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Aina, O.O., Dixon, A.G.O.and Akinrinde, E.A. Influence of shoot and root characteristics of cassava genotypes on yields in Nigeria. African Crop Science Conference Proceedings Vol. 5 (2001) pp. 1119-1125

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Paper Revision: An author receiving editorial recommendations for revision should submit the revised manuscript within 3 months; otherwise; longer intervals will be treated as new manuscripts.

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CONTENTS

EVALUATION OF RICE-TECHNOLOGY INFORMATION PACKAGES DEPLOYED BY IFAD-VCDP ON RICE PRODUCTION IN TARABA STATE

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Abstract

Rice production in Taraba state is challenged by access to land, inadequate seeds of high yielding, nutrient dense and disease resistant varieties. The gap between rice production and national demand persists. The IFAD-VCDP is a development initiative aimed at improving rice value chain in Taraba state for small holder farmers. It addresses the constraints in rice production and enhance productivity. An assessment of technology information deployed to rice growers became imperative. The study was conducted in Ardo-Kola and Gassol Local Government Areas of Taraba State to evaluate the effect of the rice-technology deployed by IFAD-VCDP on rice production. Four rice farmers' clusters established by IFAD/VCDP in Gassol and another four in Ardo-kola were selected. Twenty rice growers were randomly selected per cluster, a total of 80 growers each were interviewed in Gassol and Ardo-kola Local Government Area. Primary data was collected through interview with semi-structured questionnaires. Data collection exercise was conducted with assistance of IFAD VCDP extension officers overseeing the selected areas and research student. Data collected on the socio economic, demographic, institutional characteristics and field production and management practices was analyzed using MSTAT – C statistical software. IFAD-VCDP participants within the age group 20 - 39 years are in majority and are young adults, energetic with high aspirations to accept new technologies. The IFAD–VCDP is male dominated (79.3%). This may probably be associated with labour and time-consuming activities. Majority (44.8 %) of IFAD-VCDP participants had diploma certificate and 93.10% of the participants had contact with IFAD-VCDP extension agent. The participants belong to cooperative societies and have unrestricted access to technology information and farm input. Technology information from IFAD, research institutes and Agricultural Development Project are relied upon by rice growers. Rice growers acknowledged high awareness and reliability of the rice production technologies deployed by IFAD-VCDP. This is expected to improve adoption of these technologies and rice productivity.

Keywords: Rice technology, growers, awareness, youth, reliability, value chain

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Introduction

Rice (*Oryza sativa*) is an important staple cereal in sub-Saharan Africa (WARDA, 2003) and the most widely cultivated cereal crop after wheat (WARDA, 2003). It is ranked the sixth crop, in terms of production (Imolehin and Wada, 2000). Rice producing areas in Nigeria are Kaduna, Niger, Benue, Taraba, Kebbi, Sokoto, Adamawa, Kano, Nasarawa, Kwara, Ekiti, Ondo, Ebonyi and Abia states (Federal Ministry of Agriculture and Rural Development, 2012). The Nigerian rice ecosystem is classified as; rain fed lowland (47% of the total rice production area), rain-fed upland (30%), irrigated lowland (16%), deep water (50%) and mangrove swamp (1%) (Federal Ministry of Agriculture and Rural Development, 2012). Rice production is carried out by resource-limited small and medium scale farmers, and large-scale production is increasing. Rice growers are poorly educated, inadequately equipped with improved technologies and facilities to scale farm yields (Tiamiyu, et al, 2009). Hence the gap in production and national demand persists. Rice production and consumption is a

structural component of the Nigerian household diet. Nigeria is the second largest importer of rice in the world, spending about 356 billion Naira for about 2 million metric tonnes of imported milled rice (Adesina, 2014). This is sequel to low production capacity of local farmers. Rice consumption in the Nigeria is expected to reach 35 million tonnes by 2050 (Federal Ministry of Agriculture and Rural Development, 2012).

Agriculture is a major driver of economic growth in Taraba state and rice is of major economic significance. It provides income, employment and ensure food security. The major rice producing areas in the state are Gassol local government area (Mai Gemu – Kanu, Tak wurkun, Shagarda), Wukari local government area (Nwuku, Rafin Kada, Tudunwada), Lau local government area (Garin –Daga, Mayo- Lushi, Garin- Mashi), Jalingo (Ardo Kola) and Kareem Lamido local government area.The drive for self-sufficiency in rice production is pertinent to the administrative authorities in the state, where the local consumption of the commodity is in excess of the quantity produced by farmers. Thus, creating a demand for imported rice to meet the shortfall.

In Taraba state, rice production is challenged by access to land, inadequate seeds of high yielding and nutrient dense varieties, restricted access to extension and financial services and markets. In addition, weed interference in production, diseases (Rice Yellow Mottle Virus, African Rice Gall Midge and Bacterial Leaf Blight) outbreak, insects attack and invasion by Quilea birds limit productivity (JamilaSheu and Garba, 2011). Further, non-availability and high cost of inputs (inorganic fertilizer, agro-chemicals and nets), and difficulties in acquiring rice processing equipment, flooding and drought (Ojehomon et al, 2009a) hinders attaining sustainable production.

