)
Secondary Education	22 (29.7)	1 (2.8)	1 (0.7)	23 (9.0)
Tertiary Education	8 (10.8)	35 (97.2)	144 (99.3)	187 (73.3)
Household size				
1-4	16 (21.6)	6 (16.7)	14 (9.7)	36 (14.1)
5-8	27 (36.5)	29 (80.5)	81 (55.8)	137 (53.7)
9 and Above	31 (41.9)	1 (2.8)	50 (34.5)	82 (32.2)
Mean	**7**	**6**	**8**	**7**

Sources: Field survey, 2024.

While the pooled result revealed that (53.7%) of the respondents had between 5-8 household size, 28.7% had between 9-12% household size while 14.1% and 3.5% had between 1-4 and above 12 household size with the mean household size of the respondents to be 7 members.

Available social media platform for agricultural development stakeholders

Table 2 shows the distribution of respondents according to available social media platform available to farmers and it was revealed that all (100%) of the farmers claimed the availability of Facebook and WhatsApp respectively. Also 98.6% of farmers claimed availability of yahoo mail, Instagram and YouTube. Other social media available to farmers are twitter, google plus, messenger, LinkedIn, skype and snapchat. This implies that there are many social media platforms available to farmers which they use to interact, disseminate and retrieve information among colleagues and others stakeholder in agricultural. This finding agrees with the finding of Bhattacharjee and Raj (2016) who reported that the most available social media are Facebook and WhatsApp. The result of the availability of social media among the extension agent shows that all (100%) the extension agent revealed that the social media platform (Facebook, WhatsApp, yahoo mail, Instagram, YouTube, twitter, google plus, messenger, LinkedIn, skype and snapchat) is available for use. The result supported that of Akinyi 2021 where the aforementioned social media platforms were available. While the results of the researchers revealed that all (100%) the researchers claimed to have Facebook, WhatsApp yahoo mail and google plus respectively. Other social media available to researchers are messenger (98.7%), YouTube (93.8%), Instagram (93.1%), twitter (91.0%), snapchat (25.5%), skype (20.7%), and LinkedIn (9.0%). The research is in consonance with that of Ayinde et al, 2020 who point out that the most available and accessible social media are Facebook, WhatsApp and yahoo mail.

The pooled result for all agricultural development stakeholders revealed that all (100%) of the respondents claimed that Facebook and WhatsApp were followed by yahoo (98.8%) google plus (98.4%), had and YouTube (96.1%), Instagram (95.7%), Twitter (93.7%) and messenger (90.6%). Others are Snapchat, Skype and LinkedIn respectively. This implies that the majority of the respondents were aware of different available social media tools and this is expected to influence the extent of social media usage in the study area.

Table 2: Distribution of Respondents According to Available Social Media Platforms

Social Media Platform Available	Farmers F (%)	Extension Agents F (%)	Researchers F (%)	Pooled F (%)
Facebook	74 (100)	36 (100)	145 (100)	255 (100)
Twitter	71 (95.9)	36 (100)	132 (91.0)	239 (93.7)
WhatsApp	74 (100)	36 (100)	145 (100)	255 (100)
You tube	73 (98.6)	36 (100)	136 (93.8)	245 (96.1)
Google plus	70 (94.6)	36 (100)	145 (100)	251 (98.4)
LinkedIn	4 (5.4)	36 (100)	13 (9.0)	17 (6.7)
Skype	5 (6.8)	36 (100)	30 (20.7)	35 (13.7)
Messenger	52 (70.3)	36 (100)	143 (98.7)	231 (90.6)
Snapchat	7 (9.5)	36 (100)	37 (25.5)	44 (17.3)
Yahoo	73 (98.6)	36 (100)	145 (100)	252 (98.8)
Instagram	73 (98.6)	36 (100)	135 (93.1)	244 (95.7)

Sources: Field survey, 2024

Frequency of social media usage among agricultural development stakeholders

Table 3 shows the result on the extent of social media usage by the respondents, and it was revealed that Facebook (WMS=3.00, 2.97 and 2.92), WhatsApp (WMS=3.00, 2.99 and 2.95) and Messenger (WMS=1.32, 0.61 and 1.89) were the most used social media tools among the extension agents, researchers and farmers. Conversely, the least used social media tools among farmers, extension agents and researchers include Skype (WMS=1.32, 0.61 and 0.59); LinkedIn (WMS=1.28, 0.94 and 0.61) and Snapchat (WMS=1.03, 0.58 and 0.22) respectively. The pooled results also followed the same trend as WhatsApp was ranked 1st with weighted means score of (WMS) of 2.98, Facebook was ranked 2nd with WMS of 2.95 and messenger was ranked 3rd with WMS of 2.64. Other social media tools used include Instagram and YouTube and were ranked 4th with WMS of 2.33, google plus was ranked 6th with (WMS= 2.30), yahoo mail was ranked 7th (WMS= 2.29) twitter was ranked 8th (WMS= 2.09). The least used social media tools are LinkedIn (WMS= 0.86), Skype (WMS= 0.84), and Snapchat (WMS= 0.74). This implies that majority of the respondents make use of social media, but the most used social media are Facebook, WhatsApp and messenger, an indication that all this platform were used to retrieve, disseminate and build social networking among all agricultural stakeholders.

This result agrees with that of Jiriko et al., (2020) assertion that farmers make used social media to source agricultural information, especially, Facebook and WhatsApp.

Table 3: Distribution of respondents according to extent of social media usage

Social media tools	Farmers	Extension Agents	Researchers	Pooled	Ranking
	WMS	WMS	WMS	WMS	
Facebook	2.97	3.00	2.92	2.95	2nd
Twitter	1.73	2.00	2.30	2.09	8th
Whatsapp	2.95	3.00	2.99	2.98	1st
You tube	2.27	2.00	2.43	2.33	4th
Google plus	1.64	2.03	2.71	2.30	6th
LinkedIn	1.28	0.94	0.63	0.86	9th
Skype	1.32	0.61	0.59	0.80	10th
Messenger	2.62	1.89	2.83	2.64	3rd
Snapchat	0.22	0.58	1.08	0.74	11th
Yahoo	2.20	2.00	2.40	2.29	7th
Instagram	2.28	2.05	2.43	2.33	4th

Sources: Field survey, 2024   WMS indicates Weighted Mean Score

Categorisation based on the extent of social media usage by agricultural stakeholders

The result in table 4 reveals that more than half (51.4%) of farmers fell to low category users of social media, 29.7% fell into high category while (18.9%) make use of social media moderately. The level of use of social media by the majority of farmers was low with the percentage score of (51.4%).

Moreso, the result of the extension on the same table 4.6 shows that more than half (52.8%) fell into low category, 38.9% were moderately make use of social media while (8.3%) fell into high category of social media usage by the respondent. This implies that the level of social media usage by the extension agent was low with the percentage score to be (52.8%).

Furthermore, the output result of the researchers on table 4.6 revealed that about (49.0%) of the researchers fell into low category user of social media, 35.1% of the researchers make use of social media moderately while (15.9%) fell into high category. The level of use of social media by majority of the researchers was low with percentage score of (49.0%). This implies that the level of use of social media by the researchers in the study is low, an indication that more training/workshop needs to be done so as to let them know the benefit of social media usage.

The pooled data on the same table 4.6 revealed that about (43.9%) of the respondents were low users of social media, followed by (38.1%) of the respondents were moderately social media usage while the respondents that fell into high category of use of social media was (18.0%). Similar trend was recorded as the respondents on pooled data revealed that majority possessing low extent of social media usage with the percentage score of (43.9%).

This implies that generally, most agricultural stakeholders were low users of social media hence this can impair social interaction and information sharing ability. This finding is contrary to that of Obabire et al. (2014) who reported high social network among key stakeholders in agriculture. The low level of use of social media by agricultural stakeholders may probably be due to the inherent constraints to social media usage experienced.

Table 4: Categorization of respondents according to extent of social media usage by Agricultural Stakeholders

Category	n=74 Farmers Range of score		n =36 Extension Agents Range of score		n =145 Researchers Range of score		n =225 Pooled Range of score	
Low	≤21.4	38(51.4)	≤20.1	19(52.8)	≤23.3	71(49.0)	≤22.3	112(43.9)
Moderate	21.4-25.5	14(18.9)	20.1-22.4	14(38.9)	23.3-27.1	51(35.1)	22.3-26.2	97(38.1)
High	>25.5	22(29.7)	>22.4	3(8.3)	>27.1	23(15.9)	>26.2	46(18.0)
Mean	21.4		20.1		23.3		22.3	
Std. Dev.	4.11		2.32		3.82		3.92	

Figure in parentheses are percentage,
Std. Dev- Standard Deviation
Source: Author computation from field survey data 2024

Test of hypotheses

The result of Pearson product moment correlation in Table 5 revealed that there existed positive and significant relationships between years spent in school (r= 0.194, p≤ 0.01), Income per annum (r = 0.182, p ≤ 0.01), knowledge level (r = 0.274, p ≤ 0.01), farm size (r = -0.132, p ≤ 0.05) and extent of social media usage. All the significant variables exhibited positive and significant relationships with the extent of social media usage except farm size with negative coefficient. This implies that the more years spent in school the higher the extent of social media usage among the

agricultural stakeholders as this will have a great influence on the knowledge level of social media usage by the respondents, while an increased in the annual income of the respondents will all the agricultural stakeholder to be able to afford social media facilities that will boost their usage level of social media and subscription rate problem will be solved while the higher in knowledge level of the respondents will increase the extent of social media usage among the agricultural stakeholders. The result above implies that all the above-mentioned variables have decisive influence on the extent of social media usage among agricultural stakeholders.

Table 5: Summary of Pearson Product Moment Correlation (PPMC) establishing relationship between the selected socio-economic characteristics of the respondents and level of social media usage among Agricultural Stakeholders

Socio-economic characteristics	Correlation coefficient (r)	p-value	Decision
Age	0.093	0.138	Not significant
Years spent in school	0.194	0.002**	Significant
Household size	0.094	0.134	Not significant
Income per annum	0.182	0.003**	Significant
Years of stakeholder experiences	-0.045	0.475	Not significant
Farm size	-0.132	0.035*	Significant
Years of using social media	0.041	0.513	Not significant
Knowledge level	0.274	0.000**	Significant

Source: Field survey, 2024
** Correlation is significant at the 0.01 level
*Correlation is significant at the 0.05 level

There is no significant difference in the levels of usage of social media among agricultural stakeholders. The analysis of variance (ANOVA) in table 6 revealed that there is significant difference (F=13.206, P<0.05) in the extent of social media

usage among the agricultural stakeholders in the study area. This may be as a result of differences in access, knowledge of use exposure to social media and importance to work as stakeholders in the study area.

Table 6: Summary of analysis of variance ANOVA showing differences in the extent of social media usage among agricultural stakeholders in Oyo State.

Sources of variation	Degree of freedom (df)	Sum of Square	Sum of mean square	F	p-value	Remarks
Between selected Agricultural stakeholders	2	369.253	184.626	13.206	0.000	Significant
Within selected Agricultural stakeholders	252	3523.077	13.980			
Total	254	3892.329				

Source: Field survey, 2024

CONCLUSION AND RECOMMENDATIONS

The study assessed the use of social media by agricultural development stakeholders for agricultural information sharing in Oyo State, Nigeria. It was concluded that the most accessible social media platforms for these stakeholders for information sharing are Facebook, WhatsApp, and yahoo mail. Also, the most frequently utilised platforms are WhatsApp, Facebook, and messenger. There existed a significant difference in the extent of

social media usage among the agricultural stakeholders in the study area. Despite these findings, the overall extent of social media usage remains low among the stakeholders. Based on these conclusions, it is recommended that both the government and non-governmental organizations (NGOs) invest in building the technical knowledge and skills of stakeholders regarding social media applications. This capacity-building initiative is essential for enhancing effective information

sharing among the stakeholders in the agricultural sector.

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Marketers' utilisation of fintech banks for marketing of agricultural produce in Bodija market, Ibadan, Oyo state, Nigeria

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Abstract - The study assessed marketers' utilisation of fintech banks for the marketing of agricultural produce in Bodija market, Ibadan, Oyo state, Nigeria. Multi-stage sampling technique was used to select 150 respondents for the study. Data were collected on the marketers' socioeconomic characteristics, level of awareness, constraints faced, benefits derived and level of utilisation of fintech banks. Results revealed that the mean age was 38 ± 10 years, 61.3% were female, 76% were married, 100% had formal education with about half (44.67%) having up to tertiary level of education. Majority (58%) of the respondents have low awareness of fintech banks. Dependency on cash ($\bar{x} = 0.89$) was the most severe constraint to utilisation of fintech banks for marketing of agricultural produce. Increase in customer base and sales opportunities ($\bar{x} = 2.78$) was the leading benefit derived. Level of utilisation was low among majority (57.3%) of the respondents. A significant relationship existed between respondents' age (r= -0.173 p=0.034) and their level of utilisation of fintech banks for marketing of agricultural produce. The study concluded that respondents have low level of utilisation of fintech banks for marketing of agricultural produce and recommended increasing awareness and promoting cashless policy to enhance utilisation of Fintech banks.

Keywords: Fintech banks, Agricultural produce marketing, Agricultural produce marketers.

INTRODUCTION

In the agricultural space, buyers, sellers and other actors come together to trade in several farm produce and offer diverse services, forming an intricate network of various market systems. The efficiency of these systems has direct impact on the poverty level of a large proportion of the Nigerian population. These systems are however faced with daunting challenges demanding urgent and practical solutions (Ikore, 2024).

The marketing of agricultural produce refers to the various procedures and activities involved in ensuring that agricultural produce reach the end-users. It involves all those activities which are mostly related to the procurement, grading, storing, transporting and selling of the agricultural produce (Jeyaramya, 2022). Marketing of agricultural produce also involves presenting, advertising and selling of agricultural produce in the best possible ways (Nezamova and Olentsova, 2021).

Agricultural production and marketing are two sides of a coin, one cannot do without the other (Nwaizugbo and Abereola, 2021). In Nigeria, agricultural produce is traditionally marketed via: roadside selling, local markets, middlemen, cooperative societies, farmgate sales, community-based marketing, seasonal markets and battering. However, in contemporary times, the marketing of agricultural produce has involved the use of the internet. The digital marketplace provides farmers with a platform to reach a broader customer base, bypassing traditional middlemen and physical market constraints (Li and Zhang, 2024). It offers an efficient, scalable and cost-effective solution for farmers and agribusinesses to market their produce directly to consumers, retailers and other businesses. (Agritechtomorrow, 2024).

The rise of Fintech (Financial Technology) Banking is transforming Agricultural marketing in Nigeria, offering new opportunities for farmers and traders to reach wider markets and improve their livelihoods. At its core, Fintech is about using technology to create innovative financial solutions that cater to the unique needs of farmers, agribusinesses, and other players in the industry. An article by Forbes published in January of 2023 explores "The Next Fintech Revolution: Agricultural Finance", the broader world of Fintech is now looking at the agriculture industry as a potential growth opportunity. The author stated that the two best reasons to bring Fintech to agriculture are: 1. The size of the market: and 2. The limitations of existing service providers.

The business model of farming can also make the business difficult to bank if using traditional financial methods without specialized insight into the sector (Benni, 2023). The government's push to diversify the economy to non-oil sectors with a focus on agriculture, as seen in the Economic Recovery and Growth Plan (ERGP 2017-2020) and Economic Sustainability Plan (ESP 2020), has created opportunities for digital financial solutions. The digitization of the Agricultural sector being driven by the government for increased productivity and contribution to GDP growth, has created certain gaps demanding for more efficient systems in the sector, particularly in the marketing of its produce; a function which according to Nebo *et al* (2017) is core and vital for the sector's productivity. These gaps are such identified by financial technology (Puntilo, 2024), creating a need for its services.

Following the Central Bank of Nigeria's National Financial Inclusion Strategy (NFIS 2021-2024) which was designed to ensure a financial

inclusion rate of 95% by 2024 and the Cashless Policy (CBN, 2019) which has promoted digital payments, more opportunities have been created for Fintech banks. Presently there are over 100 Fintech companies in Nigeria (PricewaterhouseCoopers, 2024). Research also revealed that the COVID-19 pandemic led to increased usage of digital banking services and online payment platforms for financial transactions. This gave leverage to Fintech banks, particularly with the World Health Organization's advice to consumers to utilise contactless payments (WHO, 2020). The proliferation and adoption of cheap smartphones by mobile phone consumers in Nigeria and an internet penetration which stood at 51% as at 2018 (PwC, 2024) are also trends driving the adoption of financial technology in Nigeria.

The rise of e-commerce platforms or online marketplaces which enables farmers and marketers reach wider markets also necessitates more efficient financial solutions in the marketing of agricultural produce (Vavekanand and Kumar, 2024). In Nigeria, farmers and other marketers of agricultural produce are currently faced with high inflation arising from hike in fuel prices and slow growth. Global climate and economic factors are creating profitability challenges for farms, and emerging digital solutions and a new generation of Fintech companies are poised to solve many of these issues (Lumley, 2024). Marketers of agricultural produce can gain several advantages from using fintech banks for their marketing efforts. Leveraging of fintech solutions can lead to increased profitability, efficiency and competitiveness for marketers of agricultural produce. However, as fintech banks continue to revolutionize the financial services sector, information on the utilisation of these digital platforms by marketers of agricultural produce to streamline their operations, expand their market reach, and improve their financial management is yet to be documented. Hence, the study assessed marketers' utilisation of fintech banks for marketing of agricultural produce in Bodija Market, Ibadan, Oyo State. Specifically, the objectives were to:

1. identify the socio-economic characteristics of the respondents in the study area.
2. determine the level of awareness of fintech banks among marketers of agricultural produce in the study area.
3. identify the marketers' constraints in utilising fintech banks for marketing of agricultural produce.
4. examine the marketers' benefits in utilising fintech banks for the marketing of agricultural produce in the study area.
5. assess the marketers' level of utilisation of fintech banks for marketing of agricultural produce in the study area.

The study hypothesized that: There is no significant relationship between selected socioeconomic characteristics of the marketers and their utilisation of Fintech banks for marketing of agricultural produce.

METHODOLOGY

The study was carried out in Bodija market. Bodija market is located in Ibadan North Local Government Area in Oyo state, Nigeria. It was established in 1987 and falls under the jurisdiction of the Ibadan North Local Government Area with its administrative headquarters in Agodi, Ibadan. The market has a Latitude of 7.4359 N and Longitude 3.9157 E. The major occupation of the people in Bodija market is trading, as it is a commercial hub with various goods and services being bought and sold daily. Bodija market is one of the most popular markets in Nigeria representing the most popular food and agro-product market in South Western Nigeria (Ogunlade, 2024). The population of the study comprised of marketers of agricultural produce in Bodija market, Ibadan, Oyo state, Nigeria. A three-stage sampling procedure was used to select respondents for the study. The first stage involved the purposive selection of agricultural produce marketers' association in the study area for ease of access to the marketers. The second stage involved simple random selection of 5 agricultural produce marketers' association out of a total of 21 associations. The third stage involved simple random sampling of a representative 4% of each selected association population to obtain a sample size of 150 respondents for the study. Data were collected from respondents through the use of structured questionnaire containing items based on the objectives of the study. The dependent variable, level of utilisation of fintech banks, was measured by providing a list of fintech banks services and asking the respondents to indicate the rating that portrays their level of utilisation of the services. This was operationalized as Always, Occasionally, Rarely, and Never. Scores of 3, 2, 1, and 0 were assigned respectively. Data were analysed using descriptive (frequency, percentage, mean, standard deviation) and inferential (Pearson Product Moment Correlation) statistical tools.

RESULTS AND DISCUSSION

Results in Table 1 showed that majority (57.3%) of the respondents were between the age range of 20-39 years. This implied that most of the respondents were young adults who were still in their active years. This aligns with the findings of the Huong *et al* (2021) which indicated a higher percentage of significant fintech engagement among individuals aged 35-44 years. Majority (61.3%) of the respondents were female. Majority (76%) of the respondents were married; this aligns with the findings of the study of Rodríguez-González *et al* (2020) which highlighted the impact of marital

status on agricultural innovation and decision making. About half (44.67%) of the respondents received formal education up to the tertiary level aligning with the McKinsey (2021) that utilisation of fintech is higher among individuals with higher educational levels. Majority (56.0%) of the respondents were Muslims. Majority (67.3%) of the respondents had a household size of 5-7 persons. This is in alignment with findings of Isitor, Babalola and Abegunde (2019) which established that majority of the agricultural produce marketers in their study had household size of 6 persons. Majority (64.7%) of the respondents earned ₦ 1 000 000 - ₦ 4 999 999 monthly.

Table 1: Distribution of respondents by their socioeconomic characteristics

Variables	Frequency	Percentage	Mean	SD
Age			38	10
20-29	36	24.0		
30-39	50	33.3		
40-49	42	28.0		
50-59	22	14.7		
Sex				
Male	58	38.7		
Female	92	61.3		
Marital Status				
Single	29	19.3		
Married	114	76.0		
Divorced	01	0.7		
Separated	04	2.7		
Widow(er)	02	1.3		
Educational Attainment				
No formal education	0	0.0		
Primary education	19	12.67		
Secondary education	64	42.67		
Tertiary education	67	44.67		
Religion				
Christianity	66	44.0		
Islam	84	56.0		
Traditional	0	0.0		
Other	0	0.0		
Household size			5.57	1.66
2-4	36	24.0		
5-7	101	67.3		
8-10	12	8.0		
11-15	01	0.7		
Monthly Income			4,596,200.00	4,540,726.47
300,000-499,999	05	3.3		
500,000-999,999	04	2.7		
1,000,000-4,999,999	97	64.7		
5,000,000-9,999,999	31	20.7		
10,000,000-above	13	8.7		
Agricultural produce marketed				
Beans	36	24.0		
Yam	39	26.0		
Groundnut	21	14.0		
Melon	31	20.7		
Palm oil	23	15.3		

Source: Field survey, 2024

Respondents' awareness of financial technology banks

Results as presented in Table 2a showed that all of the respondents (100%) were aware of Opay. This was followed by Moniepoint (98%). In Table 2b, while specific fintech banks like Opay and Moniepoint have near-universal recognition among agricultural marketers in the study area, overall awareness of fintech banking services remains relatively low, with a majority (58%) having limited knowledge. This suggests a gap in financial literacy or outreach efforts, which could hinder the adoption and effective utilisation of fintech solutions in the agricultural sector.

Table 2a: Distribution of respondents based on awareness of financial technology banks

Fintech Banks	Aware	Not Aware
Flutterwave	04(2.7)	146(97.3)
Paystack	05(3.3)	145(96.7)
Interswitch	15(10.0)	135(90.0)
Carbon	02(1.3)	148(98.7)
Piggyvest	08(5.3)	142(94.7)
Cowrywise	07(4.7)	143(95.3)
Opay	150(100.0)	0(0.0)
Kuda	146(97.3)	04(2.7)
Paga	03(2.0)	147(98.0)
Fairmoney	87(58.0)	63(42.0)
Eyowo	0(0.0)	150(100)
Remita	02(1.3)	148(98.7)
Moniepoint	147(98.0)	03(2.0)
Mines	0(0.0)	150(100.0)
Bankly	0(0.0)	150(100.0)
OneFi	0(0.0)	150(100.0)
Thrive Agric	0(0.0)	150(100.0)
Wallets Africa	0(0.0)	150(100.0)
Renmoney	0(0.0)	150(100.0)
Risevest	0(0.0)	150(100.0)
Palmpay	78(52.0)	72(48.0)

Values in parentheses are percentages
Source: Field Survey, 2024

Table 2b: Categorisation of respondents' level of awareness of fintech banks

Awareness level	Frequency	Percentage	Minimum	Maximum	Mean	SD
Low (1-4.3)	87	58.0	1.00	11.00	4.4	1.4
High (4.4-11)	63	42.0				
Total	150	100.0				

Source: Field Survey, 2024

Respondents' constraints in utilising fintech for marketing of agricultural produce

Results of constraints in utilising fintech banks for marketing of agricultural produce in Table 3 showed that dependence on cash ($\bar{x} = 0.89$) was the most severe constraint faced by the respondents in utilising fintech banks for marketing of agricultural produce. This aligns with the findings of Denyes et al (2024) in a handbook titled Digital Financial Services for Agriculture inferred from the 2014 Global Findex Survey that a large proportion of payments in agriculture globally, including bulk payments to farmer groups and agribusiness staff, are in cash. According to Denyes et al (2024), cash is costly and inefficient to use, yet it is often preferred by farmers over more efficient digital payments.

Benefits of utilising fintech banks for marketing of agricultural produce

Results on benefits of utilising fintech banks for marketing of agricultural produce revealed that increase in customer base and sales opportunities ($\bar{x} = 2.78$), convenient and secure ways to manage my finances ($\bar{x} = 2.64$) and reduction in the risk of fraud and theft ($\bar{x} = 2.39$) were the major benefits the respondents gained from utilising fintech banks for their agricultural produce marketing.

Table 3: Constraints to utilising fintech banks for marketing of agricultural produce

Constraints	Not a constraint	Mild constraint	Severe constraint	Mean	Rank
Cyber attacks	147(98.0)	03(2.0)	0(0.0)	0.02	10th
Fraud	95(63.3)	25(16.7)	30(20.0)	0.57	3rd
High transaction costs	49(32.7)	73(48.7)	28(18.7)	0.86	2nd
Slow payment processing	139(92.7)	06(4.0)	05(3.3)	0.11	5th
Limited access to credit	146(97.3)	0(0.0)	04(2.7)	0.05	9th
Poor Internet connectivity	140(93.3)	07(4.7)	03(2.0)	0.09	6th
Dependence on cash	52(34.7)	62(41.3)	36(24.0)	0.89	1st
Language barriers	143(95.3)	05(3.3)	02(1.3)	0.06	7th
Power supply issues	143(95.3)	05(3.3)	02(1.3)	0.06	7th
Limited agent network	147(98.0)	02(1.3)	01(0.7)	0.03	11th
Difficulty operating the fintech apps	147(98.0)	02(1.3)	01(0.7)	0.03	11th
Low level of acceptance of fintech transactions	149(99.3)	01(0.7)	0(0.0)	0.01	13th
Lack of physical fintech bank offices.	123(82.0)	20(13.3)	07(4.7)	0.23	4th

Values in parentheses are percentages
Source: Field Survey, 2024

The findings implied that fintech banks play a crucial role in expanding market reach, enhancing financial management, and improving security for agricultural marketers.

Table 4: Benefits of utilising fintech banks for marketing of agricultural produce (n=150)

Benefits	Not a benefit	Low benefit	Moderate benefit	High benefit	Mean	Rank
Fintech banks make it easier to access loans for agricultural production.	138(92.0)	05(3.3)	06(4.0)	01(0.7)	0.13	8th
Digital payments through fintech banks reduce transaction costs.	20(13.3)	18(12.0)	79(52.7)	33(22.0)	1.83	6th
Fintech banks connect me directly with buyers, eliminating middlemen.	62(41.3)	04(2.7)	64(42.7)	20(13.3)	1.28	7th
Fintech banks offer convenient and secure ways to manage my finances.	08(5.3)	01(0.7)	28(18.7)	113(75.3)	2.64	2nd
Fintech banks provide real-time market information, helping me make informed decisions.	147(98.0)	01(7.0)	02(1.3)	0(0.0)	0.03	12th
Mobile banking enables me to monitor my accounts and transactions remotely.	12(8.0)	03(2.0)	69(46.0)	66(44.0)	2.26	4th
Fintech banks increase my customer base and sales opportunities.	04(2.7)	02(1.3)	17(11.3)	127(84.7)	2.78	1st
Fintech banks provide personalised financial advice for my agricultural business.	150(100)	0(0.0)	0(0.0)	0(0.0)	0.00	15th
Digital payments reduce the risk of fraud and theft.	21(14.0)	04(2.7)	20(13.3)	105(70.0)	2.39	3rd
Fintech banks enable me to easily manage my inventory and supplies.	139(92.7)	07(4.7)	01(0.7)	03(2.0)	0.12	9th
Fintech banks provide access to market trends and analysis.	148(98.7)	0(0.0)	0(0.0)	02(1.3)	0.04	11th
Fintech banks offer flexible repayment plans for loans.	147(98.0)	0(0.0)	02(1.3)	01(0.7)	0.05	10th
Fintech banks provide access to specialised agricultural products.	149(99.3)	0(0.0)	01(0.7)	0(0.0)	0.01	13th
Fintech banks enable me to sell my produce at competitive prices.	149(99.3)	0(0.0)	01(0.7)	0(0.0)	0.01	13th
Fintech banks offer efficient and transparent transaction processes.	14(9.3)	12(8.0)	63(42)	61(40)	2.14	5th

Values in parentheses are percentages

Source: Field Survey, 2024

This underscores the potential of fintech solutions to drive business growth, improve financial efficiency, and reduce transactional risks in the agricultural sector. This finding is consistent with Rayhan, et al (2024) who reported that convenience, real-time transactions and financial security are prospects of mobile financial solutions.

Respondents' level of utilisation of fintech banks services

Result of utilisation of fintech banks services in Table 5a showed that the fintech services utilised most by the respondents were digital payments and transfers ($\bar{x} = 2.55$) and savings and investment products ($\bar{x} = 2.07$). The result in Table

5b further showed that majority (57.33%) of the respondents had low utilisation of fintech banks services in the study area. This implies that while digital payments and savings services are the most used fintech solutions, overall adoption remains low among agricultural marketers. This suggests a need for increased awareness, improved financial literacy, and tailored fintech products to enhance usage and maximize the benefits of digital financial services in the sector. This result agrees with Parlasca (2022) who reported selective use of Fintech services among farmers.

Table 5a: Level of Utilisation of Fintech Banks services

Fintech services	Always	Occasionally	Rarely	Never	Mean
Digital payments and transfers.	139(92.7)	05(3.3)	0(0.0)	06(4.0)	2.55
Credit and lending solutions.	0(0.0)	04(2.7)	07(4.7)	139(92.7)	0.10
Savings and investment products	63(42.0)	56(37.3)	09(6.0)	22(14.7)	2.07
Mobile wallets and contactless payments.	05(3.3)	50(33.3)	30(20.0)	65(43.3)	0.97
Insurance and risk management.	01(0.7)	0(0.0)	02(1.3)	147(98.0)	0.03
Financial planning and management.	0(0.0)	04(2.7)	04(2.7)	142(94.7)	0.08
Foreign exchange and international trade.	01(0.7)	05(3.3)	02(1.3)	142(94.7)	0.10
Peer-to-peer lending and financial solutions.	0(0.0)	0(0.0)	0(0.0)	150(100)	0.00
Customized financial solutions for specific needs.	0(0.0)	02(1.3)	0(0.0)	148(98.7)	0.03

Source: Field Survey, 2024. Values in parentheses are percentages

Table 5b: Categorization of Respondents based on Level of Utilisation of Fintech banks services.

Level of utilisation	Frequency	Percentage	Minimum	Maximum	Mean	SD
Low (0-6.1)	86	57.3	0.00	15.00	6.04	2.30
High (6.2-15)	64	42.7				
Total	112	100.0				

Source: Field Survey, 2024

Relationship between selected socioeconomic characteristics of respondents and level of utilisation of fintech banks

Results in Table 6 showed that there is significant relationship between respondents' age (r= -0.173, p = 0.034) and their level of utilisation of fintech banks for marketing of agricultural produce.

This implies that respondents' age significantly influences their level of utilisation of fintech banks for agricultural produce marketing. This relationship could be attributed to generational differences in comfort with technology, financial literacy or exposure to digital payment systems.

Table 6: Relationship between respondents' age, household size, monthly income and level of utilisation of fintech banks

Variable	r value	p value	Decision
Age	-0.173	0.034	Significant
Household size	-0.024	0.768	Not Significant
Monthly income	-0.129	0.117	Not Significant

CONCLUSION AND RECOMMENDATIONS

The study concluded that the respondents have low level of utilisation of fintech banks for the marketing of agricultural produce in the study area. Dependence on cash was the most severe constraint

faced by the marketers in utilising fintech banks for agricultural produce marketing. Increase in customer base and sales opportunities were the highest benefit the marketers gained from utilising fintech banks for agricultural produce marketing.

The study therefore recommended that concerted efforts be made by fintech banks, policy makers, and regulatory bodies to develop user-friendly platforms to enhance the utilisation of fintech banks among agricultural produce marketers.

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Gender differences in perceptions and preferences for the safety of Fulani milk and its products in Ogun state, Nigeria

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Abstract - This study examines from a gender perspective the factors that influence the perception and consumption of milk and other dairy products produced by Fulani pastoralists, especially women. Data was sourced from 120 men and women consumers of Fulani milk in Ogun State, Nigeria, using a multistage sampling technique. The Wilcoxon Rank Sum test was used to undertake the test of differences, including gender and preference. Probit regression analysis was used to examine the factors influencing the preference for Fulani milk and its products among the male and female respondents. Findings from the study show that age, education, income, and expenditure on milk were the main determinants of the preference for milk and products among women. The study concludes that men's and women's perceptions are influenced by the safety, hygiene, and nutrition status of the Fulani milk, and these influence their preference and use of the milk and milk products. Government and other stakeholders should make concerted efforts to provide incentives and facilities that can promote good management practices among the Fulani women pastoralists. Adopting these good management practices will improve the purchase and consumption of milk and milk products among the local populace. This is important in the process of alleviating poverty and improving the economic empowerment of the Fulani women who play crucial roles in the preparation and sale of the milk and the products.

Keywords: Consumer preference, milk and milk products, gender, Fulani pastoralists, Nigeria

INTRODUCTION

Nigeria's food and nutrition security status, reflected by health and demographic indicators, is worrisome. Evidence from the body of literature in national and international reports and scholarly works points to a low level of undernourishment, high levels of food insecurity, and hunger (UNICEF, 2023; FAO *et al.,* 2024). This is despite the ambitious targets set by the government to combat the challenges. For instance, the Federal Government, in the 2016 National Policy on Food and Nutrition, set the target of 2025 to reduce by half the proportion of people suffering hunger and malnutrition, reduce stunting among under-five children from 37% to 25% and wasting to below 5% (Nigeria Ministry of National Budget and Planning, 2016; Federal Ministry of Health, 2021). With Nigeria ranking as one of the top 10 countries with the highest absolute number of undernourished people in 2023–2024, as well as an estimated 25 million people suffering from undernourishment (representing about 12–15% of the population) (FAO, *et al.,* 2024), the targets are increasingly becoming a mirage!

To perform better, Nigeria needs to improve on the equitable provision of access to nutritious foods, especially animal-sourced protein diets. This is because the staple in most African countries, especially in Nigeria, consists of cereals and root crops, which are available and affordable to many (Kumar and Kalita, 2017). On the other hand, milk, meat, egg, and other sources of animal protein in most instances are more expensive and may not be affordable by many people, especially those living below the poverty line in low- and middle-income countries (WHO, 2019). These foods are central to achieving food and nutrition security because they contain important nutrients that can enhance food and nutrition security, especially high-quality proteins, essential fatty acids, and micronutrients such as iron, zinc, calcium, and vitamin B12 (FAO *et al.,* 2024). Of these, milk is crucial, especially for maternal health, fetal development, and child growth due to the high calcium and balanced amino acid profile (UNICEF, 2023). Meeting the daily dietary protein requirements for men, women, and children, respectively, may be a challenging and difficult target for many of the poor populace in developing countries like Nigeria (Davis *et al.,* 2016). Therefore, equitable access to animal protein, especially milk and other dairy products, is important to fight malnourishment, thereby enhancing food and nutrition security.

In Nigeria, pastoralists, mainly Fulani cattle herders, play a central role in the livestock sector. According to the Federal Ministry of Agriculture and Rural Development, they supply about 90% of milk produced locally in the country (FMARD, 2021) and are important actors in enabling rural economies, livelihoods and support effective land use management in arid and semi-arid parts of the country. They play a significant role in the production of animals like goats, sheep, cattle, and camels, food products for human consumption such as meat and dairy products including milk and cheese, as well as animal products such as beef, hides, and skin (Fabusoro *et al.,* 2012). The pastoralists are responsible for local milk production and traditionally live in the northern part of the

country. Over the years, due to need for pasture and water resources, they migrate and settle in the southern part of the country and are important actors in the livestock sector in the region (Fabusoro and Oyegbami, 2009).

Gender specialisation exists along the local dairy value chain, with women pastoralists playing significant roles, especially in the processing and sale of milk and other dairy products. Men are primarily responsible for milking the cows and distributing the raw milk to women in the farmstead, who then process it into various products such as cheese, *manshanu* or *fura denunu*, and fermented milk, known locally as *nunu* (Fabusoro and Oyegbami, 2009). Fulani milk and milk products have many benefits (Majekodunmi et al., 2014). First, serves as the main source of livelihood and income-generating activities for women pastoralists. Women's ability to earn and increase income is central to alleviating poverty and economic empowerment; hence, milk processing and sales are central to women pastoralists' food and livelihood security. Women are generally responsible for food selection and preparation and for the care and feeding of children (Keeley *et al.,* 2019). When women have control of income, substantial evidence indicates that there will be a positive spillover effect on the food and nutrition needs of the household through increased spending on food, children, and other household needs (Opata *et al.,* 2020). Second, Fulani milk and its products are cheaper and could be more affordable for the majority of the poor populace in countries like Nigeria, and this could boost their chances of meeting their daily dietary protein requirements (Fabusoro and Oyegbami, 2009).

While milk is a veritable source of protein, the process of production and processing can be contaminated if adequate safety methods are not taken into consideration. Consumer perception of poor hygiene and the safety of fresh milk products can hinder the promotion of milk consumption as an intervention to alleviate the burden of malnutrition (Kunadu *et al.,* 2018). This is important in the local dairy value chain through which the Fulanis make their milk. Across Africa, the Fulanis process milk using different traditional technologies. For instance, in Burkina Faso, the Fulani community uses calabashes, gourds, or clay pots seeded with a natural microbial inoculum for fermentation, while in Ghana, they use spontaneous fermentation of cow's milk without starter cultures. In Nigeria, *Nunu* is prepared from raw cow's milk in calabashes, gourds, clay pots, or rubber containers and is left to ferment for twenty-four hours. In Senegal, the local milk product is cow's milk, made by filtering and heating milk in an aluminium pot until it is almost boiling. Further processing, including sieving to remove fat, pasteurising, and

packaging (Leone *et al,* 2022). These raise concerns of potential safety concerns, which can occur as contamination at any stage of the process.

Studies have proven that local production of milk is produced under unhygienic conditions that are prone to contamination (Omotayo *et al,* 2013; Olujimi *et al.,* 2018). Contamination can arise during or after milking by microorganisms, processing, packaging, storage, and marketing. Lack of appropriate hygienic practices can lead to poor microbiological quality of milk and potentially failed fermentation. Leone *et al* (2022) identified three major categories of contamination during the process. These are microbiological, chemical, and physical. Microbiological contamination can occur when pathogens are transferred directly from the blood of an infected animal into milk or during the process of collection by the exterior of the udder. Since milk has a high nutrient content, contamination could expand rapidly because milk provides a conducive environment for the growth of microbes. These include pathogenic bacteria, yeasts, viruses, and/or parasites. Chemical hazards, ingestion of contaminated animal feedstuffs, and application of veterinary medicines could also cause some kind of contamination to milk and milk products. Evidence has traced foodborne illnesses globally to milk contamination (Tremonte *et al,* 2014). In Nigeria, for instance, Olujimi *et al* (2018) found a high concentration of heavy metals and phthalate esters in milk and cheese samples from settled pastoralists in Oyo and Ogun states, Nigeria. Also, Oluwafemi and Lawal (2015) established microbial contamination of raw milk and local soft cheese in the same states. It is therefore important to study the consumer perception of the safety of the locally produced milk and the products to ascertain whether this affects the consumer behaviour of the products.

While evidence abounds in the literature on the perception of the consumer's safety of the milk and products from Fulani Pastoralists, these, in most instances, have provided a limited view about gender differences that may exist. This study contributes to existing literature in two ways. First, it helps in understanding the dynamics of factors that affect the consumption/perception of the safety of milk and other dairy products produced by Fulani pastoralists, especially women. This is crucial to better open market opportunities, which could increase income, promote poverty reduction, and improve livelihoods for many women pastoralists whose main source of livelihood is from the processing and sale of milk and dairy products. Thus, it becomes very crucial to establish a priority list of the factors determining the perception or consumption of milk and other dairy products produced by the Fulani pastoralists. Second, establishing the factors that influence men's and

women's perceptions about milk and the products can help improve the milk's processing, thereby improving its preference and acceptability among the populace. High preference and acceptability of the milk and its products can go a long way in cushioning the challenges of meeting the daily dietary protein requirements of many poor Nigerians. This has many implications for women because they are responsible for food preparation and play significant roles in the dietary diversity of their households. Thus, improving their preference and acceptability of Fulani milk and milk products can help in improving dietary protein intake because the milk and the products are cheaper and more affordable than canned milk, which may not be within the reach of many poor people. In doing this, the study seeks to:

- Assess the gender differences in the perception of the safety of Fulani milk and its products among consumers; and
- Assess the factors influencing the preference for Fulani milk and products among male and female consumers.

Based on this, three hypotheses are tested as follows:

H_01: There is no significant difference in the perception of the safety of Fulani milk and its products among consumers

Ho = $\mu_{preference} - \mu_{non-preference} = 0$ (the difference in the median is equal to zero)

Ha = $\mu_{preference} - \mu_{non-preference} \neq 0$ (the difference in the median is not equal to zero)

Where $\mu_{preference}$ and $\mu_{non-preference}$ are the population medians for consumers and non-consumers, respectively

H_02: There is no significant difference between male and female consumers in their perception of the safety of Fulani milk and the products

Ho = $\mu_{female} - \mu_{male} = 0$ (the difference in the median is equal to zero)

Ha = $\mu_{female} - \mu_{male} \neq 0$ (the difference in the median is not equal to zero)

Where μ_{female} and μ_{male} are the population medians for female and male respondents, respectively

H_03: The socio-demographic characteristics influence the preference for Fulani milk and products among male and female consumers

METHODOLOGY

The data for this study were sourced from consumers of Fulani milk and its products in Ogun State, Nigeria. Using a multistage sampling technique, 120 respondents were selected. First, 10% of the 20 local government areas (LGAs) from Ogun State were selected using the Probability Proportional to Sample Size (PPS) technique. Two LGAs, Odeda and Abeokuta North, were therefore purposively selected. The selection was due to the high concentration of Fulani communities (Alarima and Obikwelu, 2018; David, 2016). Second, some 60 respondents were randomly selected in each LGA, giving a total of 120 respondents. A structured questionnaire was used to collect primary data on consumption, preference, and perception of the safety of Fulani milk and its products.

Measures and estimation procedure

To achieve the objectives of the study, the Wilcoxon Rank Sum test is used to test whether there are gender differences in the perception of the safety of Fulani Milk and its products. Furthermore, it is used to test the differences in perception among those who have a preference for it and those who do not. The Wilcoxon Rank Sum test is used because perception is measured using a 5-point Likert scale and does not satisfy the conditions of a parametric test, such as normal distribution of the two independent populations. The null hypothesis of the Wilcoxon Rank Sum test is usually taken as equal medians (Oyeka and Ebuh, 2012). The use of either parametric or non-parametric tests for analysing Likert scale is a subject of debate in the literature (Jamieson, 2004; Allen and Seaman, 2007; Sullivan and Artino, 2013). However, the general understanding is that when the condition of normal distribution is violated, the non-parametric test is to be used. This justifies the use of the Wilcoxon Rank Sum test in this study.

The probit regression model is used to estimate the factors influencing the preference for Fulani milk and its products among the male and female respondents. It is ideal for testing hypotheses between a binary outcome variable and one or more categorical or continuous predictor variables. This therefore suits this study because the dependent variable, preference for milk and products, is a dummy variable coded as 1 in case one has a preference or 0, if otherwise. The independent variables include respondents' socio-economic characteristics such as age, marital status, education, religion, occupation, household size, income, expenditure on milk, and residency status. Marital status, religion and occupation are nominal variables. They are constructed as categorical variables while education is an ordinal variable also, constructed as categorical. On the other hand, age, residency status, household size, expenditure on milk and income are continuous variables.

RESULTS DISCUSSION
Gender analysis

The gender analysis of the socio-economic characteristics of the respondents is presented in Table 1. The results show gender differences in the age, occupation, monthly income, and expenditure on the purchase of Fulani milk and its products. For instance, the study shows that about 60 percent of

the women are in the young age group of less than 30 years, while the majority of the men (52.46%) fall within the mid-age group of between 30 and 50 years. On average, the age of male respondents was 33 years, while that of females was 30 years. This implies that male respondents are relatively older than their female counterparts. In terms of occupation, trading appears to be the common occupation among most women respondents (43.86%), while for men, a substantial proportion of them (33%) are artisans. The study was conducted in Ogun State in the Southwest region of Nigeria, a state that is dominated by the Yoruba people. The Yoruba women in Southwest Nigeria have been recognised to participate actively in income-generating activities, and trading is widely acknowledged as the leading pursuit among them.

Table 1: Gender analysis of socio-economic characteristics of respondents (%)

	Male	Female
Age (years) (n = 61; 59)		
Young (<30)	40.98	59.32
Mid-age (30-50)	52.46	32.20
Old (>50)	6.56	8.47
Mean age	33.49	30.69
Marital status (n = 61; 59)		
Single	31.15	37.29
Married	67.21	49.15
Widowed	1.64	11.86
Divorced		1.69
Education (n = 56; 56)		
None	21.43	12.50
Primary	14.29	16.07
Secondary	32.14	39.29
Tertiary	32.14	32.14
Religion (n = 59; 57)		
Islam	61.02	49.12
Christianity	38.98	50.88
Occupation (n = 60; 57)		
Trading	15.00	43.86
Civil service	11.67	10.53
Farming	23.33	8.77
Student	16.67	19.30
Artisan	33.33	17.54
Household size (n = 58; 57)		
Small (<5)	27.59	59.65
Medium (5-10)	68.97	38.60
Large (>10)	3.45	1.75
Mean household size	5.91	5.15
Monthly Income (Naira) (n = 48; 43)		
< Minimum wage (< 18000)	35.42	55.81
>= Minimum wage (18000 and above)	64.58	44.19
Mean income	25,541.67	19,837.21
Average expenditure on milk (Monthly in Naira) (n = 52; 51)		
Low (<=500)	48.08	58.82
Medium (501 – 1000)	26.92	21.57
High (>1000)	25.00	19.61
Mean expenditure	914.42	726.47
Residency (years) (n = 58; 59)		
<5	37.93	42.37
5-20	41.38	45.76
>20	20.69	11.86
Mean residency	12.10	9.57
Preference for Fulani milk (n = 60; 58)	66.67	58.62

Concerning the average monthly income, the results also show gender differences among the respondents. While most respondents were low-income earners, men (average 25,500 Naira) earn more income than women (average 19,800 Naira). Using the country's minimum wage at the time of the survey as a threshold, the study shows that about two-thirds of the men (64.58%) earn above the minimum wage of more than 18,000 Naira (43 US dollars). On the contrary, more than half of the women (55.81%) indicated that they earn less than the minimum monthly income. With regards to the average monthly expenditure on purchasing milk and milk products, the results show that, on average, men spent more (about 914 Naira) on milk than women (726 Naira). The breakdown further shows that more women (58.82%) than men (48.08%) spent a low amount of money (less than 500 Naira per month), while a larger proportion of men spent more than 1,000 Naira monthly on average on milk and milk products. A possible explanation is that since men earn more income than women, they may have higher disposable income than women, which allows them to buy milk and other products. Similarly, on average, men have longer residency status than women in the study area. Men had stayed for about 12 years compared to 9 years for women.

In terms of educational status, the results from this study also indicate a disparity in the educational status of men and women in the study area. While an equal proportion of respondents had tertiary education, more women than men completed primary and secondary education. The disparity is wider among respondents without formal education, with more men (21.43%) than women (12.5%) indicating that they did not have any form of formal education. On the preference for Fulani milk, our study reveals a gender difference, with the male group having a greater preference than the female group.

Preference and perception of safety of milk and its products from Fulani pastoralists

This section presents the results of the test of the first hypothesis: a statistical difference in the preference and perception of the safety of Fulani milk and milk products (Table 2). The results were interpreted from two angles: testing the hypothesis using the outcome of the Ranksum Wilcoxon test and analysing the implications using the median value. The group with the larger median value drives the change whenever there is a statistically significant difference.

Table 2: Preference for the safety of milk and products from Fulani

		Preference (n = 74)	Non-preference (n = 44)	Z
a.	I am not concerned of the safety of the milk	3.0	2.0	0.343
b.	I like the milk from Fulani to other packaged milk	4.0	2.0	4.839***
c.	The milk from Fulani does not have any contamination	3.0	3.0	1.620
d.	The milk from Fulani is safe for consumption	4.0	4.0	2.798***
e.	The hygiene status of the Fulani themselves does not affect their milk	2.5	3.0	-2.344***
f.	The milk contains essential nutrients for good body development	5.0	4.0	2.626***
g.	I am satisfied with taking the milk	4.0	4.0	1.031
h.	I can refer it to another person, as it is safe	4.0	3.0	4.879***
i.	The impurities in milk and other products from Fulani pastoralists can still be tolerated	4.0	3.0	1.288
j.	Further processing would help to remove impurities	2.0	2.0	0.969
k.	The milk is already safe, so it does not need regulation from NAFDAC	4.0	4.5	-3.298***
l.	Further processing would help to improve the safety of the Fulani milk	4.0	4.5	-0.931
m.	The product from Fulani milk is good for consumption	4.0	4.0	0.999
n.	I am sure the Fulani milk and its products would pass all regulatory and scientific processes	3.0	3.0	0.478

The null hypothesis assumes no significant difference in consumers' preference for Fulani milk and products. While this holds in some instances (a, c, g, i, j, l, m, and n), the alternative hypothesis holds in others (b, d, e, f, h, k) (see Table 2). These are explained below:

H_b: There is a significant difference in the preference for Fulani milk and its products relative to other packaged milk (z=4.839; p<0.01).

The Table reveals a significant difference in the perception of Fulani milk in comparison with other packaged milk (p < 0.01). The interpretation is that those with a preference for Fulani milk have a

higher consideration for it over packaged milk than those who do not prefer the milk. In addition, the Table shows a variation in the median figure with the preference group having a bigger value. This implies that the respondents with a preference for Fulani milk are responsible for the significant difference in the perception.

H_d: There is a significant difference on the preference for Fulani milk and its products based on their safety for consumption (z=2.798; p<0.01).

The analysis reveals a significant difference between the two groups on the safety of consumption of Fulani milk (p < 0.01). Although there is no variation in the median values for the two groups, the variation in the 25th percentile reveals that the preference group has a higher figure. Those who prefer Fulani milk consider the milk safe for consumption in comparison to those who do not prefer the milk. We can imply that respondents who prefer Fulani milk are the drivers of the differences in opinion that the milk is safe for consumption.

H_e: The belief that the hygiene status of the Fulanis does not affect their milk is statistically different between those who prefer the milk and those who do not (z=-2.344; p<0.01)

The higher median figure for non-preference in the Table shows that respondents who do not prefer the Fulani milk are responsible for the difference in the perception. Taken together with the negative coefficient, it can be inferred that the hygiene status of the Fulanis does affect their milk. This implies that people who do not prefer the Fulani milk believe that the hygiene status of the Fulanis influences their milk production.

H_f: The perception that the Fulani milk contains essential nutrients for good body development is statistically significant between those who prefer it and those who do not (z=-2.626; p<0.01)

The alternative hypothesis, that Fulani milk contains essential nutrients for good body development, holds. This shows that people who prefer Fulani milk consider the milk highly nutritious for good body development in comparison to those who do not prefer the milk. The higher median figure for the preference group indicates that the group is the driver of the perception that milk contains essential nutrients that are good for the body.

H_h: The perception that Fulani milk and its products are safe and can be referred to by another person is significantly different between the preference and non-preference groups (z=-4.879; p<0.01)

From the higher median figure in Table 2, we can infer that respondents who prefer Fulani milk are the drivers of the differences in opinion that the milk is safe and can be referred to other consumers. This implies that people who prefer the Fulani milk consider it safe for consumption when compared to those who do not.

H_k: There is a statistical difference in the perception that Fulani milk and products are safe and do not need NAFDAC regulation between those who prefer it and those who do not (z=--3.298; p<0.01).

The higher median figure for non-preference shows that respondents who do not prefer Fulani milk are responsible for the difference in the perception. Taken together with the negative coefficient, it can therefore be inferred that the Fulani milk is not safe and therefore needs NAFDAC regulation. This implies that people who do not prefer Fulani milk believe that the milk and the products are not safe and will therefore need NAFDAC regulations.

Gender variations in the perception of Fulani milk and products

The second hypothesis is tested in this section. This seeks to assess the gender differences in the perception of milk and milk products among the Fulani. The results are presented in Table 3. The result shows that there is a significant gender difference in the perception of the safety of Fulani milk around three issues: k) the product is safe, doesn't need NAFDAC regulation; l) further processing would improve the safety; and m) the product is good for consumption. Therefore, we reject the null hypothesis in these cases. Specifically, this holds for the following hypotheses:

H_k: There is a significant gender difference in the perception that the milk is already safe, so it does not need regulation from NAFDAC (z = 2.083; p<0.05).

The higher median figure shows that women account for the difference in perception. Hence, it can be implied that more women than men feel that the milk is safe and doesn't need regulation from NAFDAC.

H_l: There is a significant gender difference in the perception that further processing will help to improve the safety of the milk (z = 1.923; p<0.05).

When the analysis is based on the median values, it seems that there is no variation; however, at the 25th percentile, the figures indeed reveal the variation in perception among male and female respondents, with the female respondents having higher values. It can thus be implied that more women than men hold the belief that to improve the safety of the milk, there is a need for further processing.

H_m: There is a significant gender difference in the perception that the milk products from the Fulanis are safe for consumption (z = -2.779; p<0.01).

The differences in the perception of the safety of Fulani milk for consumption can be attributable to male respondents. Despite the seeming lack of variation in the median value, the variation can be seen from the higher figures for the male respondents at the 25th percentile. Taking together with the negative coefficient, this indicates that more men than women believe that the milk

products from the Fulani are unsafe for consumption.

Taken together, the inference is that while more women than men believe that the Fulani milk is safe for consumption, more women hold the belief that further processing is needed to improve the safety.

Table 3: Gender variations in perception of milk from Fulani

		Male (n = 61)	Female (n = 59)	Z
a.	I am not concerned about the safety of the milk	3.0	3.0	0.712
b.	I prefer the milk from Fulani to other packaged milk	4.0	4.0	- 0.891
c.	The milk from Fulani does not have any contamination	3.0	3.0	- 1.230
d.	The milk from Fulani is safe for consumption	4.0	4.0	-1.217
e.	The hygiene status of the Fulani themselves does not affect their milk	3.0	3.0	0.960
f.	The milk contains essential nutrients for good body development	5.0	4.0	-0.589
g.	I am satisfied with taking the milk	4.0	4.0	-1.040
h.	I can refer it to another person, as it is safe	4.0	4.0	-1.392
i.	The impurities in milk and other products from Fulani pastoralists can still be tolerated	4.0	3.0	-0.407
j.	Further processing would help to remove impurities	2.0	2.0	0.809
k.	The milk is already safe, so it does not need regulation from NAFDAC	3.0	4.0	2.083**
l.	Further processing would help to improve the safety of the Fulani milk	4.0	4.0	1.923**
m.	The product from Fulani milk is good for consumption	4.0	4.0	-2.779***
n.	I am sure the Fulani milk and its products would pass all regulatory and scientific processes	3.0	3.0	-1.102

Determinants of the preference for Fulani milk by sex

The results of the factors driving the preference for Fulani milk and milk products by male and female respondents are presented in Table 4. The result of the analysis of the male respondents is not reported because the model is not fit since the Prob > chi2 is greater than 0.05.

The female respondents' results show that age ($\beta = 1.205$; $p<0.5$); primary education ($\beta = 0.004$; $p<0.1$), income ($\beta = 0.999$; $p<0.1$), and expenditure on milk ($\beta = 1.003$; $p<0.1$) are the determinants of preference for Fulani milk and milk products. This shows that the older the women, the higher the odds of having a preference for Fulani milk.

Table 4: Determinants of preference for Fulani milk by female gender

	β	S.E.
Age	1.205**	0.115
Marital Status	0.615	0.788
Education		
• Primary	0.004*	0.012
• Secondary	0.214	0.410
• Tertiary	0.286	0.554
Religion	2.386	3.168
Occupation	2.275	1.507
Household size	0.789	0.364
Income	0.999*	0.000
Expenditure on milk	1.003*	0.001
Residency	0.751	0.144
_cons	0.247	1.160
Obs	34	
LR chi2(11)	20.05	
Prob > chi2	0.0447	
Pseudo R2	0.4296	
Log likelihood	-13.308514	

**p<0.05   *p<0.10

This implies that older women prefer Fulani milk products more than younger women by about 21%. Also, respondents with primary school education have lower odds of preference for Fulani milk and products than those without any formal education. The results of respondents in the higher education category are insignificant. In addition, the results show that high income and higher average expenditure on milk and its products have a minor odd of influencing the preference for Fulani milk and products.

RESULTS DISCUSSION

This study provides an assessment of gender differences in the perception of consumers with respect to the health safety of the milk and its products produced by the Fulani pastoralists. Results from the study show that there are gender differences in the economic status of the men and women respondents. Men in the study area seem to have higher economic status than women. Previous studies, especially in developing countries, have shown this trend in the economic status of men and women (Coker *et al.,* 2017). This is due to more opportunities available to men and their ability to use more of their time in productive activities where they can earn more income. In many instances, men allow their wives to work and earn income as long as the men control the income and its use (Farnworth *et al,* 2020). This gender gap in income was observed to influence women's purchasing power of milk, as the results show that, on average, men incur higher monthly expenditure on milk and milk products than women. As observed from the results, perceptions about safety, hygiene, and nutrition are factors that influence the consumers' preference for milk and milk products.

Findings from this study reveal that the older the women, the higher the preference for Fulani milk and products. Older women are likely to be either married, divorced, or widowed. This category includes about 50% who are married and another 13% who are either divorced or widowed; the number of women with children could potentially rise to 63%, about two-thirds of the sample. This possibly accounts for the high preference for Fulani milk and products. This is because married women play an important role in ensuring food security in their households, especially the nutritional needs of their children, allocating resources toward purchasing diverse and nutrient-rich foods, managing food processing, and meal preparation (Opata *et al.,* 2020; Egah *et al.,* 2023; Ukonu, *et al.,* 2024). The study of Quisumbing *et al*. (1996) attests to the fact that women, especially those in developing countries, play crucial roles in maintaining the four pillars of food security: food availability, access, utilisation, and stability. There is therefore the tendency for this group of women to seek different means to meet the protein requirements of their wards, of which consuming Fulani milk and products is an option.