The Value Chain Development Programme (VCDP) is development initiative of the Federal Government of Nigeria and International Fund for Agricultural Development (IFAD) aimed at improving rice value chain in Taraba state for small holder farmers. Also, it addresses the constraints in rice production and enhance productivity. Taraba state has more than 70% of the population living in the rural areas and cultivating less than 5 ha (Erhabor and Ahamada, 2013). In farming communities, poverty remains largely a rural phenomenon. The livelihood of rice farmers in the state is constrained by a low productivity and lack of opportunities for value addition. To mitigate these challenges, the federal government and Taraba state authorities in collaboration with IFAD seek opportunities to address challenges in attaining high productivity by adopting the value chain approach to scale up productivity of rice farmers in Taraba state.

The IFAD-VCDP in Taraba state is in its third year out of six years mandate. It is imperative to evaluate access to rice production technologies, extension and financial services and markets. The objectives of this study were to describe the socio-economic and institutional characteristics of IFAD VCDP rice value chain actors in Gassoll and Ardo Kola local government areas, evaluate access and awareness of rice production and rice field management technology information.

Methodology

Study location and characteristics

The study was conducted in Ardo-Kola and Gassol Local Government Areas of Taraba State, Nigeria. Ardo-kola Local Government has a population of 147,986 (45% are females) (NPC, 2006), and is located in the

northern part of the state, it has the following districts namely, Ardo-kola, Sunkani, Lamido-Borno, Bakin-Dutse, Alingora, Iware, Jauro-Yinu, Tau, Zango-Kombi and Mayo-Renewo District. Ardo-kola local government share a common boundary with Gassol, Bali to the West Karim-Lamido Local Government to the South West, also boundaries with Jalingo Local Government to the North. The wet season start from March to November, while dry season start from December to March. The annual rainfall is between the range of 100 to 400 mm, and the temperature of 27^0 C to 28^0 C. The soil is clay and sandy clay, with water retention capacity good for crop production.Gassol Local Government Area is located in the Taraba central senatorial zone,with headquarters in Mutum-biyu. It has twelve (12) wards namely, Gassol, Yanimel, Wuro Jam, Sendirede, Mutum-biyu (A) Mutum-biyu (B) SabongidaTakai, Wuryo, Tutare, Shira, Gunduma, and Ndamni wards respectively.

The local government area is bounded by Karim-Lamido Local Government Area in the North, Ardo-Kola in the East, Bali in the South and Wukari Local Government area in the West, respectively. Gassol local Government area has a population of 244, 749 (NPC, 2006). The rainy season starts from May to October, while the dry season begins from October to April. The main rainfall is between 100 to 420mm. The climate is warned with mean monthly temperature of 27^0 C to 28^0 C throughout the year.

Sampling procedure and Data collection procedures

Gassol and Ardo-Kola local government areas were purposively selected due to high rice cultivation, milling and other rice value addition activities. The IFAD-VCDP had selected and registered rice growers from Ardo-Kola and Gassol local government for training. Four rice farmers' clusters established by IFAD/VCDP in Gassol and another four in Ardo-kola were selected. Twenty rice growers were randomly selected per cluster, a total of 80 farmers were interviewed in Gassol and another 80 farmers in Ardo-kola Local Government Area.

Primary data were collected through interview with the use of direct semi-structured questionnaire comprising of both open-ended and close-ended questions were used as the survey instrument. Data collection exercise was conducted with assistance of IFAD VCDP extension officers overseeing the selected areas of study and the research student. The field survey was done in May 2018, this period coincides with the rainy season. Information sourced from the participants include demographic, socioeconomic and institutional variables, these variables are age (years) and sex distribution, occupation, educational attainment and experience (years), farm size, household size and marital status (etc.). Access, awareness and reliability of rice technologies from the source was investigated. In addition, secondary data were sourced from academic journals, Food and Agricultural Organization (FAO) bulletins, National Cereal Research Institute (NCRI) bulletins, and Federal Ministry of Agriculture bulletins.

Method of Data analysis

Data collected on the socio economic, demographic, institutional characteristics and field production and management practices of IFAD-VCDP participants was analyzed using frequency, percentages and Chi square goodness – of - fit test was done using MSTAT – C statistical software. The responses on the degree of reliability of information technology from source among IFAD-VCDP participants in the study siteswere categorized in accordance with Likert - type scale. This scale measures the intensity or degree of agreement by the respondents to a statement that describes a situation. A four-point Likert scale was used namely; most

reliable, reliable, somewhat reliable and unreliable. The categories were assigned scores of 4, 3, 2 and 1. The mean score was computed as 4 + 3 + 2 + 1 = 10/4 = 2.50. Using the interval score of 0.05, the upper limit cut-off was determined as 2.50 ± 0.05 and the lower limit as 2.55 ± 0.05 = 2.45. On the basis of this, mean score (s) (MS) below 2.45 (that is, <2.45) were ranked 'low', those between 2.45 and 2.54 were considered 'medium' (that is, 2.45 ≥ MS ≤ 2.54), while the mean scores greater than or equal to 2.55 (that is, MS ≥ 2.55) was considered 'high'.