The study also found that primary education has a negative and high influence on the preference for Fulani milk and its products, compared to respondents with no formal education. It implies that respondents with primary education are far less likely to prefer Fulani milk than those with no formal education. The relationship between education and consumption or preference for milk or milk products is mixed. For instance, Idris-Adeniyi and Busari, (2019) found out that the consumption of locally made cheese is positively influenced by the respondent's level of formal education. That is, the more educated the respondents are, the higher their tendency to consume locally-made cheese. On the contrary, Alimi *et al* (2016) reported no significant difference between the level of education and preference for milk products. In this study, primary education, compared to lack of formal education, has a lower likelihood to influence the preference for Fulani milk and its products. However, higher education is insignificant with a preference for Fulani milk and products. This is because education has been established to contribute to people's knowledge and individual economic decision, therefore, influencing the choice of product to use (Kim *et al.,* 2018). In addition, the educational level also improves people's income-earning capacity (Arsani *et al.,* 2020). This will have an attending positive effect on economic decision making and purchasing power ability of the individual. Therefore, the group of people with more education and higher purchasing power can prioritize better-packaged milk products rather than Fulani milk and product.

Preference for locally made milk products depended on the respondents' income. Findings from the study reveal that the lower the income, the higher the likelihood of willingness to buy locally made milk and milk products. There has been inconclusive evidence on the relationship between income and nutrition and food security. Some studies have shown a positive correlation between income and nutrition (Hoddinott and Haddad, 1995; Babatunde and Quaim, 2010) or children's nutritional status (Rodgers and Kassens, 2018; Abreha *et al.,* 2020). On the other hand, other studies, for instance, showed neutral and negative correlation between income and nutrition, respectively (Anderman *et al.,* 2014; van Asselt, J., and Useche, 2022). With higher disposable income, it was found that respondents will buy expensive substitutes like fish or beef. For instance, Idris-Adeniyi and Busari (2019) found that as the monthly income of the respondents increases, the frequency at which they consume local cheese decreases. This is because they tend to replace local cheese with

close substitutes like fish and meat, which have now become affordable to the respondents because of increased purchasing power. Hence, lower income usually hinders translation of intent into corresponding buying behaviour (Gassler *et al.,* 2018). Also, this may be true generally, but the context may also bring some different dimensions (Conner and Oppenheim, 2008). In many cases, disposable income depends on the characteristics of the household, such as household size and the presence of dependent people, e.g., children. A child's presence in the household increased the likelihood of purchasing pasture-raised milk. Alimi *et al* (2016) found in the study of safety perception and willingness to pay for *fura* and *nunu* (Fulani milk products) that respondents with higher income were less likely to pay not only for milk products but also extra for the processing of the products to guarantee safety.

Lastly, expenditure on milk was found to have a marginal likelihood of influencing women's preference for Fulani milk. While the relationship is positive, the influence, as shown by the odds ratio of approximately 1, is marginal. This implies that expenditure on milk may influence expenditure on Fulani milk and products. This indicates that women who have the financial capacity to buy processed milk will also likely buy Fulani milk and its products.

CONCLUSION AND RECOMMENDATIONS

This study identified that Fulani milk and milk products serve as a good source of dietary protein in the study area. The men's and women's perceptions are influenced by the safety, hygiene, and nutrition status of the Fulani milk, and these influence their preference and use of the milk and milk products. Gender differences in the perception of milk and milk products, as observed from the study, are an indication of the areas for interventions that can enhance equitable production, sales, and consumption of the products among the male and female population. This includes issues like safety (men) and improved processing (women).

These call for efforts on the side of women pastoralists to apply the best methods for improving milk safety and hygiene status. Government, non-government organisations, and various stakeholders need to integrate literacy programmes and capacity building into smallholder dairying so as to ensure the use of best dairying practices among the Fulani pastoralists. Agencies of government like the National Orientation Agency can lead the sensitisation process in partnership with media groups, state governments, and the civil society organisations. The government and other stakeholders should make concerted efforts to provide incentives and facilities that can promote best practices in the processing of milk among the

Fulani women pastoralists. Adopting these practices will improve the purchase and consumption of milk and milk products among the local populace. Coordinated efforts need to be made by various stakeholders, extension services, and government regulatory agencies like the National Agency for Food and Drug Administration and Control to formalise the processing of the Fulani milk and the products. This is important in the process of alleviating poverty and improving the economic empowerment of the Fulani women who play crucial roles in the preparation and sales of the milk. Addressing these issues will play a key role in the economic empowerment of the Fulani women pastoralists and help meet the daily dietary protein requirement in the study area.

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Factors influencing the utilisation of modern processing techniques in palm oil processing in Iwo ADP zone of Osun State

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Abstract - This study evaluated factors influencing the utilisation of modern processing techniques in palm oil processing. The study was carried out in the Iwo zone of Osun State, Nigeria. The research design used was cross-sectional. Data from 150 palm oil processors in three randomly chosen local government areas was gathered using a multistage sampling technique. A structured questionnaire was used to collect the data, a multinomial logistic regression model and descriptive statistics were used for analysis. The results showed that the use of modern processing methods like local hydraulic presses and mechanical digesters was significantly influenced by access to training ($p < 0.001$) and subsidized equipment ($p < 0.05$). However, age, years of experience, education, and labor availability all had varied degrees of influence on technology choice, even though they were not statistically significant. The findings imply that expanding access to subsidized equipment and improving training opportunities can boost the uptake of modern and effective processing technologies.
Keywords: Palm oil processing, technology utilisation, modern processing techniques, Nigeria, multinomial logistic regression

INTRODUCTION

Palm oil is not only a staple in Nigerian cuisine but also a major industrial raw material. It is used in food manufacturing, cosmetics, pharmaceuticals, and biofuel production (Bankole and Hammed, 2024). The oil is rich in essential fatty acids, vitamin E, and carotenoids, which provide health benefits such as improved heart health and antioxidant properties (Uchenna *et al.*, 2024).

Palm oil processing is a crucial aspect of the palm oil value chain, influencing not only the quality of the final product but also the profitability of processors. Over time, various techniques have evolved to improve efficiency and productivity. These techniques can be categorized into two main groups: traditional processing methods and modern processing techniques.

Research has shown that modern techniques improve oil extraction efficiency, reduce processing time, and enhance product quality (Okafor and Alabi, 2023). These techniques not only reduce the reliance on manual labor but also enhance the quality and quantity of oil extracted from palm fruits (Izah and Ohimain, 2015).

However, many processors still rely on traditional methods due to financial constraints, lack of technical knowledge, and limited access to modern equipment (Nwajiuba and Akinsanmi, 2023).

In addition to limiting productivity, the continued use of antiquated and ineffective techniques jeopardizes the sustainability and profitability of processing palm oil in rural areas. Development interventions might not be as successful as they could be if it is unclear what factors influence adoption decisions. Therefore, the purpose of this study is to determine the main variables affecting Osun State's use of various contemporary processing methods for palm oil processing. Gaining an understanding of these elements is essential to creating focused interventions that encourage the adoption of new technologies, enhancing yields, productivity, and the standard of living for those who process palm oil.

METHODOLOGY

This study was carried out in Iwo Zone, Osun State. The study was carried out in Osun State, Nigeria. The State has a total 2 land mass of 9,251 km (3,571.8 sq mi), it is bounded in the north by Kwara State, in the east and south-east by Ekiti and Ondo States, in the south by Ogun State and in the west by Oyo State. According to the 2006 population census, the state has a population of 4, 137, 627 and 30 Local Government Areas with more than 75% of the State's inhabitants as farmers who produce food crops such as yam, maize, cassava, beans and cocoyam. The cash crops produced include tobacco and oil palm. (Ogunleye and kehinde, 2020)

The study employed a cross-sectional survey research design, which involved the collection of data from a representative sample of palm oil processors at a single point in time. This approach was appropriate for identifying patterns in technology use and examining the socio-economic and institutional factors influencing the utilisation of different modern processing techniques.

The target populations for the study were processors involved in oil palm in Iwo Zone, Osun State. Multistage sampling procedure was used to collect data from processors. The first stage involved purposive selection of three Local Government Areas (LGAs) (Ayedaade, Isokan and Irewole) was based on the predominance of oil palm production in the LGAs. The second stage involved random selection of five communities from each of the three Local Governments. The third stage involved

random selection of ten oil palm processors from each of the communities.

A total of 150 respondents were selected based on the estimated population (Ogunleye and Kehinde, 2020) of processors using modern technologies in the selected LGAs. The sample size was determined to ensure sufficient statistical power for regression analysis and adequate representation across equipment types.

Primary data were collected through a structured questionnaire (designed to gather information on processing techniques and equipment used, factors influencing technology adoption) and was administered through interview schedules.

Dependent Variable (Y): The choice of modern palm oil processing equipment used by respondents. It was measured categorically as: 1 = Local Hydraulic Press, 2 = Mechanical Digester
Independent Variables (Z_i):
Z_1 = Education level (years): This refers to the level of formal education received by the processor. It is measured by categorical levels (0 = no formal education, 1 = primary, 2 = secondary, 3 = tertiary).
Z_2 = Labour (number of workers): This represents the total number of workers, engaged in processing activities. It is measured as a continuous variable by counting the number of workers employed during processing.
Z_3 = Age (years): This refers to the chronological age of the processor measured in years.
Z_4 = Access to Training (binary): This indicates whether the processor has received training on palm oil processing or equipment use. It is measured as a dummy variable, with 1 = access to training and 0 = otherwise.
Z_5 = Processing Experience (years): This is the number of years the processor has been involved in palm oil processing. It is measured in years.
Z_6 = Access to Subsidized Equipment (binary): This refers to whether the processor has access to subsidized equipment provided by government or cooperatives. It is measured as a dummy variable, with 1 = access to subsidized equipment and 0 = no access.

A multiple regression was used to analyze factors influencing the use of modern processing techniques

$$log \frac{P_i}{1 - P_i} = a_0 + a_1 Z_{1i} + a_2 Z_{2i} + a_3 Z_{3i} + a_4 Z_{4i} + a_5 Z_{5i} + a_6 Z_{6i} + \epsilon_i$$

Where:
Pi = Probability that the ith processor uses modern processing equipment
$Z_1 i$: Education level
$Z_2 i$: Labour
$Z_3 i$: Age
$Z_4 i$: Access to Training
$Z_5 i$: Processing Experience

$Z_6 i$: Access to subsidized Equipment
α = Intercept
ϵi = Error term

By focusing on participants' perspectives and the objective of the study as well as information from literature, the study identified key issues relevant to the research objective by analyzing the data. To ensure the themes were accurate and comprehensive, I share the initial list with experts, including my supervisor from the department of agricultural economics, Ladoke Akintola University of Technology for validation.

This study is underpinned by the Diffusion of Innovations Theory, developed by Everett Rogers 1962 (Deborah et al., 2025). It is particularly relevant for analyzing the behavioral and contextual dynamics influencing palm oil processors in Osun State as they interact with emerging processing technologies like hydraulic presses, screw presses, and mechanical digesters.

Rogers posits that the adoption of an innovation is influenced by five key attributes: relative advantage, compatibility, complexity, trialability, and observability.

In the context of this study, relative advantage refers to the extent to which modern palm oil processing techniques are perceived as improvements over traditional methods. Processors are more likely to adopt a new technique if it demonstrably enhances oil yield, reduces labor and time requirements, and increases profitability. Compatibility plays a crucial role in determining whether technology aligns with the social norms, cultural values, and existing operations of processors. If modern techniques can be integrated into the daily routines and organizational structures such as cooperative work settings or family labour systems, they are more likely to be embraced. Conversely, if a technique conflicts with traditional knowledge, gender roles, or available labor arrangements, its adoption may be resisted regardless of its technical efficiency.

The perceived complexity of modern equipment also influences its adoption. Techniques that are seen as too technical, mechanically sophisticated, or maintenance-intensive may discourage usage, especially among processors with limited formal education or technical training. Ease of use, clarity in operation, and local availability of spare parts can reduce this barrier and encourage broader utilisation.

Trialability, or the opportunity to experiment with the technology on a small scale before full commitment, is particularly important in rural contexts where investment risks are high. Processors in Osun State may be more willing to utilise a new processing machine if they have previously observed or tested it during training sessions, cooperative pilot projects, or through

borrowing arrangements. This gradual exposure allows them to assess performance, cost implications, and operational challenges without bearing the full initial burden of acquisition.

Lastly, observability pertains to how visible the benefits of a new technique are to others in the community. When early adopters visibly achieve higher-quality oil, greater output, or reduced processing time, others are likely to emulate them. In rural processing hubs where knowledge transfer often occurs informally through peer observation and experience sharing, this attribute is particularly powerful in driving wider adoption of modern techniques.

Overall, Rogers' Diffusion of Innovations Theory provides a comprehensive lens through which the varying levels of adoption of modern processing techniques in Osun State can be understood. It underscores that beyond the technical superiority of equipment, socio-economic, cultural, and informational factors critically shape the utilisation behavior of processors. This theoretical grounding informs the analysis of determinants explored in this study.

RESULTS AND DISCUSSION
Demographic information of respondents

According to Table 1.0, 34.7% of respondents were men and 65.3% of respondents were women. This suggests that there are more women than men. This may be because the majority of people who work in the palm oil processing industry are women. This is in line with previous research that highlights the important role that women play in Nigerian agricultural processing, particularly in the oil palm subsector (Ayanwale *et al*., 2020).

According to the table, the respondents' ages ranged from 21 to 70 years old and 40.9% of respondents are between the ages of 36 and 45, 35.6% are between the ages of 46 and 55, 21.5% are between the ages of 56 and 65, 1.3% are over 66, 0.7% are between the ages of 26 and 35, and 0% are between the ages of 18 and 25. The respondents' average age was 48. This suggests that the majority of the people processing palm oil are adults. Additionally, the table showed that 44% were divorced, 3.3% were widowed, 52% were married, and 0.7% were single. The majority of respondents were likely married, based on this finding. Higher household responsibilities are frequently linked to marital status, and this can have an impact on investment behavior as well as production goals. Married processors may be more likely to embrace time-saving technologies in order to satisfy domestic demands (Obayelu *et al*., 2017).

The table displays the respondents' educational attainment. About 10.7% of the respondents have no formal education, 22.7% have primary education, 21.3% have tertiary education, and 45.3% have secondary education. Secondary education accounts for the largest percentage of respondents, at 45.3%. Particularly in cases involving documentation, technical manuals, or digital interfaces, the comparatively low levels of formal education may hinder awareness and adoption of improved techniques.

Table 1.0: Demographic characteristics of the respondents

Variables	Group	Frequency	Percentage (%)
Sex	Male	52	34.7
	Female	98	65.3
Age Group	18–25	0	0.0
	26–35	1	0.7
	36–45	61	40.9
	46–55	53	35.6
	56–65	32	21.5
	66+	2	1.3
Marital Status	Single	1	0.7
	Married	78	52.0
	Divorced	66	44.0
	Widowed	5	3.3
Education Level	No Formal Education	16	10.7
	Primary	34	22.7
	Secondary	68	45.3
	Tertiary	32	21.3
Processing Experience	< 5 Years	2	1.3
	6–15 Years	15	10.0
	16–25 Years	65	43.3
	26–35 Years	60	40.0
	Above 35 Years	8	5.3

The table also reveals that 43.3% of respondents processing experience are between the ages of 16 and 25, 40% are between the ages of 26 and 35, 10% are between the ages of 6 and 15, 5.3% are over 35, and 1.3% are under five. Respondents aged 16 to 25 years have the largest percentage of processing experience (43.3%). With an average of 24.5 years of experience, processors appear to have deeply ingrained traditional knowledge. Experience is useful for production planning and technical know-how, but unless backed by training, it can also be associated with conservatism when implementing new practices.

The logistic regression model demonstrates excellent predictive performance in classifying the utilisation of modern palm oil processing techniques. The model accurately separates users from non-users of modern equipment with an accuracy rate of 88%, sensitivity of 98.46% and 20%, and specificity of 98.52% and 20%. The model's exceptional discriminatory power is confirmed by its AUC value of 0.98. With a low AIC (29.94) and a high pseudo R2 (McFadden = 0.6447), the model also exhibits strong goodness-of-fit, suggesting that the predictors account for a significant amount of the outcome's variability.

Table 2.0: Performance measures for the logistic regression model

Measures	Value
Accuracy Rate	88%
Sensitivity (Local Hydraulic Press)	20%
Sensitivity (Mechanical Digester)	98.46%
Specificity (Local Hydraulic Press)	98.52%
Specificity (Mechanical Digester)	20%
AUC (ROC Curve)	0.98
AIC	29.94
BIC	169.2
Pseudo R² (McFadden)	0.6447

Source: Data analysis, 2025

Education - Table 3.0 presents multinomial logistic regression results indicating the influence of education on the utilisation of different modern palm oil processing techniques. For processors using the local hydraulic press, the coefficient for education was $\beta = 0.204$ with a p-value = 0.346, while the odds ratio (OR) of 1.226 suggests a 22.6% increase in the likelihood of adopting the local hydraulic press relative to the hand screw press for each additional level of education attained. However, this relationship was statistically insignificant, implying that educational attainment did not meaningfully influence the adoption of the local hydraulic press among processors.

On the other hand, for users of the mechanical digester, the coefficient of $\beta = -0.505$ and a p-value = 0.065 (significant at the 10% level) implies a negative relationship between education and the likelihood of using the mechanical digester compared to the hand screw press. The associated odds ratio of 0.603 suggests that as education increases by one level, the odds of using the mechanical digester (relative to the hand screw press) decrease by approximately 39.7%. This inverse relationship, although marginally significant, might reflect contextual realities where more educated individuals may be less involved in hands-on processing or may shift toward managerial roles or alternative income-generating activities outside direct processing.

This finding diverges from conventional expectations, as many prior studies have consistently shown that education is positively associated with the adoption of improved agricultural technologies.

Conversely, the current study's finding partially aligns with Tey and Brindal (2012), who argued that while education increases awareness, it may also lead to diversification of livelihood away from primary processing activities, particularly in rural areas where better-educated individuals may explore other business opportunities or seek white-collar jobs. Moreover, Mignouna *et al.* (2011) posited that education's effect on technology adoption is highly context-specific, depending on factors such as the perceived complexity of the technology, cultural acceptance, and economic incentives. Although education is theoretically linked to increased technology adoption, this study finds its role to be weakly significant and directionally mixed.

Labour - The results in Table 3.0 show the estimated influence of the number of workers (labour) engaged by palm oil processors on their likelihood of utilising different modern processing techniques relative to the baseline category (hand screw press). For processors utilising the local hydraulic press, the coefficient for labour was $\beta = 0.786$ with a p-value = 0.548, while for those using the mechanical digester, the coefficient was $\beta = 0.897$ with a p-value = 0.443. Although both

coefficients were positive and the corresponding odds ratios were 2.194 and 2.452 respectively, neither relationship was statistically significant at conventional levels (p < 0.05).

Despite the lack of statistical significance, the direction of the relationship suggests that an increase in the number of labourers employed in palm oil processing is associated with a higher probability of adopting both the local hydraulic press and the mechanical digester. This could be attributed to the fact that modern equipment, although more efficient, may still require considerable human involvement for ancillary tasks such as loading, sorting, monitoring, and post-processing activities. As such, processors with greater access to labour may find it easier to integrate mechanized techniques into their operations without facing production bottlenecks.

The positive but non-significant result aligns with the findings of Adekanye *et al.* (2013) who studied cassava processing in Nigeria and noted that the availability of labour positively influences the decision to adopt improved processing equipment. They argued that modern technologies, especially in traditional agro-processing, often complement rather than replace human labour. However, the absence of statistical significance in the present study could reflect contextual limitations such as small operational scale or the presence of idle labour not efficiently utilised in processing operations. In line with this, Kassie *et al.* (2011) noted that while the presence of labour increases the capacity to operate improved technologies, its effect is conditional upon the scale of processing, cost of labour, and nature of the technology involved.

Although labour appears to have a positive association with the adoption of modern processing techniques, this relationship is not statistically significant in this study. Nevertheless, it remains a relevant operational factor.

Age - As shown in Table 3.0, the study examined the influence of the processor's age on the likelihood of adopting different modern palm oil processing techniques, using the hand screw press as the reference category. For the local hydraulic press, the coefficient for age was β = 0.016, with an odds ratio of 1.016 and a p-value of 0.845. For the mechanical digester, the coefficient was β = -0.090, with an odds ratio of 0.914 and a p-value of 0.251. These results were statistically insignificant at the 5% level, suggesting that age does not exert a strong or consistent influence on the choice of technology among palm oil processors in the study area.

Despite the statistical insignificance, the signs of the coefficients provide some interpretive insights. The positive coefficient (OR > 1) for the local hydraulic press implies a weak tendency for older processors to adopt this intermediate technology. In contrast, the negative coefficient for

the mechanical digester indicates a slightly reduced likelihood of adoption as age increases. This contrast suggests that while some older processors may be open to modest improvements (i.e., local hydraulic press), they might be less inclined to embrace more complex and capital-intensive technologies like the mechanical digester.

These findings are somewhat consistent with previous studies. Mwaipungu *et al.* (2023), in their study on tomato farmers in Tanzania, reported that age positively influenced the adoption of modern farming technologies, citing that older farmers tend to possess greater farming experience, risk tolerance, and decision-making authority. Similarly, Dissanayake *et al.* (2022) found a significant relationship between age and technology adoption in Sri Lanka's agricultural sector, noting that older farmers might adopt technologies they deem compatible with their accumulated knowledge and practices.

However, other studies have presented mixed results. For instance, Gebre *et al.* (2019) reported no significant effect of age on technology adoption in Ethiopia, attributing this to variations in education, risk perception, and access to finance across age groups. Likewise, Vecchio *et al.* (2020) argued that in certain agrarian contexts, younger processors may actually be more open to modern techniques due to higher levels of education and technological literacy, despite limited access to capital. In Nigeria, Kehinde (2021) also observed that younger palm oil processors were more inclined to adopt new innovations when provided with adequate training and support mechanisms.

Furthermore, the adoption of mechanized techniques may depend more on external enabling factors such as training, subsidies, and capital availability rather than age alone. This aligns with the view of Balana *et al.* (2022), who emphasized the mediating role of institutional support in shaping the relationship between socio-demographic traits and technology uptake.

In conclusion, while age may shape individual attitudes toward modern processing techniques, it does not emerge as a decisive factor in this study. Nonetheless, understanding age-related preferences can inform the customization of extension messages, ensuring they resonate with processors at different life stages.

Access to training - Access to training emerged as a highly significant predictor of the utilisation of modern processing techniques in palm oil processing. As shown in Table 3.0, the coefficient for local hydraulic press was β = 12.178 (p < 0.001), with an exceptionally high odds ratio (OR) of 193,551.8 and a 95% confidence interval (CI) of 53,201 – 704,405.9. Similarly, for the mechanical digester, the coefficient was β = 9.992 (p < 0.001), OR = 21,817.3, CI = 5,992.4 – 79,464.6. These

results indicate that processors who had access to training were significantly more likely to adopt either type of modern processing equipment than those who relied on traditional methods such as the hand screw press.

The extremely large odds ratios, although unusual, are consistent with a strong and statistically robust effect, highlighting the pivotal role of training in facilitating technology adoption. Access to training enhances the processor's technical competence, operational confidence, and familiarity with the mechanical or semi-mechanical features of modern equipment. These competencies are especially important for technologies like hydraulic presses and mechanical digesters, which often require knowledge of assembly, maintenance, and troubleshooting (Doss, 2006).

More broadly, access to training contributes to the reduction of perceived complexity and risk associated with new technologies two core constructs in Rogers' Diffusion of Innovations theory (Rogers, 2003). Training also offers opportunities for hands-on experimentation (trialability) and observation of outcomes (observability), which significantly influence adoption decisions in communal agricultural settings. Therefore, the observed relationship may be due not only to the technical knowledge gained, but also to the social validation and trust that training fosters.

This finding aligns with studies across Sub-Saharan Africa, which have consistently demonstrated that access to extension and training services increases the likelihood of adopting improved agricultural technologies. For example, Mignouna *et al*. (2011) found a positive link between extension access and the adoption of biotech maize in Kenya. Similarly, In the context of Nigeria's palm oil sector, Ogundari and Bolarinwa (2018) emphasized that access to well-designed, hands-on training programs is a critical enabler for mechanization and efficiency gains in small-scale processing enterprises.

The implication of this result is that improving training access should be a top priority for policymakers, NGOs, and other actors interested in upgrading palm oil processing in Nigeria. The extremely strong statistical significance of training in this model suggests that training interventions, when effectively designed and delivered, could be one of the most cost-effective strategies for promoting the adoption of modern processing techniques in the sector.

Experience - The influence of processing experience on the adoption of modern palm oil processing technologies was examined, and the results in Table 3.0 show that experience was not statistically significant in predicting the likelihood of using either the local hydraulic press ($\beta = 0.129$,

$p = 0.238$, OR = 1.138) or the mechanical digester ($\beta = 0.048$, $p = 0.614$, OR = 1.049). Despite the lack of statistical significance, the positive coefficients in both cases suggest a slight tendency for more experienced processors to utilise modern techniques, even though the effect is marginal and inconclusive.

The odds ratio of 1.138 for the local hydraulic press implies that with every additional year of experience, the odds of adopting this technology increase by approximately 13.8%, though this result is not significant at the 5% level. Likewise, the OR of 1.049 for mechanical digester users suggests an even smaller increase of 4.9% per year of experience. This pattern indicates that while experience may contribute modestly to the decision to adopt newer processing equipment, it does not strongly determine technological choice in the context of palm oil processing in Osun State.

These findings are somewhat contrary to the conventional belief that longer years in production are typically associated with greater technological adoption, due to accumulated knowledge, exposure, and capacity to manage processing innovations (Akinola *et al.,* 2019). In particular, Adenegan and Olagunju (2012) found that experience significantly influenced the likelihood of adopting mechanized technologies in cassava processing, attributing this to the processors' increased familiarity with the operational demands and economic benefits of modern tools.

However, the current results align more closely with a study by Ojo *et al*. (2019), which argue that experience may only play a secondary role when access to capital, institutional support, and market incentives are lacking. In such contexts, even highly experienced processors may continue using traditional or semi-traditional methods due to constraints beyond their control. Moreover, Reimers and Klasen (2013) note that in some low-income rural settings, older or more experienced farmers may resist adopting new technologies if they perceive them as risky or if they have already optimized their production routines with older methods.

In conclusion, while processing experience shows a positive but non-significant influence on the use of modern processing equipment in this study, its effect should not be dismissed outright.

Access to subsidised equipment - Access to subsidized equipment was found to be a statistically significant predictor of the utilisation of modern processing technologies in palm oil production. As indicated in Table 3.0, the coefficient for access to subsidised equipment in predicting the use of the local hydraulic press was $\beta = 1.811$ with a p-value of 0.019, and an odds ratio (OR) of 6.116 (95% CI: 1.349–27.727). Similarly, the coefficient for

predicting the use of mechanical digester was β = 1.607, with a p-value of 0.006 and an OR of 4.986 (95% CI: 1.602–15.520). These findings imply that processors who had access to subsidized equipment were about 6 times and 5 times more likely, respectively, to adopt hydraulic presses and mechanical digesters than those who did not have such access, holding all other factors constant.

This strong positive relationship aligns with the economic logic that subsidies lower the cost of acquisition, making capital-intensive equipment more financially accessible to small- and medium-scale processors. In resource-constrained rural environments where capital markets are underdeveloped, subsidies act as critical enablers by offsetting upfront investment costs that would otherwise be prohibitive (Jack, 2013).

Subsidized programs often bridge the gap between awareness and actual use of technology by mitigating the risk of financial loss and encouraging initial adoption. For instance, Ogundari and Bolarinwa (2018) noted that equipment subsidies in

Nigeria significantly boosted the uptake of mechanized technologies in agricultural processing.

The role of subsidies is not only economic but also psychological. The mere act of receiving subsidized support can signal government or institutional endorsement, boosting user confidence in the reliability and legitimacy of the technology (Cai *et al*., 2016). This aligns with Rogers' (2003) concept of "observability" and "trialability" within the Diffusion of Innovations theory, where visible external support can encourage broader community adoption.

While the positive effect of subsidies is well-documented, it is also essential to recognize the importance of proper targeting and sustainability. Misallocation or lack of follow-up support could lead to underutilisation or misuse of subsidized equipment. Therefore, subsidies should be designed to reach the most constrained but capable processors, with complementary measures such as training, technical support, and access to spare parts.

Table 3.0: Multinomial logistic regression analysis for factors influencing utilisation of different modern processing techniques

Variables	Category	Coefficient (β)	Std. Error	p-value	Odds Ratio (OR)	95% CI (Lower–Upper)
Education	Local Hydraulic Press	0.204	0.215	0.346	1.226	0.797 – 1.887
	Mechanical Digester	-0.505	0.278	0.065 †	0.603	0.349 – 1.041
Labour	Local Hydraulic Press	0.786	1.311	0.548	2.194	0.165 – 29.238
	Mechanical Digester	0.897	1.172	0.443	2.452	0.250 – 24.064
Age	Local Hydraulic Press	0.016	0.083	0.845	1.016	0.860 – 1.200
	Mechanical Digester	-0.090	0.078	0.251	0.914	0.784 – 1.066
Access to Training	Local Hydraulic Press	12.178	0.658	<0.001***	193551.8	53201 – 704405.9
	Mechanical Digester	9.992	0.658	<0.001***	21817.3	5992.4 – 79464.6
Experience	Local Hydraulic Press	0.129	0.110	0.238	1.138	0.914 – 1.416
	Mechanical Digester	0.048	0.095	0.614	1.049	0.868 – 1.268
Access to subsidised Equipment acquisition	Local Hydraulic Press	1.811	0.764	0.019*	6.116	1.349 – 27.727
	Mechanical Digester	1.607	0.583	0.006**	4.986	1.602 – 15.520

Source: Data analysis, 2025

CONCLUSION AND RECOMMENDATIONS

The findings showed that the likelihood of implementing the mechanical digester and the local hydraulic press was considerably raised by having access to training and subsidized equipment. These results confirm how important affordability and institutional support are in promoting the move to automated processing.

Despite not being statistically significant predictors in the final model, other factors like age,

experience, education, and labour availability show varying degrees of influence based on their odds ratios. Overall, the results show that policy initiatives that focus on increasing training opportunities and guaranteeing steady access to subsidized processing equipment can significantly impact the adoption of new technologies. These can then enhance the quality of the oil produced, the efficiency of processing, and eventually the earnings and standard of living of processors throughout in Iwo Zone.

The study provides the following recommendations:

1. The Osun State Ministry of Agriculture should collaborate with agricultural development programs and non-governmental organizations to arrange frequent, on-site training sessions for palm oil processors, as training access was the most important predictor of modern technology utilisation.

2. The government and donor organizations should establish equipment subsidy programs because they have a significant positive influence on the adoption of both local hydraulic presses and mechanical digesters. To remove financial obstacles, particularly for small-scale processors, a flexible hire-purchase arrangement might be implemented.

3. In order to close the gap between affordability and accessibility, palm oil cooperatives ought to receive assistance in purchasing processing equipment that their members can utilise at reduced costs. Low-interest loans and grants should be made available by the Ministry of Commerce and Industry in collaboration with cooperative unions to support cooperatively based equipment procurement.

4. To create an enabling environment, cooperation between research institutes, commercial equipment producers, agricultural extension services, and financial institutions ought to be encouraged. This includes creating loan products that are easy for processors to process and sharing information via reliable community channels.

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Impact of participation in producer organisation on the welfare of smallholding farming households in selected states of Northern Nigeria

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Abstract - Lack of access to specialized market leave numerous under-capitalized, high-cost individual smallholder farmers with low economies of scale in transaction cost or market intelligence, leaving most with unstable incomes. Sampling 604 smallholder farmers, this study evaluated the impact of agricultural producer organization membership on the welfare of smallholder farmers using cross-sectional data collected from the northern part of Nigeria. Using crop income as a welfare indicator, we measured the impact of agricultural cooperative membership by implementing the endogenous switching regression estimation technique. The estimation method indicates that joining producer organizations has a positive impact on the welfare of smallholder farmers. Furthermore, the analysis also indicates that agricultural producer organization membership has a heterogeneous impact on welfare among its members.
Keywords: Producer organization, welfare, Multinomial Endogenous Switching Regression, Smallholder farmers, Nigeria.

INTRODUCTION

Several of the developing countries, especially in the rural areas, were unable to achieve the Millennium Development Goal of reducing poverty by half between 1990 and 2015 (Aziz et al,. (2021), and the achievement of most of the SDGs are also stalling (Liu, et al., 2024). Because most rural dwellers depend largely on agriculture for their livelihoods (Mukaila et al., 2021), improving productivity and market access and increased income, and by extension their welfare, is argued to be the main pathway out of poverty (Ma et al., 2024). Therefore, approaches to link farmers to markets through the producer organization are increasingly becoming a major pathway towards inclusiveness in the agricultural sector (Vorley, Fearne and Ray, 2016). Producer organizations help small-scale farmers to consolidate as a group, and develop shared comparative advantage in terms of quantity, quality, innovation, cost, and farm management, and securing supply. Thus becoming a lifeline in the current difficult entry within the global food value chains (Kale et al, 2025), especially in the presence of the inadequacies of conventional cooperatives (Fabusoro *et al*., 2017). It enables contractual links to input and output markets (Simmons, Winters, and Patrick, 2005). For the farmers, the net benefit of selling through this market is higher as they have more income and low transaction costs (Aku, Mshenga, Afari-Sefa, and Ochieng 2018). But numerous under-capitalized, high-cost individual smallholder farmers are unable to explore the economies of scale in transaction cost or market intelligence (Poulton *et al*., 2006), leaving most smallholder farmers with unstable incomes (Uduji et al., 2021).

Several agricultural policies in Nigeria are aimed at the development of the agricultural sector and improving the welfare of farmers (Abubakar et al., 2021), however, they have not been able to bridge the gap in the growth of producer organizations and their attendant benefits as a link between smallholder farmers and the rapidly evolving modern market. The root cause often lies in policy designs that emphasize production technology improvement while overlooking the need for improved market participation, limiting the competitiveness of smallholders in markets. It is imperative to provide scientific evidence that will inform agricultural policies around producer organization to ensure inclusive participation and ultimately improve the household welfare- by increasing net income of smallholder farmers. Therefore, this study accesses the impact of participation in producer organization on the welfare of smallholder farmers. Several studies have been carried out in Africa on the impact of producer organization (Aku et al., 2018; Ahmed and Mesfin, 2017; Kizito, 2018; Verhofstadt and Maertens, 2014; Mutonyi, 2019 and Fischer and Qaim, 2012; Bachke, 2009). However, limited documentation exists on the impact of producer organizations on the income of smallholder farmers in Nigeria. Also, this study adopted the Multinomial Endogenous Switching Regression (MESR), accounting for selection bias and endogeneity originating from observed and unobserved heterogeneity, to analyze the impacts of participation in organization combinations on welfare

The benefits of participation in producer organization on welfare indicators (farm income, yields, prices received by producers, asset holdings, consumption expenditure, and other livelihood dimensions) have been extensively studied. Using Difference-in-difference, Buchke (2009) and Anirban (2019) found that participation in producer organizations contribute significantly to higher income, and thereby welfare among small-scale farmers. The effect of membership on income is stable and around 30% when the results are

significant. Using Propensity Score Matching (PSM), Aku *et al*., (2018) shows that farmers who had access to the market provided by farmer organization have more income per season (USD 220.11) than vegetable farmers who do not belong to the group membership (USD 177.90). Although not crop specific Verhofstadt *et al*., (2014) shows that cooperatives are most effective in increasing the income of smallholder farmers who are less likely to join the cooperative due to the entry requirements yet found no income effect for very low landholders of less than 0.15 hectares and it is not effective for improving the welfare of land poor or near-landless farmers although, farm income increased with landownership of 0.5 hectares and above. Similar findings are reported by Mutonyi (2019) who also found that the effect is only significant for farmers with a total farm size of 6 acres. Smallholder farmer participation is low. This is stated to be due to initial capital outlay of joining the organization. This is contrary to the findings of Ito *et al*., (2012) in China who also used PSM but found that the treatment effect for smallholder farmers is 40-41 Yuan/day compared to 23 Yuan/day for large scale farmer. Although, continent specific difference may not be explained but this finding may be due to the fact that unobservable characteristics are not included in the model. Again, using endogenous switching regression Adjin, (2020) and Ma and Awudu, (2016) suggest that farmer organizations are effective at enhancing farmers' land productivity and welfare. Mojo *et al.*, (2017) shows that cooperatives have significant positive economic impacts on members, and direct and positive spill-over effects on non-members although, cooperative provide similar marketing and non-marketing services to both members and non-members (due to a vaguely defined property right problem). Jimenez *et al.*, (2018) in Philippines shows that cooperative membership significantly increases household welfare measured in terms of household consumption expenditure.

METHODOLOGY

The study area is Plateau and Kano states. Quantitative data was collected using a semi-structured questionnaire. The population for the study were tomato and potato farmers consisting of participants and non-participants in producer organizations. Tomato and potato producer organizations in the study area were well established for sufficient period to ensure meaningful assessment their impact on the welfare of their members. A multi-stage sampling procedure was adopted for respondent selection. Plateau and Kano states were purposively selected because of the successful establishment of the activities of producer organizations (Plaisier *et al.*, 2019). Based on high farming activities and the presence of established producer organizations, two local government areas was selected from each state and four communities was selected from each local government area making a total of sixteen communities for the study. Participants were systematically selected from the list of producer organizations members while non-participants with similar characteristics were selected. A total of 604 respondents consisting of 289 participants and 315 non-participants were utilised for this study.

Descriptive statistics was analysed using frequencies, and cross tabs while the Multinomial Endogenous Switching Regression (MESR) was used to analyse the impact of participation in producer organizations on the welfare of smallholder farmers.

The first stage of the MESR employed the use of multinomial logistic regression model. This model allows dependent variables to be more than two, discrete, non-ordered categories and have nominal properties, exhibiting multinomial distribution category (Liao, 1994; Long and Greese, 2006). The model for this study has three dependent variables categories; a baseline category was determined in order to make comparisons or analyses. The baseline category (J) can be selected arbitrarily by the package software (Hosmer and Rodney, 2000). If J is selected as the baseline category, the probability of the dependent variable to lie within the baseline category is defined as given as:

$$\pi_J = p(y = J) = \frac{1}{1 + \sum_{j=1}^{J-1} exp\left[\left(\sum_{k=1}^{K} \beta_{jk} x_k\right)\right]} \quad j=1,2,\ldots,J\text{-}1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The probability of lying within the baseline category will be calculated as:

$$\pi_J = P(y = J) = 1 - \left[\left(P(y = 1_{+P(y=2)} + \cdots + P(y = J - 1)\right]\right] \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

In a multinomial logistic regression model, the logit transformation was obtained by taking the logarithms of the odd ratios after selecting the baseline category (Kienbaun and Klein, 2010). This is given as

$$ln\left[\frac{P(y=1|x_1)}{P(y=0|x_1)}\right] = \beta_1 + \beta_{11} x_1$$

$$ln\left[\frac{P(y=1|x_2)}{P(y=0|x_1)}\right] = \beta_2 + \beta_{21} x_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Variables in the model include Age, Education, Age square, Access to extension agent, access to credit, ownership of land, access to phone, distance to farm, farm income, participation in non-farm activities, entrepreneurial experience

RESULTS AND DISCUSSION
Socioeconomic

The result in table 1 shows that 56.62% of the male respondents are participating in producer organizations compared to 32.42% for female respondents (Table 1). This is in line with the finding of Adefris and Woldeyohannes (2021) who opined that more males than females are involved in producer organization. However, more female-heads (69.51%) are involved in producer organizations than male-headed (50.57%). This is also like the result found for the male headed household. This shows gender inclusion in participation in formal organization and buttresses the notion that all services, opportunities, and establishments are open to all people and that male and female stereotypes should not define societal roles and expectations. Majority of the male respondents, 92.20%, participating in the producer organization are married while the lowest percentage of non-participants, 0.6% are widowed or separated and 78.87% of the female are married. The result shows that 10.14% of the respondents are single while a higher of respondents that are widowed, divorced or separated are female. This status has a way of influencing women ability to make autonomous choices in life, which includes participation in producer organizations. Women's participation in producer organization itself reveals agency in itself, mirroring women's physical mobility and freedom to participate in collective action (Meier zu Selhausen, 2016).

Table 1: Socioeconomic distribution based on membership of producer organization

Variables	Participants(n=289)	Non-participants(n=315)	Test of Difference
Sex of respondents			
Male	218 (56.62)	167 (43.38)	
Female	71 (32.42)	148(67.58)	
Head of household			
Male headed	264 (50.57)	258 (49.43)	
Female headed	57 (69.51)	25 (30.49)	
Marital status			
Single	10 (17.24)	48 (82.76)	
Married	257 (52.77)	221 (46.23)	
Widowed	17 (41.46)	24 (58.54)	
Divorced	2 (10.53)	17 (89/47)	
Separated	3 (37.50)	5 (62.50)	
Age (years)			
Less than 20	2 (13.33)	13 (86.67)	
21-40	132 (39.29)	204 (60.71	
41-60	134 (60.91)	86 (39.09)	
Above 60 years	21 (63.64)	12 (36.36)	
Mean	**43.04 (11.13)**	**37.46 (12.07)**	**5.89***
Household size			
Less than 5	49 (62.02)	80 (62.02)	
5-10	210 (52.63)	210 (52.63)	
Greater than 10	51 (67.11)	25 (32.89)	
Mean	**7.8 (3.68)**	**6.5 (3.13)**	**4.72***
Educational status			
No education	58 (41.43)	82 (58.57)	
Primary education	55 (41.04)	79 (58.96)	
Secondary education	85 (43.81)	109 (56.19)	
Tertiary education	91 (66.91)	45 (33.09)	
Mean	**9.36 (5.79)**	**7.55 (5.58)**	
Farming experience (years)			
Less than 10	58(29.74)	137 (70.26)	
11-20	93 (48.95)	97 (51.05)	
21-30	50 (41.67)	70 (58.33)	
Greater than 30	35 (35.35)	64 (64.65)	6.29***
Mean	**22.90 (11.68)**	**16.89 (11.65)**	

Source: Data Analysis, 2025

There was found to be a significantly high disparity in the educational status of participants and non-participants in the study area. The average year of education is 9 and 7 years respectively and majority of the participants are more educated than the non-participants. Again, the result shows that the highest proportion of male and female participants have a tertiary and secondary education respectively while majority of the non–participant that are female have no formal education. This implies that the male respondents are more formally educated than the female. Majority of the female farmer, 35.21%, who are participants of the producer organization have less than 10 years farming experience with 19 years mean experience while most of the male participants, 35.32% have between 11 and 20 years farming experience with mean experience of slightly above 24 years.

Impact of participation in producer organizations on the welfare of smallholder farming households
Average treatment effect on the treated
Conditional average effects

The first panel of table 2 shows the average effect of participation in organizations on household income. Results in column (3) of Table 2 show that participation in organizations is highly associated with significant increment in household income. In all cases, households who participated in organizations would have obtained lower benefits had they not participated. Farmers who participated in producer organization only had the highest income gain (₦24,203), followed by those who participated in producer organization and cooperative (₦9,318) and those who are in cooperative only (₦2912). The impact of participation in cooperatives facilitating increase household income has over time been established (Zou and Wang, 2022), participation in producer organization has been shown to increase in household income over eight times of what will be achieved if only in cooperatives and over three times of what will be gotten if producer organization is combined with cooperative. This implies that participation in producer organization helps farmers to have access to reliable markets, have higher bargaining power, more stable prices due to consistent market and lower post-harvest losses as they are able to mitigate against risk due to market instabilities that can cause income fluctuations.

Table 2: MESR based treatment effects of participating in organizations on household welfare

Outcome variables	Organization choice	Participating	Non-participating	Average Treatment effects
	(j)	(j=2,3,4)	(j=1)	
		(2)	(1)	3=2-1
Conditional average effects				
Income (₦)	Cooperative only	51544.92	48632.41	2912.501***
	Producer organization with cooperative	56190.62	46871.66	9318.961***
	Producer organization only	123841.5	99637	24203***
Unconditional average effects				
Income	Cooperative only	73510.47	66400.52	7109.95***
	Producer organization with cooperative	79259.28	66400.52	12858.76***
	Producer organization only	108671.7	66400.52	42271.21***
Heterogeneity effects				
Income	E(4|2) vs. R(3|2)	85948.26	51544.92	34403.34
	E(4|3) vs. R(2|3)	86318.37	46871.66	39446.71
	E(3|4) vs. R(2|4)	96380.1	82315.53	14064.57

Source: Data Analysis, 2025

Unconditional average effects

Unconditional average effects of adoption on income summarize the causal effects of participation for the entire population. Results show that for all the categories of organizations considered, on average, participants realize more income compared to non-participants. Farmers who participated in cooperative only were found to have ₦7109 more than non-adopters, those who participated in producer organization and cooperative have ₦12,858 more while those who participated in producer organization have ₦42,271 more than those who do not participate in organization. This implies that participation in cooperative, cooperative and producer organization and producer organization only was found to increase income. However, these results are only indicative of the effects of participating in organizations and could be misleading due to

selection bias from both observed and unobserved factors.

Heterogeneity Effects

We also estimated average treatment effects for participants in organizations only. Participants heterogeneity effect results presented in table 18 shows that maximum gain would be obtained from both producer organization only vs. cooperative only followed by producer organization only vs producer organization cum cooperative and the producer organization cum cooperative vs cooperative only for all outcome indicators.

Average Treatment effect on the Untreated

Furthermore, table 3 shows the estimation of the average treatment effects on the untreated (ATU). If non-adopters have participated in cooperative, their income will increased by ₦2912 naira; if non adopters have participated in producer organization and cooperative, their income will have increased by ₦37,315 naira but they have participated in producer organization only, their income will have increased by ₦106,575 naira. It is worth noting that non-adopters would have benefited in terms of higher incomes had they participated in organization with highest payoff been realized from participation in producer organization only.

Table 3: MESR based average treatment effects of participating in organizations on household welfare: ATU

Outcome variables	Organization choice	Participating	Non-participating	Average Treatment effects on the untreated (ATU)
	(j)	(j=2,3,4)	(j=1)	
		(2)	(1)	3=2-1
Income	Cooperative only	51544.92	48632.41	2912.501
	Cooperative and producer organization	85948.26	48632.41	37315.84*** (5305.555)
	Producer organization only	155207.7	48632.41	106575.3** (58102.61)

Source: Data Analysis, 2025
Values in parenthesis are the standard error.

CONCLUSION

The findings of this study underscore the significant positive impact of participation in producer organization on the welfare of farming households in Northern Nigeria. To assess the impact of participation on the welfare of diverse household head structures, multinomial endogenous switching regression was employed. Estimating the impact of participating in producer organization on household welfare by correcting for selection bias and endogeneity originating from observed and unobserved heterogeneity, participation in organizations significantly increases the tomato/potato yield and household income. Notably, households who engaged in any of the organization individually or simultaneously would have obtained lower benefit had they not participated. However, maximum benefits are achieved when farmers adopt producer organizations only.

Based on these findings, it is recommended that policy makers prioritize the promotion of producer organizations as a key component of welfare improvement for farming households. Specifically, interventions should focus on:

1. Raising awareness on the benefits of producer organization membership and participation especially among smallholder farmers.

2. Facilitating and institutionalizing producer organizations to ensure larger coverage, access and inclusivity.

By implementing the targeted policies to increase awareness, and effectiveness of producer organizations, stakeholders can substantially enhance the welfare of smallholder farming households and boost the goals of rural development in Nigeria.

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Social capital differentials and rural household poverty outcomes in Osun State, Nigeria

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Abstract - This study investigates the influence of social capital differentials on poverty outcomes among rural households in Osun State, Nigeria. Social capital, operationalized through dimensions such as trust, reciprocity, group membership, and access to informal networks, is increasingly recognized as a key determinant of welfare and poverty dynamics. Using cross-sectional data collected from 312 randomly selected rural households across six local government areas in Osun State, the study employs Descriptive statistics and Composite Score to construct social capital indices and applies a m descriptive analysis to assess the validation of the relationship between social capital and household poverty status. The results reveal significant disparities in social capital endowments across the households, with households possessing higher levels of bonding and bridging social capital exhibiting a lower probability of falling below the poverty line. Particularly, membership in cooperative societies, participation in community decision-making, and strong heterogeneity index were positively associated with poverty reduction. Using discriminant analysis, the model achieved a classification accuracy of 97.8%, with membership density, annual cash and labor contributions, and aggregate social capital emerging as statistically significant discriminators. The findings underscore the need for policy frameworks that strengthen rural social networks, promote inclusive community-based organizations, and integrate social capital development into rural poverty reduction strategies. Enhancing social capital could serve as a complementary tool for improving the effectiveness of conventional poverty alleviation programs in rural Nigeria.

Keynote: Social Capital, Poverty, Composite Score, discriminant analysis

INTRODUCTION

Poverty remains one of the most persistent developmental challenges Nigeria is facing, it undermines all efforts made towards economic growth, social cohesion, and human development. Jetin (2016), Boarini *et. al* (2018), Sommer (2019), Akande and Shittu (2022). Despite various policy interventions at national and sub-national levels—ranging from direct cash transfers to agricultural empowerment programs—poverty continues to affect a large portion of the population, particularly rural and semi-urban dwellers, Ruel *et. al.* (2017), Osun State, is no exception. Although the state enjoys relative political stability and a strong cultural heritage, it still struggles with high levels of income inequality, limited access to basic services, and widespread household poverty (Abiola 2019).

Traditionally, poverty analyses have emphasized economic indicators such as income, employment, education, and asset ownership (Akinbode and Hamzat 2017). However, recent scholarly and policy attention has turned to non-monetary dimensions of well-being, Anand *et. al* (2021,) among which social capital stands out as a crucial yet often overlooked determinant of poverty and livelihood outcomes. Social capital refers to the networks, norms, values, and trust embedded in social relationships that facilitate cooperation and mutual support within and among communities (Algan 2018). It is increasingly recognized as a form of capital that households can draw upon to access resources, reduce vulnerability, and enhance their socio-economic status. (Alam *et.al*. 2016, Panday *et. al* 2021)

According to Pharm and Mukhopadhaya (2022), Liu *et al* (2021) social capital is known to be very relevance to the reduction of poverty level because of its capacity to influence access to information, employment opportunities, credit, education, health services and give emotional support. In Osun State where formal institutions may be weak or insufficiently resourced , social networks which includes family ties, community associations, religious groups, and cooperative societies frequently play a central role in bridging this institutional gaps (Adewumi and Keyser 2020, Oladeji *et. al*. 2017). However, not all households have equal access to or benefit equally from these social structures. The disparities in the type, quality, and intensity of social capital across different communities and households can significantly influence their poverty outcomes.

Furthermore, social capital manifests in different forms such as bonding which involves close ties within a group, bridging which has to do with connections across different groups, and linking which involves networks with institutions and individuals in positions of power (Claridge 2018). Each of these forms of social capital can have distinct effects on poverty levels, depending on the socio-economic and cultural context.

Despite the growing recognition of social capital in development discourse, empirical studies focusing on its relationship with poverty in specific Nigerian contexts remain limited. In Osun State, there is a noticeable gap in the literature regarding how differentials in social capital influence household poverty levels. Understanding this

relationship is crucial for designing effective and context-sensitive poverty alleviation programs that leverage existing social structures and norms.

This study, therefore, seeks to analyse the differentials in social capital among households in Osun State and examine how these disparities affect households' poverty levels. By adopting a multidimensional approach that considers the various forms of social capital and their interaction with socio-economic variables, the research aims to provide comprehensive insights into the role of social relationships in shaping household welfare though reduction in poverty level. The findings are expected to inform both academic debates and practical policy interventions aimed at reducing poverty through socially inclusive and participatory strategies using the following objectives

i. identify and describe the various dimensions of social capital available in study area.
ii. categorise households based on their poverty status and their level of social capital involvement.
iii. analyse the socioeconomic factors determining the level of social capital among the respondents.

METHODOLOGY

The study was conducted in Osun State, Nigeria. Osun State lies between latitude $8^010'$ to the North and Latitude $6^05'$ to the South. It is marked by longitude 4^0 to the West and Longitude $5^0 4'$ to the East. It lies in the equatorial rain forest belt and has a land area of 8,882.55 square kilometers and a population of 2,203,016. The State is bounded in the North by Kwara State, on the south by Ogun State, on the West by Oyo State and on the East by Ondo State. Osun State was carved out from the old Oyo State in August 1991 and has 30 local governments and one area office. The State is dominated by Yoruba ethnic group.

Agricultural activities follow the traditional system of mixed cropping. The favourable condition made the state to be agrarian, suited for the production of permanent crops such as cocoa, kola nut, oil palm as well as arable crops like yam, cassava, etc. Majority of the households in the State are predominant small-scale farmers that still depend on traditional method of farming. Besides farming, the inhabitants also engage in other occupations like trading, manufacturing and commerce. In all these farming and other livelihood activities, benefits are also derived through social capital membership.

This study employed a multistage sampling technique to select the respondents. Osun State has been stratified into three ADP (agro ecological zones): Ife/Ijesha, Iwo and Osogbo zones. These strata were selected in the first stage of sampling. In the second stage, primary sampling units (PSU) were used to select local Government areas based on sample proportionate to size.

Each of the three ADP zones is made up of ten local government areas. Therefore, because of cost and time, two local Governments (20%) were randomly selected from each zone. In the third stage, secondary sampling units (SSU) were used to select localities/rural communities per selected local government with equal probability of selection. Three 315 respondents were selected from the various rural areas in the State, out of which 312 were cleaned and used for the study.

Descriptive statistics was used to analyse the first objective of this study which was to identify the dimensions of social capital among respondents in the study area. The descriptive analysis includes the use of frequency distribution, mean, median, average, percentage. The information collected from their cash contribution, labour contribution, meeting attendance, participation in decision making etc. were used to generate heterogeneity index, membership density, decision making index and the aggregate social capital.

The aggregate social capital was arrived at through the construction of a multiplicative index of the three social capital dimensions (which have always been indicated in the literature) density of association, internal heterogeneity and active participation in decision making.

Descriptive analysis was also used categorize household based on their poverty status. It includes the use of mean, percentage etc.

The three main approaches to household poverty measurement according to Muellbauer (1980) are estimation of true indices of poverty, total household expenditures and full income concept.

This study adopted household total expenditure as a measure for household poverty considering the advantage of less required data and the fact that getting the actual total income of farming household may not be possible. The approach has been extensively used in various similar studies, Okunmadewa et al. (2007), Yusuf (2008) Adepoju et.al (2012), Heshmati (2019). This is the household monthly expenditure on food and non-food items which include consumed household's own production. Data collected from monthly expenditure on food items, clothing, electricity/telephone bills, education, health facilities, water, and monthly remittance etc. and their household sizes were used to generate their per capita expenditure (PCE). The mean PCE was generated by dividing the per capita expenditure by the number of respondents. One-third and the two-third of mean was generated which was used to categorise households into three categories of poverty level; core poor, moderately poor and the non-poor. Respondents that fall below one third of

PCE are core poor, those that fall in between the range are the poor category. While those that fall above two-third PCE are the non-poor.

Most studies have adopted a rather arbitrary and variable method of defining the poverty line on the basis of which poverty is profiled for Nigeria. For example, Aigbokhan (2000), Canagarajah *et al.* (1997), and Federal Office of Statistics (FOS, 1999, 1999b) all adopted ratios (one-third and two-thirds) of mean income/expenditure as a basis for defining the poverty line. The limitations of this approach in tracking poverty are now well known. For example, having a particular level of income/expenditure is not a sufficient indicator of the level of welfare to define the poverty line. More important is how that amount is spent in determining the level of poverty and ability to undertake economic activity. Recognition of this fact has led to adoption of consumption-based approaches to defining the poverty line.

Composite Score was used to measure the categories of household based on their levels of involvement in their various social groups. The composite score was earlier used by Yekinni (2007) and Adepoju *et al* (2013), Kim *et.al* (2015). Respondents were made to respond to questions relating to the number of associations to which they belong and their level of involvement. This was used to generate their membership density.

Membership density of the respondents and their standard deviation were used to categorise household into the level of social capital participation. Membership density was calculated by dividing the number of associations of each respondent is involved in by the total number of associations available. The mean of the observation was generated. The mean was calculated to be 0.223, while the standard deviation of the observation is 0.042.

Level 1 = 0 (no membership) – (mean –SD)

Level 2 = values between 1and3

Level 3 = mean + S.D – 6 (maximum membership for households)

Discriminant analysis was used to analyse the factors responsible for the differences in the level of social capital and poverty among the households. Households were earlier categorised into three levels of social capital and poverty, the separation in the levels of social capital is expressed in terms of variability among the group means on the variable Z. In this study, variables which describe households' socio-economic, demographic, farm and farming characteristics were included in the discriminant analysis as independent variables. The *a priori* expectation is that the variables would contribute significantly towards discriminating between the households and social capital categories. Though the present study has been conceived to critically look into the social capital and poverty differentials, it is important to study the characteristic factors and features of the households which are related to the likelihood of respondents to belong to one of the social capital and poverty groups. This *a priori* expectation is based on some relationships between the social capital groups and these variables.

Some of the exogenous variables that are thought to discriminate between the social capital groups include age, education, household size, whether a household head holds a leadership position in the community or not, farm size, total land and asset owned, access to extension, wealth index. The variables hypothesized to determine poverty include household size, monthly expenses on food, clothing, electricity bill, education, kerosene and gas, monthly remittance etc. The membership density of household was used to categorise household into three social capital groups based on their level of involvement: level one (low level) two (intermediary) and three (high level). Poverty level is categorised into core poor, poor and non-poor. This was previously used by various researchers like Campos *et.al.* (2015), Campos (2023)

Discriminant functions were estimated by maximizing the ratio of between-group to within-group variance using the following linear form:

$$D_J = a + b_1X_1 + b_2X_2 + \ldots + b_kX_k$$

Where D_J is the discriminant score for group j are the predictor variables, X_1, X_2, ……X_k and $b_1, b_2 \ldots b_k$ are the discriminant coefficients. The numbe r of discriminant functions generated is the lesser of g−1 and k, where gis the number of groups and k is the number of predictors.