Results and Discussion

The goal of the IFAD-VCD programme in Taraba state is to reduce rural poverty and achieve accelerated economic growth on a sustainable basis. The programme is to ensure: 15% reduction in households' poverty below the poverty line in target LGAs, 25% reduction in number of people under-nourished in target LGAs (children under 5 years) and 5% increase in real agricultural GDP growth rate in target LGAs (baseline at state level).

The age distributions of IFAD-VCDP participants range from 20 to 49 years. Respondents within the age range from 20 and 39 years are in majority (Table 1), followed by respondents within the age group 40 and 49 years. Participants age 50 years and above accounted for 18.6%. The Chi square goodness of fit test indicate significant difference (P< 0.01) between the age classes. This implied that IFAD-VCDP participants are young adults, energetic with high aspirations to accept new technologies than older farmers. In Ekiti and Ogun states, rice growers were found to have between 46.75 and 48.7years old (Afolami, et al, 2012). In a separate study Ogundele and Okoruwa (2006) found average of 42 years among rice growers under improved technology. As shown in Table 1, growers of IFAD–VCDP is gender sensitive (male). The males accounted for (79.3%) of the rice growers interviewed. Due to high proportion of male participants compared to female. The Chi square goodness of fit test indicates significant difference (P< 0.01) between the gender classes. This may probably be associated with labour and time-consuming activities in rice farming.

Further the men are more capable of enduring the strenuous activities involved in rice production than their female counterpart. Findings in this study correspond with previous report of various studies that rice production was dominated by male (Umeh and Atborah, 2007; Ndaghu et al; 2012; Erhabor and Ahmadu, 2013). In contrast, Adeleye (2016) reported more female compared to male rice farmers in Kaduna and Kano states. Ayoola et al, (2011) opined that women play active roles in the processing and marketing aspects of rice production. The foregoing indicates that there is a relationship between gender and some activities on the rice value chain. A large proportion (91%) of the IFAD-VCD participants are married, and are likely to have family labour force for rice production activities. The household size of 2 and 3 are in majority (43.4%), followed by household size of 1 and 2 (23.4%). In the absence of mechanized farming, a small household size may increase the need for hired labour.

The Chi square goodness of fit test show statistically significant difference (P< 0.01) between the household classes among the participants. On the other hand, with a small household size, the families may consume little part of their produce realized, and a large proportion will be available for sale to earn income. To a large proportion representing95.1% of the IFAD-VCDP participants had formal education ranging from primary

school certificate to postgraduate degree certificate while 4.8% of the participants never had formal education. The level of education attained by the respondents differed as indicated by statistically significant difference for the Chi square goodness-of-fit test. The level of education has implication on the desire to search and process technologies and adoption of new technologies. Educated farmers are likely to be more efficient in the use of farm inputs (Ogundele and Okoruwa, 2006). Olumade (2006) reported that education also improves human capital and farm management capacity, and as educational level increases, their use of improved technologies rises.

Farming experience has implication on adoption of farm technologies. IFAD-VCDP participants with 6- and 10-years' experience in rice farming are in large proportion followed by respondent with 1- and 5-years' experience. The Chi square goodness-of-fit test was statistically different at 0.01 level of probability.

Experience has effect (positive or negative) on adoption of technology, experienced farmers are better prepared to take or avert risk (Ojehomon et al, 2009). In another study, Afolabi et al, (2012) recorded 15- and 13-years' experience among rice farmers in Ogun and Ekiti states respectively. Majority (86.2%) of the respondents are engaged in other income generating activities, especially trading (43.4%) and civil servant (44.1%). Most (42.1%) of the IFAD-VCDP participants inherited their farmland, while 41.4% rented farmland for rice farming. Among the participants, those who cultivated between 1 and 5 hectares are in large proportion (81.4%), while 7% of the participants cultivated 20 ha and above. This indicates that the participants are small-scale rice farmers. The IFAD-VCDP recruit and train small scale rice growers on improved rice growing technologies, and link growers to markets, agro dealers and rice millers to scale rice productivity.