RESULTS AND DISCUSSION
Socioeconomics characteristics of households

Socioeconomic characteristics of the households presented in Table 1 shows that the mean age of the household in the study area is 42.3 years. This showed that higher proportion of the sample household are in their active and productive age. Also, the average year of education of the households is 10.53 years, the average family size is 6, 54 percent are male while 59 percent are married. Their primary occupation includes farming, Artisans, Civil service, Transportation services and contractor, which reveals all the respondent have good and stable sources of income.

Table 1: Household's Socio-Economic Characteristics

Variables	Frequency	Mean	Std. Deviation	Minimum	Maximum
Age (yrs)					
<30	67(21.47)	42.30	11.86	24	85
31- 40	106(33.97)				
41 -50	83(26.60)				
51- 60	32(10.26)				
> 60	24 (7.70)				
Education status					
0-6	51(16.05)	10.54	3.85	0	20
7-12	177(56.73)				
13-17	73(23.40)				
≥18	11(3.53)				
Household size					
1-4	29 (9.30)	6.730	1.93	2	13
5-12	229(73.40)				
13-17	53(17.00)				
≥18	1(0.30)				
Sex					
Female	143(45.83)				
Male	169(54.17)				
Marital status					
Married	184(58.97				
Not married	128(41.03)				
Primary occupation					
Farming	92(29.48)				
Artisanship	62(19.87)				
Civil service	40(12.82)				
Trading	71(22.76)				
Transportation	13 (4.17)				
Contractor	34(10.90)				

Source: Authors computation from 2023 field Survey

Dimensions of social capital

Six dimensions of social capital were the focus of this study: decision making, membership in social capital, meeting attendance, heterogeneity, cash and labour contribution (Table 2). Sixty-five percent of the respondents belong to three to four social groups: 33.97 percent falls in between the range of 5-6 social groups. 60.58 percent of the respondents participate in over 80 percent decision made in their social groups, while 10 percent make less than 40 percent participation in decision making.

The heterogeneity index for an average household to is 28 percent. Seventy-one percent of households fall between 21 to 40 heterogeneity indices. Average meeting attendance of the households is 57 percent. Only 5 percent have less than 40 percent meeting attendance index, and 0.32 percent of the respondents was above 80 percent of meeting attendance index among the respondents. 5 percent of the households contributed less than ₦50,000 as annual contribution in their social groups. Only 1.3 percent of the households contributed above ₦200,000 as annual contribution. The average amount of money the respondents contributed was ₦99,030 as annual contribution to their various social groups.

The average labour contributed annually to their various social groups is 49.8 man-days, about 30.45 percent contributed 40-50 man-days of labour annually. About 1 percent (0.96) contributed less than 20 man-days of labour annually. About 12 percent (12.1) percent contributed above 60 man-days annually to their social group. The average social capital index is 31percent, 27.2 percent have less than 20 percent social index, while 0.32 percent have over 60 percent social capital index.

Table 2: Household's Social Capital Dimensions

Social capital	Frequency	Mean	Std. Deviation	Minimum	Maximum
Membership in social group					
≤ 2	3(1.00)	4.30	0.80	1	6
3-4	203(65.00)				
5-6	106(34.00)				
Decision-making index					
21-40	33(10.57)	61.76	14.00	23.33	84.44
41-60	76(24.36)				
61-80	189(60.58)				
>80	14 (4.49)				
Heterogeneity index					
≤ 20	67(21.50)	28.18	8.82	10.00	63.30
21-40	223(71.50)				
41-60	21(6.70)				
61-80	1(0.30)				
Meeting attendance index					
21-40	17(5.45)	57.45	7.88	28.33	82.82
41-60	182(58.33)				
61-80	112(35.90)				
>80	1(0.32)				
Annual cash contribution (₦)					
<50000	16(5.13)	99030.84	28820.12	36000	186000
50001-100000	144(46.15)				
100001-150000	147(47.11)				
150001-200000	5(1.60)				
Annual labour contribution					
<30	20(6.41)	50.00	14.21	12	96
31-40	80(25.64)				
41-50	96(30.77)				
51-60	78(25.00)				
>60	38(12.18)				
Aggregate social capital index					
<20	85(27.20)	31.30	15.50	2	82.5
20-39	121(38.80)				
40-59	105(33.70)				
>60	1(0.30)				

Source: Author's Computation, field Survey, 2023

Categorisation of households according to their social capital level.

The distribution of households based on their level of social capital is shown in Table 3. Households were categorized based on the number of associations they engaged in using composite score. Households with the highest membership density was categorized as upper category while households with the lowest membership density represent the lower category. However, households that fall in between these two categories were tagged in the middle category. The membership density of the respondents was generated by adding together the number of associations the respondents belong to. The mean of the membership density is 0.2239 while the standard deviation is 0.0421. The levels were then put into three categories as used earlier used by Yekini (2007), Salimonu (2007) and Adepoju (2011).

Table 3: Distribution of Households' level of Social Capital

Social Capital Level	Frequency	Percentage
Level 1	42	13.46
Level 2	251	80.45
Level 3	19	6.09
Total	312	100.00

Source: Author's Computation from 2023 field survey

Level three or upper category = Mean + SD to 1.0 that is between 0.259 to 0.315
Level two or middle category = between lower and upper category limit = 0.265 to 0.1818
Level one or lower category = 0 to (Mean –SD) = 0 to 0.1817

Level two has highest percentage (80.45), level one has 13.46 percent. Level three has the least percentage (6.09). Majority of the respondents in the study area belong 2.

Categorisation of household according to their Poverty status

Table 4 shows the distribution of the respondent based on their poverty status Households were categorised into three poverty levels based on the measure of per capita expenditure (PCE) on food and non-food items. The PCE was generated by dividing each household monthly expenditure on food, clothing, rent allowance, toiletries, education, fuel, kerosene and gas, electricity bills, water expenditure and other expenses by their household size. The mean PCE for the sampled households in the study was also generated with a value of ₦51,210.98.

One-third and two-third of the mean PCE was generated and used to categorise the households into three poverty levels. These are the core poor, moderately poor and the non-poor. Respondents spending below one-third of the mean PCE which is ₦17,070.32 are the core poor, the moderately poor are those that spend between the one third and two-third of the mean PCE while the non-poor are the respondents spending above two-third of the Mean PCE. This approach was earlier used Yusuf 2007 and Balogun 2010

Core poor = below 1/3mean PCE = below ₦17,070.32
Moderately poor =between 1/3 and 2/3 of Mean PCE = Between ₦17,070.32 and ₦34,140
Non poor = ₦34,140 and above. The core poor household accounted for (5.77 percent) of the total respondents with the mean of ₦13,120.19. The poor households have (30.13 percent) of the respondents with mean of ₦25,930.25. The non-poor accounted for (64.10 percent) of the total respondents. They have the mean of ₦25,930.25. The respondents that are non-poor according to this study are above average. (₦51,210.98)

Table 4: Distribution of respondents' poverty status

Poverty status	Frequency	Percentage	Mean PCE (₦)
Core poor	18	5.77	13,120.19
Moderately Poor	94	30.13	25.930.25
Non poor	200	64.10	66,530.35
Total	312	100.00	105,580.79
Mean PCE	N51,210.98		

Source: Author's Computation from 2023 Field survey.

Social capital dimensions of respondents in relation to their poverty status.

The social capital dimensions of respondents in relation to their poverty level of household is presented in Table 3. Respondents in the core poor category have the highest membership density of 23.10 percent while the households that are moderately poor have the lowest membership density of 21.90 percent. The average meeting attendance for the three categories are above average with the highest mean average of 60.33 percent and 57.16 percent in the core poor and the non- poor categories respectively. The mean value of the households meeting attendance reduces as their poverty level reduces. This means that the wealthier the households are the less the meeting they attend.

Households in the non-poor category have the highest (62.84) percent of decision making, while the households in the core poor category have the lowest average (61.29) percent in decision making. This shows that poor household rarely participate in decision making in their various social groups. All the households in the three categories of poverty have low membership diversity. However, the core poor category has the highest level of membership diversity of 30.09 percent, while the second category has the least level of diversity of 25.96 percent.

However, households in the core pore category have the highest average of annual cash contribution of ₦101,660, while the poor category have the least average value. The moderately poor category has the highest mean value of 49.91 man-days as annual labour contribution. The core poor category has the least mean value of 44.66 man-days. Lastly, the highest aggregate social capital index is found in the moderately poor category, while the core poor has the least average (29.20 percent).

Table 5: Distribution of households' social capital dimensions in relation to their poverty status

Social capital dimensions	Core poor	Poor	Non-poor
Membership index			
Average	23.10	21.90	22.52
Minimum	3.0	1.0	2.0
Maximum	60.0	50	67.5
Standard deviation	9.78	8.46	7.54
Meeting Attendance index			
Average	60.33	57.73	57.16
Minimum	13.33	28.33	30.41
Maximum	43.33	70.00	82.82
Standard deviation	5.05	7.45	8.18
Decision-making index			
Average	61.30	61.70	62.84
Minimum	34.44	28.88	23.33
Maximum	84.44	84.44	84.44
Standard deviation	13.64	13.63	14.09
Heterogeneity index			
Average	30.09	25.96	27.97
Minimum	13.32	10	10
Maximum	43.33	63.63	50.00
Standard deviation	8.01	9.19	8.72
Cash contribution (₦)			
Average	101,660.67	98,230.40	99,320.35
Minimum	36,000	36,000	48,000
Maximum	150,000	144,000	186,000
Standard deviation	30270.90	27000.5	294300.12
Labour contribution (man-day)			
Average	44.66	49.91	49.70
Minimum	12	12	12
Maximum	72	84	96
Standard deviation	16.87	15.67	15.35
Aggregate Social Capital			
Average	29.19	32.72	31.07
Minimum	6	6	2
Maximum	55.86	59.89	83.50
Standard deviation	29.19	15.71	15.45

Source: Author's computation from 2023 Field survey

Description of households based on social capital level in relation to socioeconomic variables and poverty status

Table 4 presents the description households' socio-economic characteristics and poverty status in relation to their social capital level. 19.06 percent of the households in level are below 30years of age, while 22.31 percent of the households in level two are below 30 years. Only 15.80 percent of the households in level three social capital level are below 30 years. Also, 2.38 percent of the households in level one is above 70 years, 1.99 percent of the households in level two are above 70 years, none of the respondent in level three of social capital is above 70 years old.

Furthermore, 2.38 percent of the households in level one has no formal education; 1.20 percent in level two has no formal education.

2.38 percent of the households in level one has above 18 years of formal education. Only 3.19 percent of those in level two have above 18 years of formal education, 10.52 percent of the households in level three have above 18 years of formal education. It could be deduced that the level of education affects the level of social capital involvement.

Consequently, 2.38 percent of the households in level one has family size above 12. Female households have a greater percentage than male in level one while in level 2 and 3 males have a greater percentage than the female respondents. The households in the non-poor category have a greater percentage in social capitals one and two. From the results, it could be deduced that socio-economic characteristics of respondents affect their social capital level.

Table 6: Distribution of Household based on social capital level in relation to socioeconomic variables and poverty status

Variables	Level 1	Level 2	Level 3	Total
Age(yrs)				
<30	8(19.06)	56(22.31)	3(15.80)	67(21.47)
31- 40	14(33.33)	85(33.86)	7(36.84)	106(33.97)
41 -50	14(33.33)	61(24.30)	8(42.10)	83(26.60)
51- 60	1(2.38)	31(12.35)	0(0.00)	32(10.26)
61- 70	4(9.52)	13(5.18)	1(5.26)	17(5.77)
> 70	1(2.38)	5(1.99)	0 (0.00)	6(1.92)
Education (years)				
0	1 (2.38)	3 (1.20)	0 (0.00)	4(1.28)
1- 6	8(19.06)	36(14.34)	3(15.80)	47(15.06)
7-12	25(59.52)	140(55.77)	12(63.16)	177(56.73)
13-17	7(16.67)	40(15.94)	4(21.05)	51(16.35)
≥18	1 (2.38)	8(3.19)	2(10.52)	11 (3.52)
Household size				
1-4	3 (7.14)	26(10.36)	0(0.00)	29(9.30)
5-8	31(73.81)	185(73.70)	15(78.95)	231(74.03)
9-12	7(16.67)	40(15.94)	4(21.05)	51(16.35)
≥12	1(2.38)	0(0.00)	0(0.00)	1(0.32)
Sex				
Female	22(52.38)	111(44.22)	9(47.37)	142(45.51)
Male	20(47.62)	140(55.78)	10(52.63)	170(54.49)
Marital status				
Married	18(42.86)	151(60.16)	10(52.63)	179(57.37)
Not married	24(57.14)	100(39.84)	9(47.37)	133 (42.63)
Primary occupation				
Farming	8(19.05)	74(29.48)	14(75.68)	96(30.77)
Artisan	13(30.95)	51(20.32)	1 (5.26)	65(20.08)
Civil service	1(2.38)	38(15.14)	2(10.52)	41(13.14)
Trading	10(23.31)	52(20.72)	2(10.52)	64(20.51)
Transportation	3(7.14)	11(4.38)	0(0.00)	14 (4.49)
Contractor	7(16.67)	25(9.96)	0(0.00)	32(10.25)
Poverty status				
Core poor	4(9.52)	12(4.78)	2(10.53)	18 (5.77)
Poor	15(35.72)	74(29.48)	5(26.31)	94(30.31)
Non poor	23(54.76)	165(65.74)	12(63.16)	200(64.10)
Total	**42**	**251**	**19**	**312(100**)

Source: Author's computation from 2023 field survey.
Figure in parentheses are percentage

Validation of the categorisation of the levels of social capital

The result of the discriminant analysis as shown in Table 7 shows that the typologies i.e. grouping of the respondents into three groups based on the levels of their involvement in social capital group which are levels one, two and three respectively. The grouping of the respondents into the three levels was effective, in that 97.8% of the respondents were correctly placed into the respective social capital levels they belong to even in the first iteration. It could be seen from the Table 7 that all households in level one was correctly placed in their group. In level two, out of 251 households, 244 or 97.2% were correctly grouped while seven households 2.8% who ought to be in level three were wrongly placed in level two. All the households in level three were correctly placed.

Table 7: Distribution of Classification of respondents' social capital differences

Social capital level	Predicted group membership			Total
	Social capital level 1	Social capital level 2	Social capital level 3	
Original count				
Level 1	42	0	0	42
Level 2	0	244	7	251
Level 3	0	0	19	19
Total	42	244	26	312
Percentage				
Level 1	100.0	0	0	100.0
Level 2	0	97.2	2.8	100.0
Level 3	0	0	100.0	100.0

Note: 97.8% of original group cases correctly classified.
Source: Author's computation from 2023 field survey.

Wilk's Lamba statistics and level of significance

Table 8 shows Wilk's lamba statistics and level of significance of discriminating variables (with 2 and 309 degrees of freedom). Five variables emerged as statistically significant discriminators across the three social capital levels. Total expenditure of household was significant at $p<0.10$, membership density, annual cash contribution, annual labour contribution were significant at $p< 0.01$ while aggregates social capital of households was significant at $p<0.05$. In contrast, key socio demographic variables such as sex, age, household size, marital status, and years of education did not significantly discriminate between the levels of social capital. These findings suggest that behavioral and participatory attributes are more decisive in determining the depth and quality of household engagement in social capital networks rather than demographic factors.

Table 8: Test of equality of group means

Variable	Wilk's Lamba	F	df1	df2	Significant
Sex	.996	.667	2	309	.514
Age	1.000	.016	2	309	.985*
Age squared	1.000	.066	2	309	.936
Household size	.998	.332	2	309	.717
Marital status	.996	.627	2	309	.535
Education year	.992	1.304	2	309	.273**
Total expenditure	.980	3.087	2	309	.047***
Membership density	.314	333.706	2	309	.000*
Heterogeneity index	.998	.365	2	309	.695
Meeting attendance index	1.000	.005	2	309	.995
Decision making index	.998	.247	2	309	.781
Annual cash contribution	.752	51.068	2	309	.000*
Annual labour contribution	.869	23.304	2	309	.000*
Aggregate social capita index	1.971	4.550	2	309	.011**

*significant @1%level **significant @5% level ***significant @10% level
Source: Authors computation from field survey 2023

CONCLUSION AND RECOMMENDATION

The study revealed that social capital involvement helps reduce poverty, there is therefore needed to encourage social capital involvement among rural households. The study revealed that the households in the study area have a relatively high household size. This tends to increase the level of household per capita expenditure and hence increase household poverty. It is recommended that birth control campaign should be promoted among the rural households in the study area. Since most rural household see large family size as being consistent with adequate family labour, labour saving device should be put in place when birth control device control campaign is being promoted.

The involvement of education in social organization helps the organization and hence improves the poverty level of rural households. However, this may pose some difficulties since the average education level in the study area is 10 years. It is therefore very imperative for government to render further assistance to rural households in better funding of their children's education and organize adult education for the older ones. Osun state Government is in the vanguard of free education but there is need for proper enlightenment

to enable more children in the rural setting to understand the need to be educated.

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Determinants of food security status among farming households in Oriire local government area, Ogbomoso Oyo state

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Abstract - Food insecurity remains a major development challenge in Nigeria, particularly among rural farming households. This study analysed the determinants of food security status and assessed the extent of food insecurity among farming households in Oriire Local Government Area, Oyo State. Primary data were collected from 150 farming households through a multistage sampling technique and analysed using descriptive statistics, the Foster–Greer–Thorbecke (FGT) technique, and a Logit regression model. Results showed that the average age of household heads was 41 years. Most of the respondents were male (61%), married (54%), with a mean household size of five persons. About 41% had tertiary education, farming experience averaged nine years, and the mean farm size was 1.06 hectares. Average monthly income was ₦80,320, while mean monthly food expenditure was ₦64,873, representing a large share of household income. The FGT analysis revealed that 51.7% of households were food insecure, with a depth of 22.7% and severity of 12.5%. The Logit regression identified years of schooling, household size, income, and farming experience as significant determinants of household food security. Specifically, education, income, and farming experience improved food security, while larger household sizes reduced it. The study concludes that food insecurity in Oriire LGA is both widespread and severe, even among food-producing households. It recommends policies that expand access to education and extension services, promote income diversification, strengthen social protection measures, encourage family planning, and support farmers with improved technologies and training to enhance productivity and resilience.

Keywords: Food security, determinants, farming households, Oriire LGA, Nigeria

INTRODUCTION

One of the most pressing challenges globally is how to ensure sufficient food supply for more than seven billion people (Ayinde *et al.,* 2020). Food security is a multifaceted and dynamic concept comprising various dimensions, including availability, affordability, accessibility, consumption, utilisation, and stability (Roosevelt *et al.,* 2023). Malnutrition and inadequate diets can result in poor health, reduced productivity, and adverse social outcomes which further reinforce the importance of food security. At the household level, adequate intake of safe and nutritious food is fundamental for a healthy and productive life, while at the national level, food security underpins political stability and economic development (Ogunniyi *et al.,* 2020; Omotayo, 2020).

The Food and Agriculture Organization (FAO) (2023) defines food security as a situation in which 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. Despite this recognition, hunger and malnutrition remain widespread. The FAO's State of Food Security and Nutrition in the World Report (2023) estimates that around 735 million people globally faced hunger in 2022, while more than two billion experienced moderate to severe food insecurity. In Nigeria, the burden is particularly severe.

The World Food Programme (WFP, 2025) reports that about 30.6 million Nigerians are currently facing acute food insecurity. This is supported by the National Bureau of Statistics (NBS) (2023), which found that 62.4% of Nigerian households are unable to afford sufficient and nutritious food. Projections by the Famine Early Warning Systems Network (FEWS NET) (2024) indicate that food insecurity will likely worsen between 2024 and 2025, driven by rising food inflation, conflict, and climate-related shocks. These alarming figures highlight the paradox of a country with vast agricultural potential still struggling to guarantee adequate food access for its population. The 2024 Global Hunger Index (GHI) places Nigeria 110th out of 127 countries, signaling a "serious" hunger level (GHI, 2024). Moreover, rapid population growth projected to reach 400 million people by 2050 further aggravates the challenge of ensuring adequate food supply (Otekunrin *et al.,* 2019; Amzat and Aminu, 2020).

The availability of food depends on factors determined by the demand side, while the supply side determines factors contributing to the access to food. As a result, factors that trigger variations in both the demand and the supply of food would additionally influence the availability and access to food, respectively. This eventually results in food insecurity (Bashir and Schilizzi, 2013). Food insecurity at the household level is related to several factors, including poverty, low income, level of

education, household size, employment status, age, the type of household head (gender) and food price (Ihab *et al.,* 2015). Understanding the characteristics and determinants of household food insecurity is crucial to developing policies that address the challenges associated with household hunger and food insecurity (Ihab *et al.,* 2015).

Although rural households are directly engaged in food production, farming households often spend a significant share of their limited income on food purchases, leaving them vulnerable to rising prices and production shortfalls. Household-level factors such as income, education, household size, farm size, and farming experience have been shown to influence food security outcomes in Nigeria (Onasanya and Obayelu, 2016; Wudil *et al.,* 2023; Oduntan, 2024). Several recent studies have examined food security among Nigerian farming households, but their findings highlight strong contextual differences. For instance, household size, education, and credit access shaped outcomes among vegetable women producers in North-West Nigeria (Maharazu *et al.,* 2024), while education reduced food insecurity, but household size worsened it among cassava farmers in Oyo State (Babarinde *et al.,* 2024). Similarly, credit access, marital status, education, farm size and farming experience were key drivers of food security for rice farmers in Ebonyi (Fasakin *et al.,* 2024), gender, age and occupational patterns influenced food security in Kogi (Shaibu *et al.,* 2023), and farm size and gender were key for plantain-producing households in Edo (Ozor *et al.,* 2023).

While these studies provide valuable insights, they are often crop-specific, commodity-focused, or occupation-based, and therefore do not capture the broader farming population at the household level within local government areas. Yet, local-level analyses are crucial because interventions and policies in Nigeria are frequently implemented through local government structures. Moreover, most existing studies rely on pre-2024 data, limiting their ability to account for recent shocks such as persistent food inflation, climate variability, and heightened rural insecurity, all of which have intensified food insecurity. This study therefore contributes to filling this gap by providing updated, household-level evidence on the determinants of food security status among farming households in Oriire Local Government Area of Oyo State. By employing the Foster–Greer–Thorbecke index alongside regression analysis, it offers a more comprehensive assessment of both the incidence and drivers of food insecurity in a typical rural farming community. This study focuses on three objectives:

1. Describe the socioeconomic characteristics of farming households in the study area.
2. Determine the food security status of farming households in the study area
3. Examine the determinants of food security status among farming households in the study area.

METHODOLOGY

This study was conducted in Oriire Local Government Area (LGA) of Oyo State, Nigeria. The headquarters of the LGA are in the town of Ikoyi and the LGA is made up of several towns and villages such as Afekulu, Ikoyi ile, Igboroko, Mosumoje, Onimangoro, Oolo, Olokomeji, Gbemiro, and Alokomanro. Oriire is predominantly agrarian, with most households engaged in crop production and livestock rearing for subsistence and income (Manpower, 2023). The area lies within the derived savannah agro-ecological zone, characterized by a bimodal rainfall pattern and fertile soils that support the cultivation of crops such as yam, maize, cassava, and legumes (Manpower, 2023). The population consists largely of smallholder farmers, and agriculture remains the main source of livelihood, making the area suitable for investigating the link between food expenditure and household food security.

A multistage sampling procedure was adopted for selecting respondents. In the first stage, six communities were purposively selected from Oriire Local Government Area based on preliminary reports from agricultural extension officers indicating high densities of farming households. The communities selected were Abaja, Ajegunle, Alapamowo, Maya, Elebe, and Ikoyi-Ile. In the second stage, within each of these six communities, 25 farming households were randomly selected, resulting in a total sample size of 150 households. This approach ensures even representation and allows comparative community-level insights. The unit of analysis is the household head, because resource allocation, food purchasing, and consumption decisions are largely influenced by the head of the household in these rural settings.

Primary data were collected through a structured questionnaire administered to household heads. Information gathered covered respondents' socioeconomic characteristics (age, sex, marital status, education, household size, farm size, farming experience, and income), food and non-food expenditure patterns, and food security indicators. The food security measures included meal frequency, dietary diversity, food and non-food expenditure shares, and coping strategies during food shortages. The instrument was adapted from the Household Food Insecurity Access Scale (HFIAS) and related survey modules to ensure reliability and comparability.

Data were analysed using both descriptive and inferential methods. Descriptive statistics,

including means, percentages, and frequency distributions, were used to summarize household characteristics and expenditure patterns. To examine food security status, the Foster–Greer–Thorbecke (FGT) technique was employed. This technique decomposes food insecurity into incidence, depth, and severity. According to Foster, Greer, and Thorbecke, (1984), FGT technique is expressed as:

$$P_\alpha = \frac{1}{N} \sum_{i=1}^{q} \left(\frac{z - y_i}{z}\right)^\alpha$$
$$\alpha = 0, 1, 2$$

where:

- $P\alpha$ = food insecurity measure,
- N = total number of households,
- q = number of food-insecure households,
- z = food security line,
- y_i = food expenditure (or per capita food expenditure) of the ith household,
- α = 0, 1, 2 represent incidence, depth, and severity of food insecurity respectively.

To examine the determinants of food security, logit regression model was used, which was expressed as:

$$\ln\left(\frac{P_i}{1 - P_i}\right) = Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \mu_i$$

where:

- P_i = probability that the ith household is food secured,
- Y_i = Household food security status (1 = food secure; 0 = food insecure)
- $X_1 \ldots X_n$ = socioeconomic characteristics (age, sex, marital status, household size, years of schooling, farm size, farming experience, and income),
- β_0 = constant term,
- β_n = estimated parameters,
- μ_i = error term.

RESULTS AND DISCUSSION
Socioeconomic characteristics

Table 1 presents the socioeconomic characteristics of the respondents. The results show that the average age of household heads was 41 years, with nearly 53% of respondents below the age of 40. This indicates that the farming population in the study is relatively young and economically active. Similar findings by Wudil *et al.,* (2023) in Kano State reported a mean age of 40 years among farmers, reinforcing the idea that agriculture in Nigeria is largely sustained by young to middle-aged adults. The gender distribution reveals that 61% of respondents were male, while 39% were female. This male dominance in farming aligns with studies showing that men typically control land, inputs, and decision-making in Nigerian rural communities (Ogunniyi *et al.,* 2020).

The result also shows that a majority (54%) of the respondents were married, which may positively influence household labor supply and resource pooling. Household size averaged 5 members, with most households (62.7%) having between 4 and 6 members. Larger households generally face higher food requirements, potentially leading to increased food expenditure and greater vulnerability to food insecurity. This observation supports the findings of Amao *et al.,* (2023), who noted that larger households in Nigeria tend to allocate a greater share of income to food.

In terms of education, 41% of the respondents had tertiary education, while 25% had no formal education. Education is an important determinant of agricultural productivity, income diversification, and nutrition awareness. The relatively high share of tertiary-educated respondents is encouraging, as it suggests potential for better decision-making in resource allocation. Farm characteristics show that respondents cultivated an average of 1.06 hectares, confirming the dominance of smallholder farming. About 58% operated on ≤1 hectare, a constraint that limits economies of scale and income generation. Farming experience averaged 9 years, with 40% of farmers having less than 5 years' experience. Limited experience, coupled with small farm sizes, could reduce household resilience to shocks.

From the findings, the average monthly income was ₦80,320, while mean monthly food expenditure stood at ₦64,873, representing roughly 81% of income. This suggests that many households in the study area are highly food-expenditure dependent and therefore at greater risk of food insecurity.

Food security status of farming households

Table 2 shows the food security status of farming households using the Foster–Greer–Thorbecke (FGT) index. The results reveal that 51.7% of households were food insecure, meaning more than half of the farming households in Oriire LGA were unable to meet the minimum food security threshold. The incidence rate of 51.7% in Oriire LGA is comparable to findings by Osabohien *et al.,* (2020), who reported that over 50% of Nigerian households face food insecurity, and by Otekunrin *et al.,* (2019), who noted worsening vulnerability among rural households due to rising population pressure. The depth of food insecurity (22.7%) indicates the average shortfall in food consumption among the food-insecure households relative to the food security line. This suggests that, on average, food-insecure households would need at least 22.7% of the food security line to escape food insecurity.

Table 1: Distribution of respondents by socioeconomic characteristics

Characteristics	Frequency (n =150)	Percentage	Mean
Sex			
Male	91	60.67	
Female	59	39.33	
Age (Years)			41
≤ 30	36	24.00	
31 – 40	43	28.67	
41 – 50	30	20.00	
51 – 60	26	17.33	
Above 60	15	10.00	
Marital Status			
Single	33	22.00	
Married	81	54.00	
Widowed	16	10.67	
Divorced	20	13.33	
Household Size			5
≤ 3	22	14.67	
4 – 6	94	62.67	
Above 6	34	22.66	
Educational Status			
No Formal Education	38	25.33	
Primary Education	21	14.00	
Secondary Education	29	19.33	
Tertiary Education	62	41.33	
Farm Size (hectare)			1.06
≤ 1	87	58.00	
1.1 – 2	44	29.33	
Above 2	19	12.67	
Farming Experience (Years)			9
≤ 5	60	40.00	
6 – 10	42	28.00	
11 – 15	22	14.67	
16 – 20	14	9.33	
Above 20	12	8.00	
Monthly Income (N)			80,320
≤ 50,000	54	36.00	
51,000 – 100,000	47	31.33	
101,000 – 150,000	29	19.33	
Above 150,000	20	13.33	
Food Expenditure (N)			64,873.33
≤ 25,000	14	9.33	
26,000 – 50,000	54	36.00	
51,000 – 75,000	24	16.00	
76,000 – 100,000	34	22.67	
Above 100,000	24	16.00	

Source: Field Survey, 2025

The severity index (12.5%) reflects the inequality among food-insecure households, showing that the burden of food insecurity is disproportionately heavier among the poorest households. This further highlights the structural vulnerability of farming households in Oriire. These values suggest that food insecurity in the area is not only widespread but also intense, with many households facing severe deficits that push them deeper into deprivation. This aligns with Engel's law, as confirmed earlier in the regression analysis, where large household sizes significantly increased food expenditure but did not guarantee food security.