Table 1. Socioeconomic Characteristics of IFAD VCDP participants in Gassol and Ardo kola Local Government Area

Variables	Frequency	Percentage (%)	Df	Chi square	Probability
Age					
20 – 29	60	46.9	2	17.47	0.00
30 - 39	50	34.5			
40- 49	27	18.6			
Marital status					
Married	132	91.0	1	97.66	0.00
Single	13	9.0			
Gender					
Male	145	79.3	1	49.82	0.00
Female	30	20.7			
Household size					
1	34	23.4	4	70.00	0.00
2	63	43.4			
3	31	21.4			
4	10	6.9			
5	7	4.8			
Educational attainment					
No formal education	7	4.9	5	107.46	0.00
Primary education	11	7.6			
Junior secondary	9	6.2			
Senior secondary	37	25.5			
OND/NCE	65	44.8			
HND/University degree	16	11.0			
Years in rice farming					
1-5 years	40	27.6	4	22.34	0.00
6-10	61	42.1			
11-15	27	18.6			
16-20	5	3.4			
20>	12	8.3			
Engagement in other income earning activities					
Yes	125	86.2	1	76.02	0.00
No	20	13.8			
Types of income earning activities					
Craftwork	8	5.5	3	82.07	0.00
Trading	63	43.4			
Civil servant	64	44.1			
Others	10	6.9			
Land acquisition					
Purchase	10	6.9	4	161.91	0.00
Rent	60	41.4			
Leased	10	6.9			
Gift	4	2.8			
Inheritance	61	42.1			
Farm size					
1-5 ha	118	81.4	3	134.34	0.01
6 -10 ha	21	4.5			
11 – 15 ha	2	1.4			
16 – 20 ha	4	2.8			

Farm size allocated for rice production					
< 1 ha	4	2.8	5	189.34	0.01
1-5ha	131	90.3			
6-10 ha	5	3.4			
11-15 ha	2	1.4			
16 -20 ha	2	1.4			
20 ha >	2	7			

Field survey 2018

Institutional Characteristics of IFAD Rice Value Chain Participants

The majority (93.10%) of the participants had contact with IFAD-VCDP extension agent. The Participants who had between 6 and 10 extension contacts annually are in greater Proportion (30.2%), compared to 1 and 5 times. The Chi square goodness-of-fit test for the frequency of extension contacts showed that the classes were significantly different from one another. (Table 3). Increased extension contact will improve adoption technology information (Odoemenem and Obinne, 2010; Saka et al, 2005). The IFAD-VCDP participants belong to cooperative societies, social and developmental groups in their respective communities. Cooperatives are useful in overcoming access barriers to assets, information, land, labour and capital problems (Nweke, 1979; Holloway et al, 2000). Large proportion (33.80%) of rice growers' source for rice seeds from research institutes, agro-dealers, and IFAD (31.8%). The participants (98%) indicated that rice technologies introduced by IFAD fit to existing farming system, and are not difficult to practice without complex technology (62.8%). Before membership of IFAD VCDP, 87.5% of the participants harvested between 1 and 5 hectares of rice farm. Upon membership, participants who harvested 6-10 t ha^{-1} accounted for 34.6%, 20 t ha^{-1} (22%) and 11- 15 t ha^{-1}(18.5%).

Table 3. Institutional characteristics of IFAD VCDP participants in Gassol and Ardo kola Local Government Area of Taraba state

Variables	Frequency	Percentage (%)	Df	Chi square	Probability
Contact with extension agent					
Yes	135	93.10	1	107.76	0.00
No	10	6.89			
Number of extension contacts in a year					
1-5 times	18	5.7	4	234.09	0.01
6-10 times	96	30.2			
11-15 times	16	5.0			
16-20 times	08	2.5			
20>	07	4.9			
Membership of any association					
Yes	144	99.3	1	141.02	0.00
No	1	0.07			
Source of rice seeds after enrolling into IFAD VCDP					
Friends	1	0.3	4	90.43	0.00
Previous farming	1	0.3			
Agro dealers	49	33.80			
Research institute	49	33.80			
IFAD	45	31.80			
Rice technology fits well into existing farming system					
Yes	143	98.6	1	137.11	0.00
No	2	1.4			
Difficult to use IFAD recommended technologies					
Yes	54	37.2	1	8.44	0.002
No	91	62.8			
Estimated rice harvested by IFAD VCDP participants					
1-5 t/ha	24	7.0	4	24.84	0.00
6-10 t/ha	45	34.6			
11- 15 t/ha	10	18.5			
16- 20t/ha	22	16.9			
20 t/ha	29	22.0			
Estimated rice (t/ha) harvested before enrolling into IFAD- VCDP					
1-5 t/ha	115	87.8	2	175.20	0.00
6-10 t/ha	11	8.4			
11 – 15 t/ha	5	3.8			

Field survey 2018

Access to information on a particular agricultural innovation is the first step towards the creation of awareness among farmers. Various sources of information are used to disseminate agricultural technologies depending on the type of technology and level of education of the farmers. The reliability on rice technology information from various sources (Table 4) indicated that technology information on rice production from IFAD was most reliable, with a mean score of 3.54 out of 5.00, followed by research institutes (mean score =2.55, and information from Agricultural Development Project (mean score = 2.20). The reliability of technology information on rice production, processing, value addition, and markets from IFAD –VCDP may be associated with high credibility of the source for tomato technologies. High reliability of the source by rice value chain actors will account for increase area under cultivation, farm yield/hectare, improved quality of harvest and household income. The rice technology information from opinion leaders, village heads are least reliable, they recorded mean score of 1.37, 1.58 and 2.13 respectively. This trend may be associated with ineffectiveness of rice technologies from these source.Jamala et al, (2011) working on rice reported high effectiveness of rice

production technologies from research institutes and universities compared with informal sources (friends, opinion leaders etc.). These technologies are expected to scale up grain yield (t ha^{-1}).

Table 4. Degree of reliability of information technology from source among IFAD VCDP participants in Gassol and Ardo-kola Local Government Area of Taraba state

Degree of reliability of information technology from various sources	Most reliable 4	Reliable 3	Somewhat reliable 2	Not reliable 1	Mean score	Rank
IFAD	89 (2.45)	56(1.09)	0	0	**3.54**	**1**
Radio, Television and print media	41 (1.13)	10 (0.21)	10 (0.14%)	84 (0.58)	2.06	
Agricultural Development Project	8(0.22)	36(0.74)	78(1.08)	23 (0.16)	**2.20**	**3**
Research institute	48(1.19)	44(0.91)	14(0.19)	37 (0.26)	**2.55**	**2**
Friends	23(0.63)	23(0.48)	49(0.68)	49 (0.34)	2.13	
Opinion Leaders	5(0.14)	9(0.19)	22(0.30)	107 (0.74)	1.37	
Village heads	5(0.13)	11(0.23)	49(0.68)	78 (0.54)	1.58	

Field survey 2018

Awareness by IFAD-VCDP participants was high for use of improve seeds, biofortified seeds, accredited agro dealers, planting techniques, seed treatment, soil tests, crop rotation, method and time of fertilizer application in rice farm (Table 5). High awareness percentage for these technologies may be ascribed to relevance of these technologies in rice production. The prevalence of insect pests attack and diseases on rice farm results in severe yield loss. Management of insects and diseases in rice is important for high seed yield. The foregoing is responsible for high desire for insect pests and disease management practices. Hence high awareness for insect pests' management methods and disease management. The preponderance of insect pests and diseases necessitate types of insecticides, agro dealers, source of loan and rice millers and market for milled rice in the farming communities.

Table 5. Awareness of rice technologies by IFAD- VCDP participants in Ardo Kola and Gassol Local Government Areas

Rice technologies	**Awareness of rice technologies by IFAD- VCDP participants in Ardo Kola and Gassol Local Government Areas**	
Rice technologies	Yes (percentage %)	No (percentage %)
Improve rice seeds	141 (96.6)	5 (3.4)
Bio fortified rice seeds	140 (96.6)	5 (3.4)
Reliable agro dealers	140 (96.6)	5 (3.4)
Recommended spacing	138 (95.2)	7 (4.8)
Land preparation methods	134 (92.4)	11 (7.6)
Planting techniques	140 (96.6)	5 (3.4)
Weeding	133 (91.7)	12 (8.3)
Fertilizer types	136 (93.8)	9 (6.2)
Types of insect pests management methods	134 (92.4)	11 (7.6)
Diseases management	136 (93.8)	9 (6.2)
Harvesting methods	138 (95.2)	7 (4.8)
Rice millers	137 (94.5)	8 (5.5)
Market for milled rice	138 (95.2)	7(4.8)
Lowland rice production	138 (95.2)	7 (4.8)
Upland rice production	138 (95.2)	7 (4.8)
Time of fertilizer application	139 (95.9)	6 (4.1)
Method of fertilizer application	140 (96.6)	5 (3.4)
Source of loan	135 (93.1)	10 (6.9)
Types of insecticides	138 (95.2)	7 (4.8)
Seed treatment	129 (89.0)	16 (11.0)
Crop rotation	127 (87.6)	18 (12.4)
Soil test	110 (75.9)	35 (24.1)

Field survey 2018

As indicated in Table 6, the IFAD-VCDP participants had unrestricted access to rice tillage equipment (77.8%) during land preparation and use of pumping machine (82.1%). The Chi square Goodness-of-fit test were statistically significant at 0.01 level of probability. In traditional rice production, labour requirement for land preparation is high. To increase productivity mechanized land preparation is important.

The IFAD-VCDP participants' responses on access to pumping machines (82.1%) and sprayers (88.2%) diverged. The Chi square Goodness-of-fit tests are statistically significant at 0.10 % of probability. Unrestricted access to pumping machines and sprayers is necessary to deliver water and insecticides to plants. Unrestricted access to pumping machines and sprayers is consistent with high awareness percentage for use of insecticides and disease management.

Upland rice production is challenged by wild animals and Quelia birds, upland and lowland rice are attacked by Quelia birds. The use of wire mesh is an important technology widely practiced by rice farmers. The participants who had unrestricted access to use of wire mesh were 66.7%, while 33.30% had limited access to wire mesh. 68.1% had unrestricted access to net, 31.9% had no access to net and 45.8% of the participants had free access to use of sked crow. On the other hand, 54.2% had no access to sked crow. The Chi square goodness- of-fit test for access to sked crow, wire mesh and net showed statistically significant difference at 0.01% level of probability. This indicates that the responses differed in management of birds.