Table 2. Food security status of farming households in Oriire LGA (FGT Index)

Food Security Measure	Value
Incidence of food insecurity (Headcount ratio, P_0)	0.517 (51.7%)
Depth of food insecurity (Poverty gap, P_1)	0.227 (22.7%)
Severity of food insecurity (Poverty severity, P_2)	0.125 (12.5%)

Source: Field Survey (2025)

Determinants of Household Food Security Status

Table 3 presents the logit regression analysis of the determinants of household food security status among farming households in the study area. The model incorporates key socioeconomic variables such as age, sex, marital status, years of schooling, household size, farming experience, farm size and household income to examine their influence on monthly food expenditure. The model was statistically significant at the 1% level (Prob > Chi² = 0.000), with a Pseudo R² of 0.396, indicating that the selected socioeconomic variables jointly explain about 39.6% of the variation in food security status among farming households.

Years of schooling had a positive and significant effect (p < 0.05), suggesting that education improves the likelihood of being food secure, likely through better knowledge of nutrition, farm management, and income diversification. Household size exerted a negative and significant influence (p < 0.05), implying that larger households are more vulnerable to food insecurity due to higher consumption requirements relative to available resources. Household income was also positive and significant (p < 0.05), confirming that higher earnings improve household purchasing power and food access. Farming experience was positively associated with food security at the 10% level, indicating that more experienced farmers are better able to cope with production and market risks. Other variables, such as age, sex, marital status, and farm size, did not significantly influence food security status, although their coefficients showed expected signs. For instance, farm size was positively related, suggesting potential benefits of larger holdings, while sex had a negative sign, hinting at possible gender-related disadvantages in achieving food security.

Overall, the results emphasize the importance of education, household size, income, and farming experience as critical drivers of food security in Oriire LGA. These findings align with previous studies in Nigeria that highlight the role of human capital and resource endowments in shaping food security outcomes (Babarinde *et al.,* 2024; Fasakin *et al.,* 2024; Maharazu *et al.,* 2024).

Table 3: Determinants of household food security status in the study area

Variable	Coefficients	Std. Err	z-value	P > {t}
Age	1.70356	0.42453	1.56	0.575
Sex	-0.43598	0.24154	-1.64	0.101
Marital status	0.42832	0.14422	1.60	0.109
School years	1.89717**	0.58160	2.23	0.026
Household size	-2.23752**	1.29877	-2.36	0.022
Farm experience	0.36338*	0.12132	1.84	0.065
Farm size	2.98776	1.75801	1.41	0.156
Household income	0.47654**	0.15587	2.05	0.045
Constant	2.46570	1.23272	1.81	0.078
Pseudo R^2 = 0.3956				
Prob > Chi^2 = 0.0000				

Source: Field Survey, 2025

CONCLUSION AND RECOMMENDATIONS

This study assessed the determinants of food security status among farming households in Oriire LGA, Oyo State. Results showed that more than half (51.7%) of households were food insecure, with considerable depth (22.7%) and severity (12.5%), despite spending over 80% of their income on food. Education, income, household size, and farming experience emerged as the most important determinants of food security. Based on these findings, the study concludes that addressing food insecurity requires both household-level and policy-level interventions.

Given the study's findings, the study recommends that

1. At the household level, improving access to education and extension services will enhance nutrition awareness and farm decision-making.
2. Income diversification through non-farm enterprises and agro-processing should be promoted to strengthen household purchasing power.

3. Family planning programs can help reduce pressure from large household sizes; and support for farmers through training, improved inputs, and climate-smart technologies will boost productivity.
4. Government and development partners should design localized food security programs at the LGA level, integrate food security objectives into rural development planning, expand social protection measures such as conditional cash transfers and food subsidy schemes, and strengthen rural credit access.

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Assessment of charcoal marketing structure and its socioeconomic and environmental effects in Maiduguri, Borno State

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Abstract - This study examined the charcoal marketing structure and its socioeconomic and environmental effects in Maiduguri, Borno State. Using a mixed-methods approach involving structured questionnaires, key informant interviews, and field observations, data were collected from 150 respondents across the charcoal value chain. Results revealed that charcoal remains the dominant cooking fuel for 54% of households, with producers capturing only 38% of final value despite bearing the highest environmental costs. Although 70% of producers are aware of environmental impacts, only 15% practice conservation measures. The study identified poorly organized value chains, arbitrary price setting, and severe environmental degradation as key challenges. Producers derive 72% of household income from charcoal activities, highlighting heavy dependence on this livelihood source. Despite environmental concerns, 68% of respondents expressed willingness to switch to cleaner fuels if affordable and accessible. The findings demonstrate weak institutional regulation and governance gaps in the charcoal market. The study recommends formalizing the value chain, supporting producer cooperatives, enforcing forest conservation measures, and promoting clean energy transitions to balance socioeconomic benefits with environmental sustainability.
Keywords: Charcoal marketing, environmental degradation, socioeconomic impact

INTRODUCTION

Charcoal remains a significant source of household energy in Maiduguri, especially in the context of prolonged insecurity and poverty that have limited access to alternative fuels such as LPG and electricity. Charcoal is a primary source of cooking energy in Maiduguri, especially among low-income households. As of 2024, over 70% of households in Maiduguri rely on firewood or charcoal for daily cooking due to limited access to LPG and erratic power supply (Chima, 2021).

The charcoal trade has economic significance in Borno State, providing livelihoods for hundreds of smallholder producers, transporters, and vendors. However, its unregulated nature contributes to widespread deforestation, inefficient production techniques, and unsustainable resource extraction (FAO, 2022). Despite this dual nature, little scholarly or policy attention has been paid to the market structure, limiting effective intervention.

Recent studies have highlighted the increasing reliance on traditional biomass for cooking in Sub-Saharan Africa, particularly in conflict-affected areas such as Northeast Nigeria (Ogundele et al., 2023a). According to the Food and Agriculture Organization (FAO, 2022), unsustainable charcoal production is a leading driver of deforestation in dryland forests. UNDP (2023a) emphasizes the urgent need for decentralised, renewable energy solutions in crisis-prone regions to reduce dependence on fuel wood.

Conflict-driven displacement, particularly from Boko Haram violence, has spurred heavy dependence on charcoal and firewood. HumAngle reports that IDPs and low-income households in Borno have significantly depleted surrounding bush areas to meet fuel needs, causing severe deforestation in Maiduguri, Jere, Konduga, and Kaga (Umar, 2025). Daily Trust estimates nearly 600 firewood truckloads enter Maiduguri daily, highlighting the scale of unsustainable fuelwood consumption (Omirin, 2024).

Aliyu and Ibrahim (2024) highlighted that even in the face of government bans, deforestation in Borno remains severe, trees are still being felled because no viable alternatives have been offered to local communities. Despite regulatory bans, illegal tree-felling persists in Borno. Blueprint (Yusuf and Musa, 2024) noted that the practice is expanding, exacerbated by rising kerosene and gas prices.

Local youth-led enterprises such as Kariye Green Bio Energy are pioneering agrarian waste-based charcoal briquettes, using cassava, rice husks, coconut shells, and banana peels (Alibe, 2024). These eco-friendly briquettes are more efficient, reduce deforestation, provide livelihoods, providing a grassroots model for decentralized energy systems and empower wyouth (Alibe, 2024; Aliyu and Ibrahim, 2024; Umar, 2025).

While direct studies are limited, successful models in Niger and Benue showed that community-led woodlot and cooperative frameworks can stabilize incomes and support regrowth (Yusuf and Bakare 2022). Field accounts provided details of women and IDPs trained in charcoal briquette production by NGOs like SPeHDI. Participants reported improved income, social purpose, and cleaner fuel alternatives (Adamu and Kaletapwa, 2023).

Charcoal marketing in Maiduguri is marked by poorly organized value chains, arbitrary price setting, low value capture for rural producers, and severe environmental degradation. Without proper knowledge of the market structure,

regulatory interventions may fail to address the core issues or may worsen socio-economic vulnerabilities. This study explored the marketing structure of charcoal in Maiduguri and evaluated its socioeconomic contributions and environmental impacts to inform sustainable energy policies and promote responsible forest management.

The study was guided by the following hypotheses:

$H_0 1$: The charcoal marketing structure in Maiduguri is characterized by poorly organized value chains where producers capture the smallest share of economic value despite bearing the highest environmental costs.

$H_0 2$: There is a significant knowledge-practice gap among charcoal producers regarding environmental conservation, with high awareness but low implementation of sustainable practices.

$H_0 3$: Households in Maiduguri demonstrate heavy dependence on charcoal for both energy needs and income generation, but express willingness to adopt cleaner alternatives if they are affordable and accessible.

$H_0 4$: The charcoal market operates with weak institutional regulation and governance gaps, contributing to unsustainable resource extraction and environmental degradation.

METHODOLOGY

The study was conducted in Maiduguri Metropolitan Council (MMC) and surrounding local government areas including Jere and selected areas of Konduga Local Government Area. The study area was chosen due to its significance as a major charcoal consumption centre and its proximity to production areas affected by conflict and environmental degradation.

A mixed-methods research design was employed, combining quantitative and qualitative approaches to provide comprehensive insights into the charcoal marketing structure and its effects. This approach enabled data triangulation for robust analysis and validation.

Data collection involved three primary methods:

1. **Quantitative data collection:** Structured questionnaires were administered to producers, transporters, retailers, and consumers across the charcoal value chain. The questionnaires captured information on demographics, income sources, pricing mechanisms, market structure, environmental awareness, and energy preferences.

2. **Qualitative data collection:** Key informant interviews were conducted with community leaders, forestry officers, NGO representatives, and market association leaders to gather in-depth insights into market dynamics, policy gaps, and governance challenges.

3. **Field observation:** Direct observation was conducted at charcoal production areas, markets, storage facilities, and transportation routes to document operational practices, market conditions, and environmental impacts.

Stratified random sampling was employed to ensure representation across different actors in the charcoal value chain. The sample was stratified into four categories: producers, transporters, wholesalers/retailers, and consumers. A total sample size of 150 respondents was selected, distributed as follows: producers (40), transporters (30), wholesalers/retailers (35), and consumers (45).

Data analysis employed multiple techniques:

1. **Descriptive Statistics:** SPSS software was used to generate frequencies, percentages, means, and standard deviations for quantitative data.

2. **Value Chain Mapping:** Visual mapping of actors, processes, and value flows to understand market structure and relationships.

3. **SWOT Analysis:** Assessment of strengths, weaknesses, opportunities, and threats in the charcoal marketing system.

4. **Environmental Impact Scoring:** Proxy indicators were used to assess environmental degradation levels associated with charcoal production and trade.

Qualitative data from interviews and observations were analysed using thematic analysis to identify key patterns and themes related to market dynamics, governance gaps, and sustainability challenges.

RESULTS AND DISCUSSION

**Charcoal value chain structure and value capture - ** The charcoal value chain in Maiduguri consists of five main actors: producers, transporters, wholesalers, retailers, and consumers. The analysis revealed a linear value chain with limited integration and coordination among actors.

Table 1: Key actors and their roles in the charcoal value chain

Actor	Role	Average price (₦/100kg bag)
Producers	Cut and carbonize wood in rural areas of Borno/Yobe State	3,000
Transporters	Transport charcoal using trucks, motorcycles, donkey carts	4,000
Wholesalers	Store and distribute in bulk to retail vendors	5,600
Retailers	Sell small bags to final consumers at roadside and markets	7,600
Consumers	End users including households, restaurants, food vendors	-

Value capture analysis showed significant disparities across the chain. Producers, who have the highest environmental and labour costs, captured only 38% (₦3,000) of the final retail value (₦7,600). Transporters captured 22% of the added value, wholesalers 15%, and retailers 25%. This distribution pattern confirms the first hypothesis (H_1) that producers capture the smallest economic value despite bearing the highest costs.
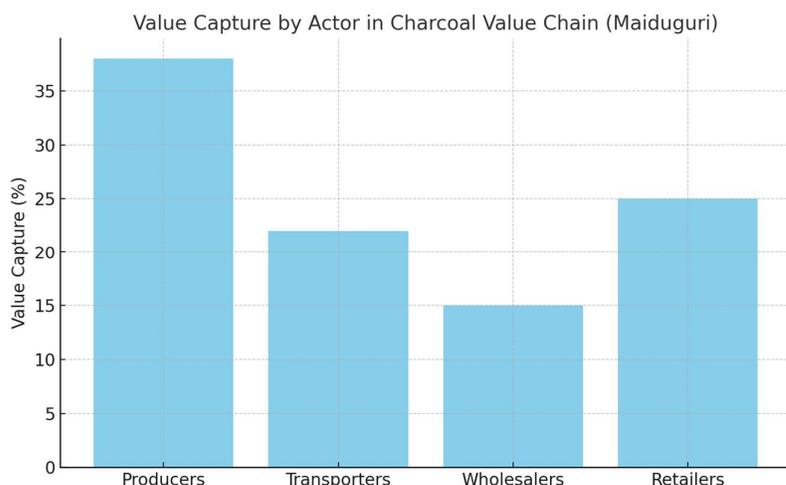
Figure 1: Value capture by actors in the charcoal value chain (Bar chart showing: Producers 38%, Transporters 22%, Wholesalers 15%, Retailers 25%)

Socioeconomic impact assessment

Household income dependency - The study revealed heavy dependence on charcoal-related activities for household income across all actor categories. Producers derived the highest proportion of household income from charcoal activities at 72%, followed by transporters at 65%, and retailers at 58%.

Table 2: Household Income Share from Charcoal Activities

Actor category	Percentage of household income from charcoal (n=150)	Average Monthly Income (₦)
Producers	72%	90,000
Transporters	65%	104,000
Retailers	58%	96,000
Overall Average	65%	96,666

This finding supports hypothesis H_3, demonstrating a significant household dependence on charcoal for income generation. The high dependency rates reflect limited alternative livelihood opportunities in conflict-affected areas of Northeast Nigeria.
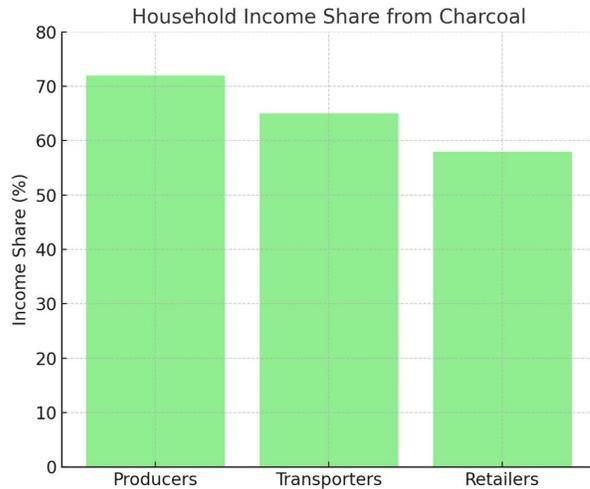
Household Income Share from Charcoal

Figure 2: Share of household income derived from charcoal activities (Bar chart showing income percentages by actor category)

Employment and livelihood impacts - Field observations and interviews revealed that the charcoal trade provides employment opportunities for various demographic groups, particularly youth, women, and displaced persons. Approximately 60% of producers were found to be young adults (18-35 years), while 35% of retailers were women engaged in small-scale trading activities.

Environmental impact and conservation practices

Environmental awareness vs practice gap - The study revealed a significant knowledge-practice gap regarding environmental conservation among charcoal producers, supporting hypothesis H_2. While 70% of producers demonstrated awareness of the environmental impacts of charcoal production, only 15% actually practiced conservation measures such as selective harvesting or tree planting.

Table 3: Environmental awareness and conservation practices among producers

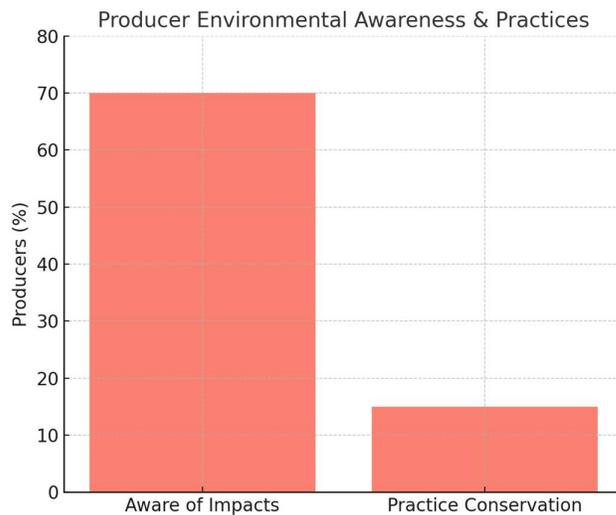| Awareness/Practice Category	Percentage (n=40)
Aware of environmental impacts	70%
Practice selective harvesting	12%
Engage in tree planting	8%
Use improved carbonization techniques	18%
Participate in forest conservation programs	5%

Producer Environmental Awareness & Practices

Figure 3: Environmental awareness and practices among producers (Bar chart comparing awareness (70%) vs actual practices (averaging 10.75%)

The knowledge-practice gap was attributed to several factors identified through key informant interviews: poverty constraints, lack of incentives for conservation, absence of alternative livelihoods, weak regulatory enforcement, and limited access to improved technologies.

Deforestation impacts - Field observations documented extensive tree cutting in production areas, with an estimated 600 truckloads of firewood entering Maiduguri daily (Omirin, 2024). Key informants reported visible forest degradation, reduced tree density, and increased distances to access suitable wood resources. Producers reported traveling increasingly longer distances (average 15-25 km) to find adequate wood supplies, indicating progressive resource depletion.

Consumer energy use patterns and preferences primary cooking fuel usage - Consumer survey results showed charcoal as the dominant cooking fuel among households in Maiduguri, used by 54% of respondents. This was followed by firewood (28%), LPG (10%), and other fuels (8%).

Table 4: Primary Cooking Fuel Usage Among Consumers

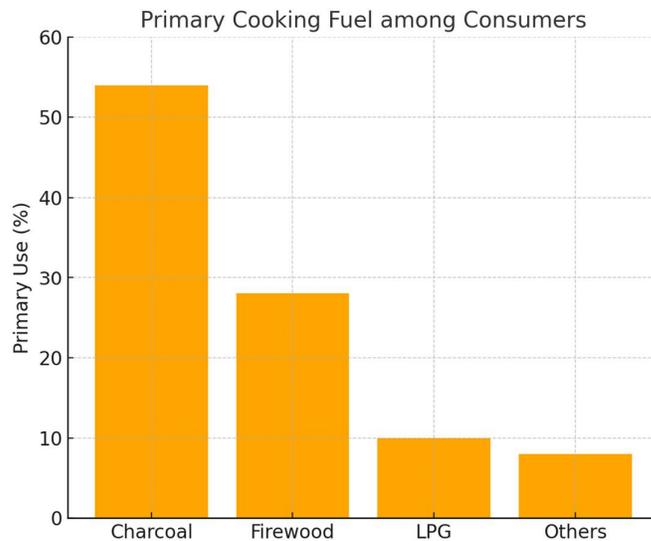| Fuel Type	Percentage (n=45)	Main Reasons for Use
Charcoal	54%	Affordability, availability, reliability
Firewood	28%	Low cost, cultural preference
LPG	10%	Convenience, cleanliness
Others (kerosene, electricity)	8%	Availability, specific uses

Figure 4: Primary cooking fuel among consumers in Maiduguri (Bar chart showing fuel distribution percentages)

Willingness to adopt alternative fuels - Despite heavy reliance on charcoal, 68% of consumers expressed willingness to switch to cleaner fuels if they were affordable and accessible. This finding partially supports hypothesis H_3 and indicates significant potential for clean energy transitions. The main barriers to adoption identified were high initial costs (72%), limited availability (58%), and lack of awareness about alternatives (45%).

Market structure and price-setting mechanisms, price formation and market power - The study revealed arbitrary price-setting mechanisms with limited transparency and high information asymmetry. Prices were primarily determined by wholesalers and retailers, with producers having minimal influence on pricing decisions. Market power was concentrated among transporters and wholesalers who controlled access to urban markets.

Table 5: Price variations and seasonality in charcoal markets

Season	Producer Price (₦/100kg)	Retail Price (₦/100kg)	Price Margin (₦)
Dry Season (Nov-Mar)	2,400-13,000	6,400-7,600	4,000-4,600
Rainy Season (Apr-Oct)	3,000-3,600	7,600-9,000	4,600-5,400
Average	3,000	7,600	4,600

Price variations were influenced by seasonal factors, transportation costs, and market demand fluctuations. During the rainy season, transportation difficulties and reduced production led to higher prices, benefiting intermediaries more than producers.

Policy and governance analysis

regulatory framework assessment

The study confirmed hypothesis H_4 regarding weak institutional regulation and governance gaps. Key findings included:

1. **Informal Operations:** 85% of producers operated without formal licenses or permits, indicating widespread informality in the sector.
2. **Multiple Taxation:** Transporters faced numerous informal levies at checkpoints, adding to operational costs and consumer prices.
3. **Weak Enforcement:** Environmental regulations existed but were poorly enforced due to security constraints and limited institutional capacity.
4. **Absence of Support Systems:** Lack of cooperatives, credit facilities, and technical support for sustainable practices.

Table 6: Governance challenges in charcoal marketing

Challenge Category	Specific Issues	Percentage of respondents affected
Licensing and Regulation	Lack of formal permits	85%
Taxation	Multiple informal levies	78%
Market Access	Limited transportation options	65%
Credit Access	No formal credit facilities	92%
Technical Support	Limited extension services	88%

SWOT analysis of charcoal marketing in Maiduguri

Based on the findings, a SWOT analysis was conducted to assess the charcoal marketing system:

Strengths:
1. Provides significant employment and income opportunities
2. Well-established market networks and distribution channels
3. High consumer demand and acceptance
4. Indigenous knowledge of production techniques

Weaknesses:
1. Poorly organized value chains with unfair value distribution
2. Environmental unsustainability and resource depletion
3. Weak institutional regulation and governance
4. Limited access to improved technologies and credit

Opportunities:
1. Growing market demand due to energy poverty
2. Potential for sustainable production methods and alternatives
3. Government interest in renewable energy and forest conservation
4. Youth and women engagement in value-added activities

Threats:
1. Continued environmental degradation and deforestation
2. Climate change impacts on resource availability
3. Security challenges affecting production and transportation
4. Competition from improved alternatives (LPG, renewable energy)

CONCLUSION AND RECOMMENDATIONS

This study examined the charcoal marketing structure and its socioeconomic and environmental effects in Maiduguri, Borno State. The findings confirmed all four research hypotheses, revealing a complex system that provides crucial livelihoods but operates unsustainably with significant environmental costs.

The charcoal value chain in Maiduguri is characterized by poorly organized structures where producers, despite bearing the highest environmental and labour costs, capture only 38% of the final economic value. This inequitable distribution reflects power imbalances and weak market organization that disadvantage rural producers while benefiting intermediaries.

The study identified a significant knowledge-practice gap in environmental conservation, with 70% of producers aware of environmental impacts but only 15% implementing sustainable practices. This gap stems from poverty constraints, lack of incentives, weak regulatory enforcement, and limited access to alternative technologies and livelihoods.

Heavy household dependence on charcoal-related activities was evident, with producers deriving 72% of their income from charcoal trade. This dependency reflects limited livelihood alternatives in conflict-affected Northeast Nigeria. However, the finding that 68% of consumers express willingness to adopt cleaner alternatives if affordable and accessible indicates significant potential for sustainable energy transitions.

The study confirmed weak institutional regulation and governance gaps, with 85% of producers operating informally, multiple informal taxation, and minimal enforcement of environmental policies. These governance deficits perpetuate unsustainable practices and limit opportunities for sector transformation.

Based on the findings, the following recommendations are proposed:

Policy and regulatory reforms

1. **Formalize the Charcoal Value Chain:**
The Federal Ministry of Environment (FME), in collaboration with the Federal Ministry of Agriculture and Food Security (FMAFS) and State Ministries of Environment, should develop and enforce policies to formalize charcoal production and trade, including simplified licensing procedures, fair taxation, and legal recognition of producer associations.

2. **Strengthen environmental governance:**
The National Environmental Standards and Regulations Enforcement Agency (NESREA) and State Forestry Departments should enforce forest conservation laws, establish monitoring systems, and apply penalties for unsustainable practices. Local Government Councils and NGOs should support alternative livelihood programs.

3. **Integrate energy and climate policies:**
The Energy Commission of Nigeria (ECN), in partnership with the Federal Ministry of Power and National Council on Climate Change (NCCC), should incorporate sustainable charcoal production into national energy and climate action plans.

Market development and value chain enhancement

1. **Support Producer Cooperatives:**
The State Ministries of Commerce and Cooperative Societies, NGOs, and Development Partners (e.g., UNDP, FAO) should facilitate the formation and registration of producer cooperatives to improve bargaining power and promote collective action.

2. **Improve Market Information Systems:**
The Federal Ministry of Trade and Investment (FMTI) and National Bureau of Statistics (NBS) should develop and maintain market information platforms and transparent pricing mechanisms, while charcoal associations help disseminate data to producers and traders.

3. **Develop Value-Added Activities:**
The Small and Medium Enterprises Development Agency of Nigeria (SMEDAN) and Bank of Industry (BOI) should support value addition (e.g., briquette manufacturing, packaging) through training, funding, and technology transfer.

Environmental Sustainability

1. **Promote sustainable production techniques:**
The State Forestry Departments, Nigerian Forestry Research Institute (FRIN), and Extension Services should provide training on improved carbonization, selective harvesting, and reforestation.

2. **Establish forest management programs:**
The State Ministries of Environment, in collaboration with Community-Based Organizations (CBOs) and traditional institutions, should implement community-based forest management, woodlot development, and reforestation initiatives.

3. **Develop alternative energy sources:**
The Federal Ministry of Science, Technology and Innovation (FMSTI) and Renewable Energy Research Centres should promote clean cookstoves, biogas, and solar energy adoption, supported by private sector investors.

Socioeconomic support

1. **Provide financial services:**
The Central Bank of Nigeria (CBN), through microfinance institutions and development banks, should design micro-credit schemes tailored for charcoal producers, transporters, and marketers.

2. **Enhance capacity building:**
The National Directorate of Employment (NDE) and Non-Governmental Organizations (NGOs) should organize training programs on sustainable production, entrepreneurship, and alternative livelihoods.

3. **Support vulnerable groups:**
The Federal Ministry of Women Affairs, National Youth Service Corps (NYSC) Skills Unit, and Humanitarian Agencies should design programs targeting women, youth, and displaced persons engaged in charcoal trade.

Research and development

1. **Promote technology innovation:**
The Forestry Research Institute of Nigeria (FRIN), universities, and polytechnics should lead RandD on efficient charcoal production technologies and alternative biomass fuels, supported by TETFund and international partners.

2. **Conduct regular monitoring:**
The National Bureau of Statistics (NBS), NESREA, and academic institutions should establish

monitoring frameworks to assess environmental impacts, market trends, and policy effectiveness.

3. **Document best practices:**

The Federal Ministry of Environment, in collaboration with research institutions, NGOs, and media organizations, should identify and document successful community-based models for replication and scaling up.

Multi-Stakeholder collaboration

1. **Strengthen institutional coordination:** Enhance coordination among government agencies, NGOs, private sector, and community organizations involved in energy, environment, and development sectors.
2. **Promote public-private partnerships:** Encourage partnerships between government, private sector, and development partners to mobilize resources and expertise for sector transformation.
3. **Engage communities:** Ensure meaningful participation of local communities, particularly producers and consumers, in policy development and program implementation.

These recommendations should be implemented through a phased approach, starting with immediate interventions to address urgent needs while building foundations for longer-term sustainable transformation of the charcoal marketing system in Maiduguri and similar contexts.

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Effect of climate shocks on food security among farming households in northeast Nigeria: A binary logistic regression approach

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Abstract - Food security in Nigeria is threatened by multiple factors including rising energy/fuel costs, food prices inflation, persistent terrorism and impacts of climate shocks. This study examined the effects of climate shocks on foods security among farming households in Northeast Nigeria. Data on socioeconomic characteristics, food security indicators and climatic shocks including flood, drought, irregular rain and extreme heat (above 40^0c) were sourced from the General Household Survey (GHS) Wave 5 conducted by the National Bureau of Statistics. Descriptive statistics and binary logistic regression were employed to analyze the data. Results of analysis revealed that majority of the respondents were responsible, adult male household heads, with an average family size of 7.15. Only 18.43% of the households were classified as food secure while a significant 81.43% were food insecure. Furthermore, one unit increase in exposure to irregular rain, drought and extreme heat greater than 40^0C was found to reduce the probability of food security among respondents in the study area by 13.78%, 15.56% and 18.08% respectively. The study concluded that exposure to irregular rain, extreme heat and drought had significant negative effects on food security in the study area. The study recommends the training and retraining of respondents in climate-smart agricultural practices as a strategic approach to mitigating the impact of climate shocks on food security.