This study shows the preponderance of wire mesh and net compared to sked crows and Rodents.

Table 6. Access to rice production and processing facilities provided by IFAD VCDP

Variables	Frequency	Percentage (%)	df	Chi square	Probability
Tillage equipment					
Unrestricted access	112	77.8	1	44.44	0.00
No access	32	22.20			
Access to pumping machine					
Unrestricted access	119	82.1	1	61.36	0.00
No access	25	17.2			
Sprayers					
Unrestricted access	127	88.2	1	84.02	0.00
No access	17	11.8			
Automobiles					
Unrestricted access	64	44.4	1	1.77	0.18
No access	80	55.6			
Wire mesh					
Unrestricted access	96	66.70	1	16.00	0.00
No access	48	33.30			
Net					
Unrestricted access	98	68.1	1	18.77	0.00
No access	46	31.9			
Sked crow					
Unrestricted access	66	45.8	1	1.00	0.31
No access	73	54.2			
Threshers					
Unrestricted access	110	78.4	1	40.11	0.00
No access	34	23.6			

Field survey 2019

Conclusion

The study revealed that majority of the IFAD-VCDP participants are fairly educated, young adults with some years of experience in rice farming. They practiced rice production technologies made available to them by IFAD-VCDP. Growers are aware of the need to have soil test before planting, access to improve and high yielding rice seeds, land preparation and field management techniques and processing. The IFAD-VCDP has provided rice value chain actors with technologies that will scale up rice productivity in Taraba state and improve the livelihood of rice value chain actors. Awareness was high for most rice technologies. Unrestricted access to tillage equipment, pumping machine and sprayers. On the long run the adoption and impact of IFAD-VCDP will be assessed. The IFAD-VCDP should be extended to other rice producing states in the country.

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EFFECT OF GROUP PARTICIPATION ON MARKETING EFFICIENCY AMONG PRODUCE DEALERS IN KWARA STATE

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Abstract

The study determined the effect of group participation on marketing efficiency among produce dealers in Kwara State. A total of 304 respondents were randomly selected from Kwara State Produce Dealer Association. Descriptive statistics, marketing efficiency model, binary logistic regression and Student's t- test were used to analyse the data. The study revealed that the majority (77.55%) of the produce dealers were between 31 and 50 years of age, 67.72% of produce dealers were male and 80.70% of the respondents were married. The result further showed that the marketing efficiency of produce dealers traded less than 5 tons of cashew nuts was 71.33% while those that sold between 5 and 20 tons of cashew nuts was 127.29% and those that traded more than 20 tons was 213.42%. The result of the finding also revealed 43.7% of produce dealers had a high level of group participation while 56.3% of produce dealers had a low level of group participation. Furthermore, the result showed that age, marketing experience, quantity of cashew nut sold and benefits from the group were significant factors influencing the level of group participation among produce dealers. The result of t-test shows that there is significant difference in the marketing efficiency between produce dealers with high level of group participation and low level of group participation. The study concluded that the majority of the produce dealers were inefficient in their marketing activities. The level of group participation among produce dealers was low and influenced by their socioeconomic characteristics. The study recommends governance of the association should design a suitable and sustainable framework to facilitate benefits from group such as prompt marketing information, group networking as well as joint trading to attract and encourage participation of their members in group activities.

Keywords: Cashew nuts, Group Participation, Produce Dealer, Market and Marketing Efficiency.

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Introduction

Cashew is believed to be originated from Brazil. It is introduced to Nigeria by Portuguese traders between 15th and 16th century (Oladejo, 2015). It is held with great esteem and value in many customs and cultures. The plant favourably grows and strives in Sub-Sahara Africa. The wood made from cashew tree is used for making fishing boats and furniture. The apple is rich in vitamin C and sugar which can be fermented to produce wine, alcoholic drink and non-alcoholic drinks. Cashew nut is known to contain minerals such as iron, phosphorus and calcium and the fat-soluble vitamins A, D, E and K which are vital for the healthy growth of the human body (Akanni & Adams, 2011; Hammed, Anikwe & Adedeji, 2008). The cashew nut is made up of three different parts namely, the adhering testa, the kernel and the shell. The kernel is main product of cashew nuts. It is the edible portion of the nut often consumed as roasted and salted nuts. It is also used in confectionery and bakery products. The cashew nutshell contains a viscous and dark fluid, known as cashew nut shell liquid (CNSL). It is used as raw material for phenolic resins and brake lining compound for the automotive industry (Panda,

2013). The above uses of cashew nut have made it a valuable commodity for local consumption and as an export commodity.

Participation in group activities could be understood as the concept whereby all members of association or group are involved in contributing ideas and resources as well as taking responsibility for actions that concern and affect the wellbeing of the groups. Individuals that find it difficult to achieve certain goals efficiently as an individual are been brought together by the group. Such goals can be achieved by aggregating their resources such as capital and labour together. Hence, this will enhance their ability to engage in a profitable venture (Amondo, 2013). Members' socioeconomic characteristics may provide an avenue to benefit from participating in group activities. Indeed, participation in group activities may also contribute to learning and training in marketing of cashew nut. The group is, therefore, very crucial for credit accessibility, improved productivity, increased sales and profit (Suresh, 2009). These benefits of group participation could be achieved by enhancing members' access to information about capital and market requirement.

Marketing is one of the important aspects of agriculture. Agricultural marketing entails all the economic activities involved in the movement of agricultural produce/products and services from the point of production to the end-users. The poor agricultural commodity marketing in Nigeria has been traced to inadequate marketing knowledge with respect to some produce and their products. Specifically, the cashew nut is an untapped treasure with an abundance of economic importance in Nigeria. However, due to unawareness of its market opportunities, it has been difficult to harness its potential as a major export crop for the country (Adejo, Otitolaye & Onuche, 2011). Cashew nut marketing is a major source of income to many people in Nigeria. It provides significant contributions to job creation, foreign exchange earnings and Gross Domestic Product (Aliyu & Hammed, 2008).

The increase in demand for cashew nuts as raw materials for confectionery, medicine, automobile and other industrial usages across the globe, efficient cashew nut marketing has become important (Sivakumar & Mart, 2016). However, the cashew nut industry in Nigeria has not lived up to the expectation due to inefficiencies in the produce marketing, including high marketing cost, poor storage and processing facilities. The high level of inefficiency prevalent in cashew nut marketing across the country has been traced to the complex marketing structure (Akanni & Adam, 2011).

Besides, there is little or no empirical evidence on the effect of group participation on marketing efficiency among produce dealers in Kwara State. Therefore, this study intends to fill this gap in knowledge by proffering solution to the following research questions: Are the marketing of produce dealers efficient? What is the level of participation in group activities among produce dealers? What are the determinants of the level of participation of produce dealers in group activities? Can the level of participation in group activities have effects on the marketing efficiency of produce dealers? The main objective of this study is to determine the effect of group participation on marketing efficiency among produce dealers in Kwara State. The specific objectives are to: determine marketing efficiency of produce dealers; examine the level of participation in group activities among produce dealers; assess the determinants of the level of participation of produce dealers in group activities and determine the effects of level of participation in group activities on the marketing efficiency of produce dealers.

The study will be helpful to produce dealers on how to improve marketing efficiency in cashew nut marketing. The knowledge of factors that affect the participation of members in group activities and their characteristics is important in designing appropriate intervention for efficient participation of every stakeholder in decision making, price determination and market information for efficient cashew nut marketing. In addition, the outcome of this research will help provide information to produce dealers and other actors along the cashew value chain on the issues to be addressed in forming groups. Also, the findings from this study will further add to the existing knowledge on cashew nut marketing in Nigeria.

Literature review

Concept of Market and Marketing

Market can be defined in various dimensions such as location, product, time, institution etc. Market is generally an area or setting in which price making forces operate. It may be a city, state or a place of buying in a given town and such is referred to as market place (Aminu, 2009). According to Kotler and Armstrong (2012) market can be described as the set of all actual and potential buyers of a product or service. This market comprises a set of marketing channels through which the commodity is transferred from producers to consumers. The most important factors for the existence of markets are; the goods to be sold must exist, the presence of sellers and buyers and both must agree on a price. In addition, the market can be a local market, a domestic market, and a world market. The limits of this kind of market are set not by a physical boundary fence but by the ease of communication, transportation, political and monitory barriers to the free movement of goods and money.

Morton (2017) defined market as an area or setting within which the forces of demand and supply converge to establish price and where producers and consumers meet for an exchange to take place. Also, he categorized markets into three types. These are produce-consumer market; local assembly market (rural market); and retail Market. Producer-Consumer Market is a situation in which producers sell directly to consumers and it is the cheapest source of purchase for the consumer. Local Assembly Market (Rural Market), on the other hand, is usually operated in an open space where farmers bring their produce on accepted market days. While the retail market comprises stalls in which all types of commodities are directly available for sale to consumers. These markets are operated directly or periodically throughout the year. Majority of traders in most parts of developing countries are in this category.

Marketing is a broad concept which means different things to different people. There is no universally acceptable definition. However, the basic principle is that exchange occurs for the mutual benefits of all parties involved. Marketing encompasses all the business activities performed in directing the flow of goods and services from the producer to the consumer or final user (Brunswick, 2014). These activities are usually classified into six stages. These include production; assembly; processing; wholesaling; retailing and consumption. Marketing is a social and managerial process by which individuals and organisation obtain what they need and want through creating, offering as well as exchanging value with others. It is a process of managing profitable customer relationships. The ultimate goal of marketing is to attract new customers by providing superior value as well as to keep and grow current customers by delivering satisfaction. The mission of marketing is satisfying customer needs and making profit (Kotler & Armstrong, 2012). According to Acharya and Agarwal (2000), agricultural marketing is defined as all activities involved in the supply of farm inputs to the farmers and movement of agricultural products from the farmers to the consumers. It is both physical distribution and an economic bridge designed to facilitate the movement and exchange of goods and services, cashew nut in this instance, from the farm to the end user.