Keywords: Climate shocks, Food security, Farming households, Logistic regression

INTRODUCTION

The world faces increasing threats from climatic shocks driven by global warming. These impacts are particularly severe in agriculture that largely depends on rainfed systems; any changes in rainfall pattern or intensity can significantly disrupt crop and livestock production, thereby affecting human well-being, especially in terms of food security. The giant strive of every country is to attain food security which 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 preferences for an active and healthy life (FAO et al., 2024). However, food security remains a pressing challenge in Sub-Sahara Africa where agriculture is predominantly rainfed and highly sensitive to climatic variability. Nigeria is among the countries whose agricultural systems largely depend on rainfall to sustain food production for its growing population (Adamagashi *et al.,* 2023). Within Nigeria, Northeast region stands out to be vulnerable to climate-related shock such as irregular rainfall, extreme heat, floods and drought due to its semi-arid climate, fragile farming systems and persistent insecurity (FAO, 2021).

Climatic shocks refer to sudden, extreme or unanticipated (short to medium term) climatic-related events that have significant adverse impacts on human systems, agricultural productivity, livelihood and natural ecosystems. World Bank (2020) gave effects of climatic shocks as persistent drought, severe storms, massive flooding and punishing heat waves that limit people to work, attend school, access healthcare and otherwise live productive lives. Effect of climatic shocks remain a global threat with Africa including Nigeria bearing the major burden due to heavy reliance on rainfed agriculture, limited adaptive capacity, high poverty and socioeconomic vulnerability, environmental degradation, rapid population growth, conflict and insecurity. FEWS NET, 2022 emphasized that climatic change reduces food supply which in turn drives up food prices and weakens households' purchasing power. This aligns with Omokaro *et al.* (2025) who reported that climate-induced shocks are intensifying the food security crisis. It is worthy to note that Nigerian Government has launched several valuable programs such as irrigation schemes, watershed restoration, and the development of climate-smart seed varieties alongside policy frameworks aimed at addressing climate-related shocks. However, their effectiveness has been limited by persistent implementation challenges including underfunding, insecurity and low adoption at the grassroots level.

Although numerous scholars have explored the broad impacts of climatic change, only a limited number have specifically analyzed the effects of climatic shocks on food security in Nigeria (Emagha, 2025; Sambo and Sule, 2023; Gittard, 2023; Ogar *et al.*, 2025; Akinkuolie *et al.,* 2025). Moreover, there remain a significant gap in literature regarding the magnitude and directional effect of these climatic shocks on food security, particularly in the semi-arid Sahelian savanna of the Northeast region. Hence the specific objectives of this study were designed to address this gap and contribute meaningfully to the existing body of knowledge.

The specific objectives of the study are to:

- describe socio economic characteristic of respondents in the study area'
- analyze food security status of respondents in the study area
- examine the effect of climatic shocks on food security in the study area

METHODOLOGY

This study was conducted in Northeast Nigeria. It is one of the six regions of the country and comprises six states: Borno, Yobe, Bauchi, Gombe, Adamawa and Taraba. Geographically, it is the largest region covering nearly one third of Nigeria's total land area. The region spans two major ecological zones: the semi-arid sahelian savanna in the northern part and the tropic west sudanian savanna in the south. Climatically, Northeast Nigeria experiences high temperature throughout the year with a short rainy season typically occurring between June and September, characterized by brief but intense rainfall. The population is predominantly Fulani, except in Borno State where Kanuri people constitute the majority. The economy of the region is primarily agrarian with most inhabitants engaged in farming and livestock rearing. Key crops cultivated include millet, wheat, sorghum, beans, groundnut and maize. Despite its agricultural potential, the region faces multiple challenges that hinder productivity. These include climatic shocks, land degradation, persistent insecurity due to insurgency and communal conflicts all of which have significantly worsened food security in the area.

This study utilised pooled secondary data drawn from the six states that make up Northeast Nigeria: Adamawa, Bauchi, Gombe, Taraba, Yobe, and Borno. A total of 814 respondents were included in the analysis. However, the distribution of the sample across states was not uniform based on the severity of security challenges being experienced in some parts of the region. The sampling percentages for each state were as follows: Adamawa (28.75%), Bauchi (27.64%), Gombe (16.34%), Taraba (13.14%), Yobe (8.48%), and Borno (5.65%).

The higher representation of Adamawa and Bauchi states in the sample may be attributed to their relatively stable security conditions and better accessibility compared to other states in the region. These two states have experienced fewer disruptions from insurgency and are generally more accessible to field researchers and survey teams, enabling more robust data collection.

In contrast, the lower representation from Borno and Yobe states is likely due to ongoing security challenges such as armed conflict, insurgency, and displacement, which have made many areas within these states unsafe and inaccessible for fieldwork. As reported by various humanitarian and security agencies, large portions of Borno and parts of Yobe remain under severe threat from Boko Haram insurgency and related insecurity (UNOCHA, 2023). These limitations have inevitably constrained field activities and reduced the effective sampling coverage in these locations.

However, the unequal sampling size across states, while not ideal, reflects the real-world operational difficulties in conflict-affected zones and does not necessarily indicate sampling bias. Instead, it underscores the challenges of conducting empirical research in volatile regions.

This study utilised secondary data from General Household Survey (GHS) wave 5, obtained from National Bureau of Statistics (NBS). Relevant variables extracted for analysis include climatic shock indicators such as erratic rainfall, flooding, drought and extreme temperature exceeding 40^0C as well as responses to food-insecurity related questions

This study employed Binary logistic regression to analyze the influence of climatic shocks on food security in study area. The food security (dependent variable) was captured using Household Food Insecurity Experience Scale (HFIES) methodology developed by the food and Agriculture Organization (FAO). The HFIES composed eight standardized questions that captured self-reported food related behaviours and experience associated with increasing level of food insecurity over a recall period (12 months). Each question is binary coded, where Yes=1 and No=0. The total HFIES score ranges from 0 to 8 and higher scores indicate more severe food insecurity. Following the classification guideline provided by FAO (2021), households were grouped into four major categories: Food Secure(Score=0), Mildly food insecure(Score=1-3), Moderately food insecure(Score=4-6), Severely food insecure(score=7-8).Moreover, for the purpose of binary analysis, a dummy variable was created thus as: household with an HFIES score of Zero were regarded as being food secure(food secure=1) while households with a score of one or more were categorized as being food insecure(food insecure=0). However, the independent variables (climatic shocks: irregular rain, drought, high temperature ($>40^0$C) and flood) were also captured as dummy. Therefore, the binary logistic model is explicitly specified as:

$$\text{Logit}(P_i) = In\left(\frac{P_i}{1-P_i}\right) = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon_i \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where:

P_i = probability that household i is food secure

X_1 = irregular rainfall

X_2 = flood

X_3 = drought

X_4 = very high temperature ($>40^0$C)

β_o = intercept
β_1 to β_4 = coefficients of independent variables
ε_i = error term

RESULTS AND DISCUSSION
Socioeconomic and climatic shocks demography

The socio economic and climatic Shock variables in Table 1 showed that most of the respondents were male household head (86.86%), married (83.23%) and lived in rural area (84.89%). The mean household size and household head age were estimated at 7.15 and 50.42 years, respectively. This household size is notably higher than the national average of 4.7 to 5.0 persons per household (World Bank, 2021), indicating that families in the study area tend to be larger. The average age of household heads suggests that many are middle-aged to older adults, which may reflect a pattern of youth migration to urban areas, leaving older individuals to manage rural households. This demographic structure places a significant burden of food provision on aging household heads and may heighten their vulnerability to food insecurity, particularly under conditions of economic hardship, rising food prices, and increasing exposure to climate shocks. Furthermore, the key climatic shocks reported by respondents in the study area include flooding (13.39%), irregular rainfall (14.00%), extreme heat above 40°C (12.65%), and drought (35.63%). Among these, drought emerged as the most prevalent, affecting more than one-third of the surveyed population. This high incidence highlights the region's growing susceptibility to extended periods of dry weather. According to Gbefo and Attigah (2022), average rainfall across Northern Nigeria has declined significantly, especially in the core Sahelian zone. Similarly, UNDP Nigeria (2022) highlighted that the Northeast region is experiencing more frequent and intense drought episodes, driven by global warming and deforestation. Collectively, these climatic shocks have led to a decline in agricultural productivity, increased food insecurity, and greater vulnerability for both human populations and livestock in the region

Table 1: Socioeconomic and climatic shocks demography

Variable		Frequency	Percentage	Mean
Household head sex	Male	707	86.86	
	Female	107	13.14	
Sector	Rural	691	84.89	
	Urban	123	15.11	
Marital status	Single	24	2.29	
	Married	675	83.23	
	Widow/widower	94	11.59	
	Divorced	18	2.22	
Household size	<=4	197	24.20	7.15
	5-8	375	46.07	
	>8	242	29.73	
Household head age	<=40	212	26.04	50.42
	41-50	216	26.54	
	50-60	216	26.54	
	>60	170	20.88	
Flood shocks	Yes	109	13.39	
	No	705	86.61	
Irregular rains	Yes	114	14.00	
	No	700	86.00	
Very high temperature (>40^{0}C)	Yes	103	12.65	
	No	711	87.35	
Drought	Yes	290	35.63	
	No	527	64.37	

Source: Data Analysis 2025

Figure 1 revealed that most of the respondents (81.57%) in the Northeast Nigeria were food insecure while only 18.43% were food secure. In order words, less than one fifth of the population sampled were food secure. This suggests that most respondents in that region did not have consistent access to adequate, safe and nutritious food required for maintaining a healthy and active life. Several interconnected factors such as notably prolonged insurgency, recurrent climatic shocks and widespread poverty contributed to the high rate of food insecurity observed in the region. Apart from these aforementioned factors, another one of the most immediate and impactful is national food inflation, which has drastically eroded household purchasing power. The period during which the

survey data was collected (2023/2024) coincided with a nationwide spike in food prices, a crisis that reached critical levels in 2024, triggering widespread "hunger protests" across several Nigerian states (Abati, 2024). As food prices soared, especially for staples like rice, maize, and beans, low-income households in Northeast Nigeria were disproportionately affected, pushing many below the threshold of food security.
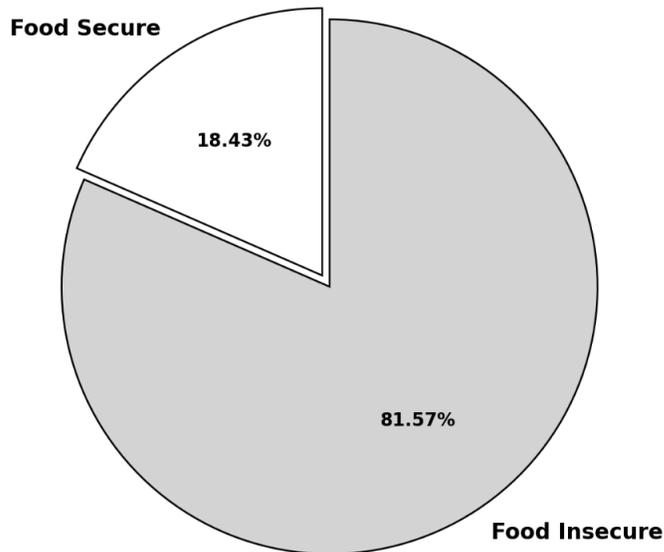

Figure 1: Food security status among Northeast households
Source: Data Analysis 2025

Effects of climatic shocks on food security in Northeast Nigeria

Table 2 showed how climatic shocks (Irregular rainfall, floods, droughts and very high temperature) among respondents in the study area influenced food security in the study area. It is obvious from Table 2 that irregular rainfall, droughts and very high temperatures above 40^0C negatively impacted food security. This suggests that as the frequencies of aforementioned climatic shocks increase in the study area, there will be probability or likelihood that food security will reduce. In order words, climatic shocks experienced by respondents in Northeast Nigeria significantly posed a serious threat on food security. Results from Table 2 showed that a one-unit increase in exposure to irregular rainfall is associated with a 13.78% average decrease in the probability of a household being food secure, holding other variables constant. This relationship is statistically significant at the 5% level, suggesting that erratic rainfall is a critical determinant of food security in Northeast Nigeria. This finding aligns with expectations, as irregular rainfall often disrupts planting and harvesting schedules, reduces access to pasture for livestock, and contributes to increased food prices and reduced access to food (FEWS NET, 2022). In support of this, Gbefo and Attigah (2022) reported that rainfall in Northern Nigeria has declined by roughly 20%

during key growing seasons over the past two decades, posing significant threats to agricultural output and the sustainability of rural livelihoods. In addition, a 2025 regional study revealed that agricultural productivity decreases by 12–18% in response to rainfall variability, thereby exacerbating food insecurity. It is important to note that rainfall variability directly affects soil moisture availability, which is essential for crop germination, growth, and yield. As highlighted by Gbefo and Attigah (2022), the consequence of such climatic disturbances is often complete crop failure or severely reduced yields.

Drought shocks were found to have a significant negative impact on food security in the study area. As presented in Table 2, a one-unit increase in drought exposure reduces the probability of being food secure by an average of 15.55%, holding other variables constant. This relationship is highly statistically significant at the 1% level. These findings align with Gittard (2023), who observed that experiencing a drought reduces agricultural yields by approximately 14% and lowers dietary diversity by 1%. Similarly, Akinkuolie *et al.* (2025) reported that droughts significantly diminish crop productivity and exacerbate food insecurity, especially in Nigeria's semi-arid northern zones where rain-fed agriculture predominates. Notably, a 15.55 percent reduction in the likelihood of being

food secure suggests that approximately one in every six households could fall into food insecurity as a result of drought, which represents a serious and alarming outcome. This has cascading effects on household nutrition, livelihoods, and adaptive resilience, particularly in conflict-affected regions of Northeast Nigeria. Therefore, it is crucial to prioritize climate adaptation strategies that specifically address food insecurity caused by drought in the region, as this remains an urgent policy concern.

Furthermore, result revealed that very high temperature ($>40^0$C) negatively impacted food security among respondents in the study area. Result from Table 2 showed that a unit increase in exposure to extreme heat (>40 °C) reduces the chance of being food secure by 18.08% on average. This is consistent with Akinkuolie et al. (2025) findings that a 1 °C increase in temperature can reduce cereal crop yields by 10–15%, intensifying food insecurity especially in arid and semi-arid zones like Northeast Nigeria. Similarly, assessment by Oderinde et al. (2022) confirmed that rising temperatures are among the most influential factors destabilizing food availability and affordability in Nigeria. It is important to note that the effects of rising temperatures are not limited to agriculture; they also extend to livestock rearing, another critical livelihood activity in Northern Nigeria. Heat stress reduces livestock productivity, affecting weight gain, reproduction rates, and milk production, thereby reducing food diversity access and food security among respondents in the study area.

Table 2: Effects of climatic shocks on food security in Northeast Nigeria

Climatic Shocks	Dy/dx of Food Security Coefficient	P>|z|
Irregular rain	-0.1278**	0.015
Floods	0.2418	0.639
Droughts	-0.1551***	0.000
Very high temperature ($>40^0$C)	-0.1808**	0.021
Number of observations = 814		
LR chi2(4) = 53.32		
Prob > chi2 = 0.0000		
Log likelihood = -362.28327		
Pseudo R2 = 0.0685		

Note: The number of observations is 814 with **, *** statistically significant at 5% and 1% level, respectively.
Source: Data Analysis 2025

CONCLUSION AND RECOMMENDATIONS

The study concluded that the majority of respondents were middle-aged to older male household heads, predominantly married and residing in rural areas, with an average household size larger than the national norm. Among the climatic shocks reported, drought emerged as the most prevalent, highlighting its significance in the region. Furthermore, less than one-fifth of the respondents were food secure, with climatic factors such as irregular rainfall, extreme heat, and drought found to have significant and negative effect on food security in the study area.

Based on the findings of this study, it is therefore recommended that:

- Respondents should be trained and retrained in climate smart agricultural practices that include cultivation of climate-resilient crop varieties, soil and water conservation, improved agronomic practices, agroforestry, afforestation and use of technology and information like mobile weather alerts and climate forecasts.
- Government and stakeholders should strengthen early warning and response systems by expanding Nigerian Meteorological Agency (NIMET's) localized weather forecasting services and integrating them with farmers' cooperatives
- Governments and relevant stakeholders should target social safety nets to climate-vulnerable zones by prioritizing food and cash aid to areas with high drought and temperature stress.

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Food security analysis among farming households in northeast Nigeria: A binary logistic regression approach

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Abstract - Food security is fundamental human right and a cornerstone of national stability, yet millions of people in developing countries especially Nigeria still face daily uncertainty about their next meal. This study analysed food security among respondents in the Northeast Nigeria where poverty and insurgency continue to prevail. Specifically, it identified the food security status and its key determinants among farming households in Northeast Nigeria. This study utilised secondary data obtained from the General Household Survey (Wave 5) conducted by the National Bureau of Statistics. Descriptive statistics and binary logistic regression were employed to analyse the data. Results from the study revealed that only 34.64% of the respondents were food secure. The state-level analysis showed that Taraba state ranked as the most food secure state in the study area whereas Borno state remained the least food secure state in the region. Moreover, household size, marital status and drought shocks significantly and negatively influenced food security while the number of children and price increase shocks were positively correlated to food security. This study therefore recommends that government and relevant stakeholders should promote family planning and awareness programs to help manage large household size, implement climate-smart agricultural strategies to mitigate weather shock and address insurgency realistically beyond political rhetoric.

Keywords: Food security, Northeast households, Binary logistic regression.

INTRODUCTION

Household food security exists when all the members of a family have consistent access to enough food for an active life (FAO, 2008). Food security is fundamental human right and a cornerstone of national stability, yet millions of people around the world especially in developing countries like Nigeria still face daily uncertainty about their next meal (World Bank, 2025). This uncertainty exposes individuals to health risks, economic hardship and social suffering (Smith and Doe, 2023). The World Food Programme (2024) reported that Northeast Nigeria faces a multi-dimensional food security crisis due to ongoing conflict, climate shocks, and economic instability leaving an estimated 3.8 million people projected to face acute food insecurity.

Agriculture serves as the primary source of livelihood for smallholder households, contributing approximately 25% to Nigeria's Gross Domestic Product (GDP) and employing 70% of the active workforce (Oxford Business Group, 2024), thereby making it a critical foundation for both livelihoods and national food supply. According to Nano (2023), 1% improvement in technical efficiency achieved through enhanced input use, improved seed varieties, and better agronomic practices can reduce moderate food insecurity by 0.40% and severe food insecurity by 0.45% at the provincial level. Furthermore, the adoption of Climate-Smart and Precision Farming Technologies is crucial to maintaining production in the face of climate change. Despite the sector's potential to significantly improve food availability, boost incomes and enhance food access, several constraints continue to hinder its impact on food security. Key challenges include climate variability, insecurity in farming areas, and chronic under-investment in storage facilities, agro-processing, and rural infrastructure to mention a few.

The Nigerian government, in collaboration with agricultural stakeholders and non-governmental organizations has implemented several programs and policies aimed at improving food security nationwide with specific attention to the Northeast region. Key initiatives include the Nigeria Resilience Strategy (2021–2023) which focused on strengthening agriculture-based livelihoods in the face of conflict and climate shocks; the USAID Feed the Future – Rural Resilience Activity (2019–2024) (Feed the Future Nigeria Rural Resilience Activity, 2022), designed to transform agriculture through inputs, finance, technology, climate adaptation, and market systems; Mercy Corps' BRICC and ALMRI interventions which emphasized livelihood rehabilitation through training, input support, and cash transfers. Other notable efforts include Agricultural Insurance Innovations to mitigate risk through digitization and youth involvement, Social Safety Nets and Home-Grown School Feeding (HGSF) programs targeting income support and nutrition and the Nigeria–Brazil $1 billion (Reuters, 2025) agriculture deal promoting mechanization and scalable impact. Despite these well-intentioned interventions, challenges such as persistent insurgency, corruption, abrupt funding cuts, weak monitoring, bureaucratic bottlenecks, and politically biased implementation

have limited their effectiveness in addressing food security in the region.

Despite the growing concern of improving food security, the measurement and determinants of food security among rural households in Northeast Nigeria is not well-documented. As a result, there is a need to measure and examine the determinants of food security among households in northeast Nigeria. This is what this study aims to address and also help in providing information for the formulation of appropriate policies that can mitigate food insecurity, especially amongst rural households in the study area.

Objectives of the Study
1. describe socio economic characteristics of respondents in the study area
2. analyze food security status of respondents in the study area
3. examine food security status of respondents by states in the study area
4. examine food security determinants of respondents in the study area

METHODOLOGY

The study covered Northeast Nigeria, one of the six geopolitical zones of the country. It comprises six states which include Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe. The region covers nearly one third (about 272, 395km^2) on Nigeria's total landmass making it the largest geopolitical zone in the country (Ibrahim and Sule, 2023). Moreover, the region lies within the Sudano-Sahelian agro-ecological zone characterized by semi-arid climate, erratic rainfall, frequent droughts, and high temperature, all of which negatively impact agricultural productivity (USAID, 2023). Futhermore Oruonye (2020) said the region experiences a dry and hot season known as the harmattan with high temperatures and little to no rainfall between November and March. The dominant livelihood includes subsistence and pastoralism with staple crops such as millet, sorghum, groundnut, rice, cowpea and maize. Northeast Nigeria is known for a wide range of ethnic groups each with its unique culture, language and traditions. The major ethnic groups in this region include Kanuri, Falani, Hausa, Tiv and Ngas. More importantly, Christianity and Islamic religion are the prevalent in that region with the majority of the population being Muslim.

The study used secondary data and was sourced from General Household Survey (GHS) wave 5 conducted by National Bureau of Statistic. Some of the required sourced for the study includes household head sex, marital status, states covered, sector, household size, children age and sex, price increase shocks, drought and household's food consumption data by item.

The socioeconomic characteristics were captured using percentage frequency distribution table while food security status of respondents was analysed using FAO proposed food security base line (2500kcal/adult equivalent/day): households were described into food secure and food insecure. Household food security status according to Mukaila *et al.* (2021) was compared to the based daily energy consumption recommendation of 2500kcal/AE/day. Households that consumed 2500kcal/AE/day and above were considered food secure whereas, households that consumed less than 2500kcal/AE/day were considered food insecure. This is also in line with Babatunde *et al.* (2013) findings. Therefore, this study used the same food security base line recommended by Mukaila *et al.* (2021) and Babatunde *et al.* (2013) respectively. Furthermore, household food consumption data covering 105 food items were used to derive calories supply or calories intake per respondent in this study. Food quantities consumed at household level were converted to calories using the locally available food consumption table for Western African (2012 and 2019). The calorie result value was divided by the number of Adult Equivalent (AE) in a household so as to obtain the per capita calorie intake and then divided by 7 days recall period to obtain per capita daily calorie intake of the respondents.

According to food security model specification by Ahungwa *et. al.* (2013), the food security index is expressed empirically as:

$$Z= \frac{\text{Household's daily per capita calorie available (A)}}{\text{Household's daily per capita calorie requirements (R)}}$$
……………………… (1)

However, determinants of food security were analysed using binary logistic regression model and the model specification is as follow:

$$\text{Logit}(P_i) = In\left(\frac{P_i}{1-P_i}\right) = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots.(2)$$

Where:
P_i = probability that household i is food secure
$X_1 - X_5$ = Household size, number of children, marital status, price increase shock, drought shock and non-food expenditure
β_o = intercept
β_1 to β_4 = coefficients of independent variables
ε_i = error term

RESULTS AND DISCUSSION
Socioeconomic characteristics

Table 1 revealed respondents' socio-economic characteristics across six states (Adamawa, Bauchi, Taraba, Gombe, Yobe and Borno) in Northeast Nigeria. The socio-economic variables included state distribution, sector (rural or urban), household head gender, marital status, exposure to price shocks, drought experiences, household size, number of adult or children per

household and non-food expenditure among others. The result from Table 1 suggested that Adamawa (28.75%) and Bauchi (27.64%) had highest number of respondents, while Borno (5.65%) and Yobe (8.48%) had the least representation respectively. The low representation in Borno and Yobe may indicate security challenges, accessibility issues peculiar to those states. The study also revealed that vast majority of respondents were male household head (86.69%) with 84.89% populace residing in rural areas while only 15.11% are from urban areas, suggesting that the study primarily focused on rural populations where food insecurity and economic hardship tend to be more pronounced. This is in line with Thomas and Turk (2023) findings that 52% of rural households experienced food insecurity compared to 18% in urban areas. Most respondents were married (83.23%) with 11.59% being widows/widowers. Very few of the respondents were single/unmarried (2.96%) or divorced/separated (2.22%). This indicated that majority of households were structured around married couples with widowhood being a notable social concern. The average household size was 7 with a minimum of 1, indicating single-person households and a maximum of 24 representing the largest household size recorded. The mean household size of 7 suggested larger household size that exceeded 2020 Nigeria Living standards Survey household size average threshold of 5.

Moreover, 81.33% and 38.45% of respondents reported experiencing price increase shock and drought respectively, which might exacerbate food security challenges in the region under study. Study by Nakanwagi *et al.* (2021) found that high food price shocks adversely affect the food security of poor households leading to increased poverty and negative long-term effects on health, labour supply and education. In a similar manner, Gbadegesin *et al.* (2024) research work indicated that drought and floods drive up food prices and depressing agricultural wages, further exacerbating food insecurity.

Table 1: Socioeconomic characteristics

Variable		Frequency	Percentage	Cum.
	Adamawa	234	28.75	28.75
	Bauchi	225	27.64	56.39
States	Borno	46	5.65	63.04
	Gombe	133	16.34	78.38
	Taraba	107	13.14	91.53
	Yobe	67	8.48	100.00
Sector	Rural	691	84.89	84.89
	Urban	123	15.11	100.00
Household	Male	707	86.89	84.89
head Sex	Female	107	15.11	100.00
	Single/unmarried	24	2.96	2.96
Marital status	Married	675	83.23	86.19
	Widow /widower	94	11.59	97.78
	Divorce/separated	18	2.22	100.00
Price increase	No	152	18.67	18.67
shocks	Yes	662	81.33	100.00
Drought	No	501	61.55	61.55
	Yes	313	38.45	100.00
Variable	Observation	Mean	Min	Max
Household size	814	7.1511	1	24
Adult	814	3.4692	1	12
Children	814	3.6818	0	17
Non-food expenditure	814	115582.4	0	1313400

Source: Data Analysis, 2025

Table 2 revealed that 34.64% of sampled households from Northeast Nigeria were food secure while 65.36% experienced food insecurity. This suggests that majority of the respondents were food insecure, meaning they were unable to meet the recommended daily energy (kilocalorie) intake for proper nutrition. This study revealed a 14.36% increase in food insecurity compared to the 51% reported by the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) in 2023 for Northeast Nigeria. This suggests that by the 2024 harvesting season, more households experienced inadequate food consumption. In essence, food insecurity in the region has risen by 14.36%, highlighting a growing crisis. Similarly, Amaza (2008) reported that over 58% of sampled

households in Northeast Nigeria were food insecure, aligning with the findings of this study. Furthermore, some plausible reasons for higher food insecurity in the region may be attributed to factors such as the removal of fuel subsidies, widespread poverty, and ongoing insurgency driven by anti-Western education ideology (Boko Haram) among others.

Food security status of respondents

Food security status	Frequencies	Percent	Cum.
Food Secure	282	34.64	34.64
Food insecure	532	65.36	100.00
Total	814	100.00	

Source: Data Analysis, 2025

Food security status of Northeast households by state in Nigeria

Table 3 outlined the food security and insecurity percentages across six northeastern Nigerian states, ranked by their food security status. Taraba State exhibited the highest food security with 54.88% of its population being food secure. This suggests relatively better agricultural productivity and access to food resources compared to other states. This relatively higher percentage can be attributed to the state's substantial agricultural potential, including fertile soils and favorable climatic conditions (Umar, 2014). Additionally, the state produces cereals (maize, millet, sorghum and rice), root and tubers (yam, cassava and sweet potatoes) and cash crops (coffee, tea, groundnuts, and cotton) along with livestock rearing, particularly cattle, sheep, and goats, is also prevalent, especially on the Mambilla Plateau and along the Benue and Taraba valleys. These agricultural activities contributed significantly to the state's food security status.

Bauchi State followed with a 44.89% food security rate. Despite being second, over half of its population still faced food insecurity, indicating significant challenges in food availability or accessibility. This finding is consistent with Mailumo *et al*. (2015) and Sadiq *et al*. (2023) that revealed that 67% rural farming households and 61.4% households in Bauchi state faced food insecurity.

Gombe State had 38.35% of its population food secure, highlighting higher (61.65%) food insecurity issues. Yakubu (2021) highlighted that conflicts between farmers and herders significantly contributed to food insecurity in the region, with 59.3% of farmers and 31.3% of herders in Gombe State experiencing moderate hunger. Also, Mani et al. (2019) concluded that farmers' vulnerability to food insecurity in Gombe State was primarily influenced by access to credit, output levels and land ownership.

Yobe State result revealed 31.88% moderate food security rate. Notably, Yobe, along with Borno and Adamawa, has been significantly affected by conflict, leading to displacement and disruption of agricultural activities. Akpoghelie et al. (2024) reported that ongoing conflict in the North East has displaced 2.2 million people and left 4.4 million people food insecure across Borno, Adamawa, and Yobe states.

Table 3: Food security status of Northeast households by state in Nigeria

States	Food security	Food Insecurity	Total	Food security status ranked by states
	58	49	107	
Taraba	54.21	45.79	100.00	1
	101	124	225	
Bauchi	44.89	55.11	100.00	2
	51	82	133	
Gombe	38.35	61.65	100.00	3
	22	47	69	
Yobe	31.88	68.12	100.00	4
	44	190	234	
Adamawa	18.80	81.20	100.00	5
	6	40	46	
Borno	13.04	86.96	100.00	6
	282	532	814	
Total	34.64	65.36	100.00	

Source: Data Analysis, 2025

Adamawa State showed only 18.80% food security. The ongoing armed conflicts in northeastern Nigeria, as well as increased prices of food items and agricultural inputs, have continued to negatively affect food security and nutrition in the region. About 74.2% of farmers reported production difficulties, mainly due to limited access to fertilizers during the last rainy season. This led to reduced cultivated cropland area (43.1 percent) and crop harvests (53.4 percent) across five states, including in Adamawa, Borno and Yobe (FAO, 2022).

Borno State had the lowest food security at 13.04%, with highest (86.96%) of its population sampled experiencing food insecurity. Borno is the epicenter of insurgency, with three million people facing food insecurity, exacerbated by displacement and destruction of livelihoods (Ofuani-Sokolo and Okunrobo, 2023).

Determinants of food security in Northeast Nigeria

Table 4 showed that positive relationship exists between number of children, price increase shock and non-food expenditure with respect to food security in the study area while household size, marital status and drought shock tend to be negatively correlated with food security and all these variables were statistically significant. This suggests that an increase in size of households, number of married respondents and drought shock experienced by respondents reduce the likelihood of food security while non-food expenditure, price shock increase and number of children increase by a unit increase in food security status of respondents in the study area.

Household size from Table 4 revealed that an increase in household size by a unit will likely reduce food security by 11.60% and it is statistically significant at 1%. This result indicates that as household size increased, the likelihood of being food secure decreased. This aligns with the findings of Oyediran and Olajide (2023) that highlighted the strain larger families place on limited food resources and concluded that household size has a negative impact on food security status. Similarly, Wudil et al. (2023) investigated food security among rice farmers in Nigeria's Kano River Irrigation Project and found that larger household sizes significantly increase vulnerability to food insecurity. It is worthy to note that Nigeria Living Standards Survey (NLSS) 2020 reported an average household size of 5.06 persons nationwide while the Northeast region exceeded this threshold with an average of 2 persons. This implied that if factors such as early marriage, misconceptions about child education and family planning continue to drive large household sizes in the Northeast, they could worsen food insecurity, compounded by insurgency-related challenges that have already severely disrupted agricultural production in the region.

Number of children result from Table 4 showed that a unit increase in number of children improves food security by 16.35% and it is statistically significant at 1%. This result may seem counterintuitive that increase in number of children do decrease food security status as opined by Owoo (2020), Alade et al. (2023) and Muhammad and Shaufique (2019). But possible explanations could be that older children engaged in farming or economic activities, contributing to household income that might in turn improve food security. In the Northeast region, prevalence of child labour (aged 5 to 17) stands at 49.4% indicating that nearly half of the children in the area engaged in labour activities (NBS and ILO, 2024). This inferably means the higher the number of children in that region, the likelihood of increased child labour that might also contribute to family income to improve food security. Moreover, in terms of socio support system, families with more children might tend to benefit more from Governmental and Non-Governmental Organisations' support programmes which might make them improve their food security than those families with fewer children. However, while increase in number of children may improve food security through increased labour, the long-term consequences of child labour which include limited educational attainment and reduced future earning potential, may perpetuate cycles of poverty and food insecurity which the region is currently experiencing.

Marital Status: The marital status of respondents affects food security status among respondents in the study area, and it is statistically significant at 1%. By implication, being married reduces the likelihood of food security. This finding is consistent with Adeoye et al. (2022) that found non-partnered households (Single, divorce, widowed) were more likely to be food secure compared to partnered (married) households. This could be due to higher financial burdens associated with supporting spouses and children because married respondents may have more dependents and face increased consumption needs most especially when income is low or being eroded by inflation rate. Moreover, conflict and dissatisfaction within marriage can also lead to negative consequences including potentially reduced attention to household food security. Being married does not automatically lead to reduced food security, but related factors like low or reduced household income, increased household expenses, marital discord among other factors can lead to food security reduction among married respondents in the study area.

Food price increase result from Table 4 revealed that an increase in food price by one unit will increase probability of food security in the study

area by 13.23% and it is statistically significant at 1 percent. This result is contrary to a priori expectation that increase in food price tends to reduce probability of food security as opined by National Bureau of Statistic (2024). However, increased in food price may benefit food producing households by raising their income, especially in Northeast Nigeria where agriculture is a main livelihood source. According to FAO (2022), higher agricultural products' prices can incentivize production and improve income for net producers, potentially enhancing their food security. Similarly, this study's findings align with Manda et al. (2020) who observed that farming households who are net sellers of food crops in rural Nigeria tend to have better food access during periods of favourable market prices. Thus, increased food prices might improve food security among food producers who are able to sell their products at higher margin and reinvest in nutrition and productivity. Moreover, it is important to note that the positive effects of increased food prices on food security are not universal. Poor households, especially those that are net buyers of food often suffer from reduced purchasing power when food prices rise leading to decreased food access and increased vulnerability to food insecurity.

Drought Shocks: The results from Table 4 showed that a unit increase in drought shocks-characterized by prolonged or sudden reductions in rainfall and water availability that negatively affect agriculture, the environment, and livelihoods-leads to a 5.16% decrease in the probability of food security. This implied that an increase in drought shocks significantly lowers the likelihood of achieving food security. According to Ayanlade et al. (2017), extended dry spells in Nigeria results in soil degradation, loss of fertile land and reduced water availability, all of which lower agricultural productivity. This decline in productivity directly impacts food insecurity (Orimoloye et al., 2020). Furthermore, Blueprint (2024) reported that maize and millet yield in northern Nigeria declined by 25–30% during severe drought years, worsening food insecurity in the region. This aligns with the findings of this study, indicating that drought shocks negatively affect food security.

Non-food Expenditure: An increase in non-food expenditure among households in the study area is positively associated with improved food security. In order words, increase in non-food expenditure by one unit increases probability of food security by $4.96e^{-04}$ % and it is statistically significant at 1 percent. This is consistent with finding from the study carried out by Oyediran and Olajide (2023) that emphasized that investment in non-food areas contribute to overall household well-being and resilience which in turn positively impacts food security. Furthermore, Kolawole (2024) concluded that non-food expenditure indicative of improved living standard and economic stability, are linked to better food security. Similarly, the findings of this study align with Amao *et al.* (2023) who reported that non-food expenditure has a positive and significant relationship with household dietary diversity. This implies that as households increase spending on non-food items, their food expenditure and dietary diversity also improve

Table 4: Food Security determinants in Northeast Nigeria

Food security	*dy / dx*	P> |Z	
Household size	-0.1160***	0.000
Number of Children	0.1635***	0.000
Marital Status	-0.1963**	0.016
Price increase shock	0.1323***	0.001
Drought Shock	-0.0516*	0.095
Non-food expenditure	$8.65e^{-07}$	0.000
Logistic regression	Number of obs = 814	
	LR chi2 (6) = 192.09	
	Prob > chi2 = 0.0000	
Log likelihood = -429.16029	Pseudo R2 = 0.1829	

Note that *, ** and *** indicate statistically significant at 10%, 5% and 1% level, respectively Source: Data Analysis, 2025

CONCLUSION AND RECOMMENDATIONS

The study concluded that most respondents in Northeast Nigeria were male, married, adult aged individuals with larger household sizes, many of whom experienced price increase shocks. A significant portion of these households were found to be food insecure. Among the states surveyed, Taraba recorded the highest level of food security while Borno had the lowest. Key determinants of food security included household size, marital status and drought shock, all of which had a negative and significant impact. Conversely, non-food expenditure, price increase shocks and number of children per household had positive and significant influence of food security outcome in Northeast Nigeria.

Based on the findings of this study, the following recommendations were made to improve food security in Northeast Nigeria.

- Government and public sector should encourage family planning and promote awareness programs that can help manage large household size.
- Farming households should adopt climate - smart agricultural practices and drought-resilience strategies to mitigate the impact of weather shocks
- Government should encourage and support non-food income generating activities to improve household purchasing power
- Government should prioritize implementation of policies and interventions that specifically address localized food insecurity and the challenges posed by insurgency in the study area.

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Trend and trade potentials of ginger export in Nigeria

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Abstract - Ginger (Zingiber officinale), a high-value crop with significant economic potential, has experienced fluctuating export levels due to Nigeria's infrastructural challenges, market volatility, and competing international producers, such as India. This study examined the trends and trade potential of ginger exports in Nigeria. Utilizing quantitative research methods, data were collected from the World Bank, CEPII Database, and UNCTAD. Descriptive statistics, time-series, and gap analyses were employed to investigate the historical trends and assess Nigeria's ginger export potential in key international markets. The results highlighted Nigeria's fluctuating ginger export performance, with significant variations in production and export volumes over time. Historical data from 2014 to 2022 showed volatility in export values, reflecting global demand shifts and domestic challenges like infrastructural deficiencies. Additionally, the analysis of trade potential further revealed export gaps in key markets, including the United Arab Emirates (0.0280658), the United States (0.7111641), India (0.2998686), Netherlands (0.0423501), Spain (0.8434551), South Africa (0.3006455) and Germany (0.1363955), where actual exports fall short of their potential in markets and the predicted trade volumes suggested room for expansion. The study concludes that, while Nigeria has substantial trade potential for ginger, achieving consistent export growth requires targeted interventions to address logistical challenges, improve quality standards, and enhance market access. By focusing on strategic markets and investing in supply chain infrastructure, Nigeria can better leverage its ginger exports to support economic growth and increase its presence in the global ginger market.
Keywords: Ginger exports, trade potential, trade potentials, trade barriers, trade diversification

INTRODUCTION

Ginger (Zingiber officinale) is an annual herbaceous plant which is extensively grown for its aromatic, pungent rhizomes, utilized in both traditional and modern medicinal systems and as a spice (Ravindran and Babu, 2016). Ginger is a key cash crop and a substantial source of revenue for smallholder farmers in Nigeria, making the country one of the world's top producers of the vegetables (Okwu and Oliafor, 2021). In Nigeria, ginger (Zingiber officinale) is a significant economic crop and it is one of the ten most widely grown crops. Nigeria's northern states account for the majority of the country's ginger production; the top producers are Kaduna, Gombe, Benue, Nassarawa, and Plateau (Akpan and Iniloh, 2020).

Nigeria is one of the world's largest producers of ginger, an important agricultural commodity known for its diverse uses in food, beverages, medicine, and cosmetics (FAO, 2020; Olaniyi, 2017). Nigeria, particularly in areas like Kaduna, has the ability to produce high-quality ginger with distinctive flavors and smells thanks to its rich, fertile land and ideal temperature, which makes it a fierce competitor in international markets (Adegboye et al., 2021).

However, despite this high production potential, Nigeria's ginger export sector has not reached its anticipated performance. The sector faces volatility, reflected in export values and inconsistent trade flows (Adeoye and Dada, 2019). Key challenges include logistical inefficiencies, trade barriers, currency fluctuations, and competitive pressures from other countries, especially India, the world's leading ginger exporter (Ogunsina and Emeka, 2019). As a result, Nigeria's ginger sector fails to capitalize on high-demand international markets, such as Europe and North America, leading to underutilized trade potential and reduced economic benefits.

Therefore, this study evaluated the trends in ginger production and exports in Nigeria and trade potential of Nigerian ginger exports in key international markets

METHODOLOGY

The study area is Nigeria, located in West Africa. The country's northern region, particularly Kaduna State, is known for high-quality ginger production due to favorable environmental conditions (NBS, 2022).

This study used a quantitative research design, which is suitable for analyzing numerical data on trade trends and determinants. Quantitative methods provide an objective approach to understanding the relationship between variables affecting ginger export performance (Creswell, 2014).

Data were collected from the World Bank, CEPII Database, and UNCTAD.

Descriptive statistics and time-series analysis were used to examine historical data. Gap analysis and comparative analysis were used to assess the trade potentials of ginger export in Nigeria.

RESULTS AND DISCUSSION
Ginger export in Nigeria

The descriptive statistics presented offer a comprehensive view of the variables influencing

ginger production and export from Nigeria. The mean production value of 631,857.31 tons, with a standard deviation of 197,847.94, highlighted the large-scale production of ginger in Nigeria, with values ranging from 168,128.24 to 834,634 tons. The average export value of ginger is 1492.309 (in $1000s), with a wide standard deviation of 2599.073 and a maximum export value of $11,136. This high variability indicates a large disparity in the value of ginger exports across different periods or destinations. The mean quantity of ginger exported stands at 961.051 tons, with a significant standard deviation of 1821.848 tons. The wide range, from 0.42 tons to 11,740.38 tons, again emphasizes the variation in Nigeria's export volumes. These figures suggested that while Nigeria has the capacity to export large quantities of ginger, export volumes can be erratic. According to Nwokolo *et al.* (2019), this inconsistency can be attributed to both internal factors such as logistics and supply chain inefficiencies, as well as external factors such as trade regulations in destination countries.

The GDP of Nigeria has a mean of 4.544e+11 (approximately $454.4 billion), with a moderate standard deviation of 5.489e+10. The relatively small variation in Nigeria's GDP during the observed period indicates a stable macroeconomic environment, though growth has been modest. However, the GDP of destination countries, however, shows a much higher mean of 2.401e+12 (approximately $2.4 trillion) and a large standard deviation of 4.843e+12, indicating significant variability in the economic size of

Nigeria's trading partners. This broad range (from $10.06 billion to $23.59 trillion) reflects the diversity of Nigeria's trading partners, from smaller economies to major global markets. Larger GDP destination countries generally imply greater purchasing power and demand for imports, which correlates with higher export values.

The average population of the origin country (Nigeria) has a mean of 198.6 million, with a relatively small standard deviation of 12.68 million, reflecting Nigeria's large and growing population, which serves as both a labor force for ginger production and a domestic market. In contrast, the population of destination countries varies widely, with a mean of 159.3 million and a standard deviation of 384 million, ranging from 1.31 million to 1.417 billion. This significant variability suggests that Nigeria exports ginger to both smaller markets and populous nations such as China and India, where the demand for agricultural products is high (Nguyen, 2018).

The mean distance between Nigeria and its trading partners is 5936.624 kilometers, with a standard deviation of 2971.657 kilometers, ranging from 105.18 kilometers to 15,521.28 kilometers. The wide range suggests that Nigeria exports ginger to both nearby countries (e.g., Benin) and distant markets (e.g., China). According to Lawal *et al.* (2021), distance is a significant determinant of trade costs, which include transportation, logistics, and insurance expenses. Greater distances generally increase these costs, making Nigerian ginger less competitive in distant markets.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Production	207	631857.31	197847.94	168128.24	834634
Ginger Export Value	207	1492.309	2599.073	1	11136
Quantity	207	961.051	1821.848	.42	11740.38
GDP (Origin)	207	4.544e+11	5.489e+10	3.757e+11	5.742e+11
GDP (Destination)	207	2.401e+12	4.843e+12	1.006e+10	2.359e+13
Population (Origin)	207	1.986e+08	12684075	1.794e+08	2.185e+08
Population (Destination)	207	1.593e+08	3.840e+08	1311134	1.417e+09
Distance	207	5936.624	2971.657	105.181	15521.28
Exchange	207	210.199	205.991	.321	1132.923
Landlocked	207	.087	.282	0	1
Regional Trade Agreement	207	.087	.282	0	1
Common official language	207	.261	.44	0	1
Common colonial	207	.13	.338	0	1
Contiguity	207	.043	.204	0	1

Source: Author's computation, 2024

Historical trends and patterns of ginger production, exports, and their contributions to Nigeria's GDP
Historical Trends of Ginger Export Value in Nigeria (2014–2022)

The figure 1 below depicting the historical trends of ginger export values in Nigeria from 2014

to 2022 revealed significant volatility in export performance during this period. Between 2014 and 2016, ginger export values showed pronounced spikes and declines. The year 2014 began with low export values, followed by a significant upward movement. By 2015, export values experienced a remarkable surge, reaching a peak above 9,000

USD. However, this is quickly followed by a dramatic fall in 2016. The high volatility during these years can be attributed to changes in the global demand for ginger, as well as variations in domestic production. According to Olayinka *et al.* (2017), ginger prices and export values are strongly influenced by global market conditions, with demand for spices and herbs rising sharply due to increasing global interest in natural remedies and health products.

From 2017 to 2019, the graph showed relatively moderate export values, with occasional peaks, suggesting a period of consolidation after the extreme volatility witnessed earlier. While the export values did not reach the peaks observed in 2015, there are still discernible increases in certain years, such as 2018 and 2019. The fluctuations seen within these years are still indicative of Nigeria's ongoing challenges in fully capitalizing on its ginger export potential. As Bolarinwa and Gbadebo (2019) noted, Nigeria's export market has been constrained by several factors, including inconsistent trade policies and the volatility of the naira.

From 2020 onwards, the graph reflected a resurgence in ginger export values, with consistently high peaks each year. By 2021 and 2022, the export values once again approached the levels seen in 2015, reflecting renewed vigor in the ginger export market. This recovery can be partially attributed to the global rise in demand for ginger products during the COVID-19 pandemic.

Despite the overall recovery seen after 2020, the graph still showed noticeable volatility, with sharp dips following each peak in export values. This pattern suggested that while the ginger export sector has shown resilience, it continues to face underlying challenges that prevent sustained and stable growth. Usman *et al.* (2020) emphasized that issues such as poor market access, infrastructure deficits, and the impact of climate change on ginger production continue to hinder Nigeria's ability to maintain consistent export levels. The findings from this graph showed the need for more robust and sustained interventions to ensure the consistent growth of Nigeria's ginger export sector. While the global demand for ginger remains strong, Nigeria's ability to meet this demand on a consistent basis requires further investment in agricultural infrastructure, market access, and trade facilitation. FAO (2022) highlighted the importance of improving agricultural value chains, particularly in the areas of post-harvest handling, storage, and transportation, to reduce losses and enhance the export quality of ginger.
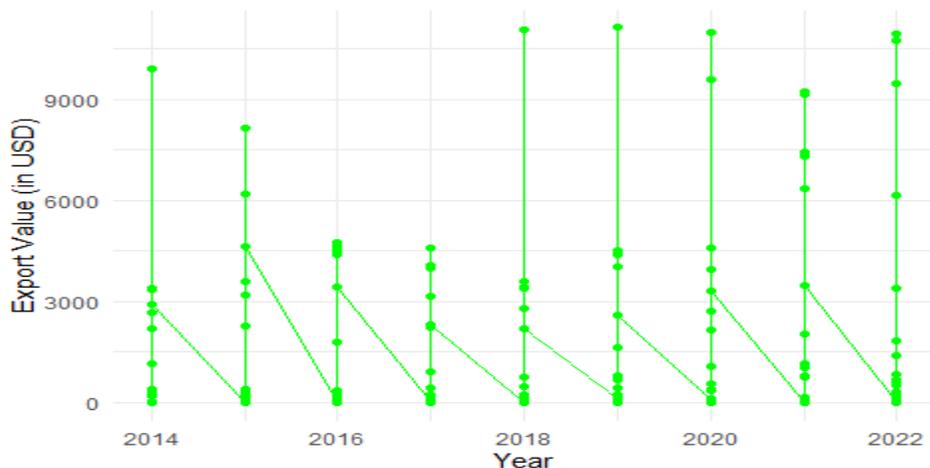

Figure 1: Historical trends of Ginger export value in Nigeria
Source: Author's Data Analysis, 2024

GDP Trend of Nigeria Over Time (2014–2022)

The figure 2 depicting Nigeria's GDP over the period from 2014 to 2022 showed significant fluctuations, reflecting both the country's economic challenges and periods of recovery. From 2014 to 2016, Nigeria's GDP showed a sharp decline, falling from approximately 550 billion USD in 2014 to below 400 billion USD by 2016. This period coincides with the significant drop in global oil prices, which severely impacted Nigeria's oil-dependent economy as noted by Ejiogu *et al.* (2018). The graph showed a notable recovery in Nigeria's GDP between 2017 and 2019, with GDP rising from below 400 billion USD in 2016 to nearly 500 billion USD by 2019. This recovery can be attributed to the stabilization of global oil prices and efforts by the Nigerian government to implement economic reforms aimed at boosting growth. The GDP decline observed in 2020 is consistent with the global economic downturn caused by the COVID-19 pandemic.

Following the decline in 2020, Nigeria's GDP showed signs of recovery in 2021 and 2022, rising once again to nearly 500 billion USD by 2022.

Ogundipe and Oladeji (2022) argue that Nigeria's economic recovery in the post-pandemic era has been supported by the global recovery in oil prices, as well as a focus on enhancing agricultural production and boosting non-oil exports. However, the recovery remains fragile, as structural issues such as inflation, unemployment, and insecurity continue to pose challenges for sustained economic growth.

The GDP trends in Nigeria from 2014 to 2022 reflected the broader challenges faced by the

country in achieving stable economic growth. While periods of recovery are evident, the economy remains highly vulnerable to external shocks, particularly fluctuations in oil prices and global economic conditions. Moving forward, Nigeria will need to prioritize economic diversification, infrastructure development, and improved governance to build resilience and promote sustained growth.
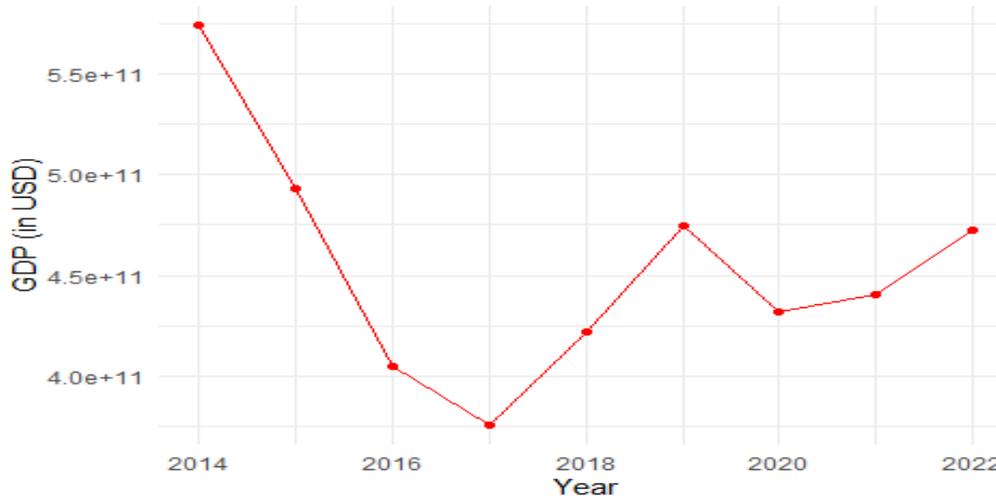

Figure 2: GDP of Nigeria over time
Source: Author's Data Analysis, 2024

Relationship between ginger export value and GDP in Nigeria

The analysis of the relationship between ginger export value and GDP in Nigeria, as illustrated in the scatter plot from figure 3 below, revealed a weak and nearly insignificant correlation between the two variables. The scatter plot showed that even when the value of ginger exports increases, there is no significant corresponding increase in Nigeria's GDP. This observation is in line with previous research on agricultural export crops in developing countries. For example, studies by Ajayi

and Olu (2019) and Meier (2020) on agricultural commodities in Africa suggested that the contribution of single agricultural products, such as ginger, to overall GDP is often overshadowed by larger industries like oil and gas, especially in resource-dependent economies like Nigeria.

The wide scattering of data points in the graph, particularly in the lower ranges of export values, further reinforced the observation of minimal correlation. This widespread dispersion might be attributed to external economic factors that overshadow the contribution of ginger exports.
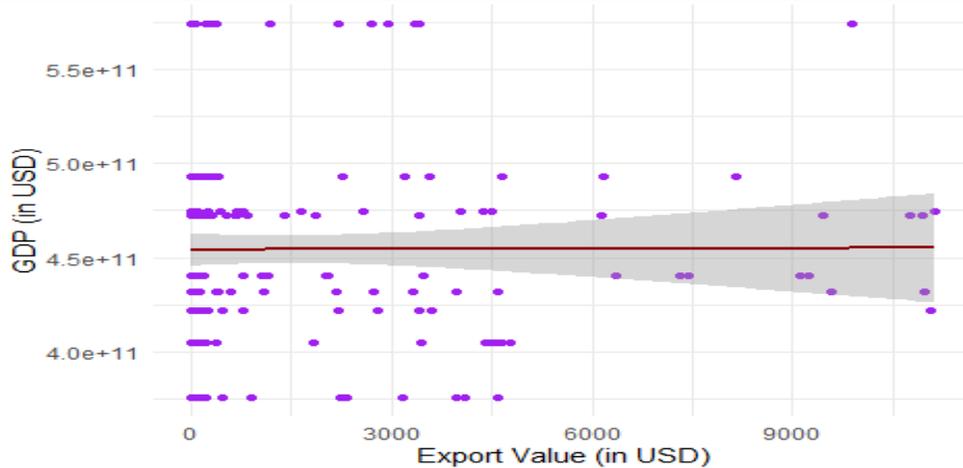
Figure 3: Relationship between Ginger export value and GDP
Source: Author's Data Analysis, 2024

Trade potential of Nigerian Ginger exports

The analysis of Nigerian ginger exports highlighted significant variations in trade performance across different countries. Nigeria's actual exports fall short of their potential in markets like the UAE, India, Germany, the United States, and South Africa, where trade ratios are much lower than expected. The UAE, for instance, showed a trade ratio of just 0.028, indicating a large, untapped potential. Similarly, India's growing demand for ginger, especially for health-related uses, offers Nigeria an opportunity to expand its market share. In Europe, Germany is another key market with significant potential, offering high-value opportunities for agricultural exports.

Table 2: Trade potential of ginger export in Nigeria

S/N	Countries	Trade Ratio	Trade Differences
1	United Arab Emirates	0.0280658	-6086.216
2	Australia	12.33654	304.1299
3	Belgium	32.75053	109.8819
4	Benin	5.107316	91.53699
5	Bahrain	4.57955	-3.779043
6	Bosnia and Herzegovina	3.441216	22.71954
7	Canada	1.849197	128.2385
8	Switzerland	2.125834	-14.46604
9	China, mainland	84.14978	963.3276
10	Germany	0.1363955	-3969.869
11	Spain	0.8434551	-117.1711
12	France	1.666441	146.0483
13	United Kingdom of Great Britain and Northern Ireland	2.071503	39.2465
14	India	0.2998686	-6008.787
15	Latvia	1.131709	-27.7017
16	Morocco	0.1282915	-2367.701
17	North Macedonia	1.129126	0.2644902
18	Netherlands	0.0423501	-4314.611
19	Norway	8.700646	112.1893
20	Poland	3.705341	190.1231
21	Ukraine	2.217774	110.069
22	United States of America	0.7111641	-991.5822
23	South Africa	0.3006455	-1006.845

Source: Author's computation, 2024

On the other hand, Nigeria has exceeded its potential in markets like China, Belgium, and Norway, where trade ratios are significantly higher than expected. China, with a trade ratio of 84.15, is overperforming due to its high demand for ginger, driven by its use in food and medicinal products. Belgium and Norway also show higher-than-expected trade figures, likely due to Belgium's role as a gateway for

agricultural goods in the EU and Norway's strong demand for health foods like ginger.

Some countries, such as Canada and France, have trade ratios close to 1, indicating a balanced performance in line with expectations. These markets present opportunities for further growth, particularly by promoting Nigeria's organic and sustainably sourced ginger products.

CONCLUSION AND RECOMMENDATION

The study revealed that Nigeria's ginger exports have experienced significant fluctuations over the years, with major export destinations including Europe, Asia, and North America. The trade potential analysis indicated that while Nigeria has established trade relations with several countries, there remains substantial under-trading with key markets such as the United Arab Emirates, Germany, India, the United States, and South Africa. In contrast, countries like China, Belgium, and Norway showed over-trading, suggesting market saturation or fulfilled demand levels. These findings highlight untapped export opportunities for Nigeria in markets where actual exports remain below potential levels. Despite Nigeria's comparative advantage in ginger production, infrastructural deficits, high logistics costs, and inconsistent quality standards continue to constrain export performance.

Given the study's findings, it is recommended that Nigeria adopt strategic measures to expand its ginger exports, particularly to under-traded markets such as the UAE, Germany, India, the United States, and South Africa. The Nigerian government, in collaboration with export agencies, should invest in improved transport infrastructure, storage facilities, and logistics systems to minimize costs and enhance supply chain efficiency. Additionally, enforcing strict quality control and standardization measures will help Nigerian ginger meet international standards and improve its competitiveness. By implementing these strategies, Nigeria can strengthen its position in the global ginger market, increase foreign exchange earnings, and promote agricultural diversification for sustainable economic growth.

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