Group Formation

There are no universally accepted definitions for the term “group”. Some sociologists emphasized the importance of mutual dependence or communication as the basis of group formation while others stressed that a shared purpose is what turns a mere aggregate of people into a group (Forsyth, 2016). According to Aiken (2013), a group is defined as two or more individual who perceive themselves to be members of the same social category. Group comprises two or more persons who think of themselves as a group, are interdependent, communicate with one another, and share common social identification. According to Smith (2018), group can be categorized into various forms depending on their purpose, structure, etc. However, purpose and structure categories have retained their usefulness for both practitioners and researchers. Types of group include primary and secondary groups; and planned and emergent groups. Primary groups refer to families and close friends where there is close, face-to-face as well as intimate interaction. There is also often a high level of interdependence between members. It

is the key means of socialization in any society, the main place where attitudes, values and orientations are developed and sustained. On the other hand, **s**econdary groups are types of groups where members hardly have face to face contact. They are often large and usually formally organized; these include trade unions and membership organizations. It is an important place for socialization. The Kwara State Produce Dealers Association could describe as planned group. It is because produce dealers come together to form a group in order to achieve some purpose.

Theoretical Framework

In attempt to provide sound theoretical underpinning for the study, two theories were critically reviewed and adopted. These are the general theories of fundamental *explananda* of marketing and group formation theory.

General Theories of Fundamental *Explananda* of Marketing

According to Hunt (1983), marketing is the behavioural science that seeks to explain exchange relationships. He adopted the customary convention of designating one party to the exchange as the "buyer" and another party as the "seller". From this definition he deduced four fundamental *explananda* (phenomena to be explained) directed at facilitating or consummating exchanges. These include: the behaviour of buyers, sellers, the institutional framework in which exchange between buyers and sellers occur, and the consequences on the society.

The main focus of this theory is that it lay emphasis on the behaviour of the both buyers and sellers towards the adoption of marketing mix which are also known as four Ps (product, price, promotion and place) of marketing mix and the effect of the institutional framework on the adoption of this marketing strategy. The theory further described the consequences of their interaction on the society.
The first set of fundamental *explananda* is the behaviour of buyers indicating that produce dealers tend to adopt marketing mix which seek to answer why produce dealers purchase cashew nut, where do they purchase the nut and when and how do they purchase the nut?

The second set of fundamental *explananda* which is the behaviour of sellers in relation to the method used to improve cashew nut quality. The promotional method employed in creating awareness of the availability of cashew nut at the local and international market. The pricing strategy adopted to attract new and existing buyers and finally the location in which the cashew nut is sold.

The third set of fundamental *explananda* is the institutional framework in which exchange between buyers and sellers occur. This is concerned with the government policy and incentive on cashew nut marketing as an export produce commodity. Other institutional environments that influence the activities of produce dealers are the financial institutions', insurance companies, produce dealer's association, ministry of agriculture as well as ministry of commerce and industry which are responsible for the registration and smooth running of their business activities.

The fourth set of fundamental *explananda* is the consequence of the continuous interaction among the buyer, seller and institutional framework. The impact of these interaction on the society are income generation for state inform of taxes and levies, employment generation within the locality, provision of raw materials to industries and reduction of social vices thereby fostering peace harmony within locality.

Homans' Theory of Group Formation

According to Homans (1950), group formation is based on three elements. The elements included activities, interaction and sentiments. These three elements are directly related to each other. The activities can be defined as the assigned tasks to group member to do. The interaction takes place when any person's activity takes place or is influenced by the activity of any other person. Sentiments are the feelings or attitudes of a person towards others, i.e., his likes or dislikes, approval or disapproval. The nature of the interdependence among the elements suggest that if the frequency of activity and

interaction between two or more persons increases, the degree of their liking for one another will increase and vice versa". In other words, activity, interaction, and sentiment feed on one another such that an increase (decrease) in one is often followed by an increase (decrease) in the other. Activities, interaction and sentiments are not only help in attaining group's goals but also to solve problems, facilitate coordination, reduce tension and achieve a balance.

This implies that the more the produce dealers participate in group activities the more the interaction as well as sentiments and the greater the benefits individual member drive from group. The benefit could be having better access to credit, improving productivity, reduction in transportation cost and improving efficiency of cashew nut marketing.

Methodology
Study Area

This study was conducted in Kwara State. The State is located in the North-Central geographical zone, and has a land mass of about 32,500 square kilometres (Km^2). It is situated between latitudes 7^0 45'N and 9^0 $30^{'}$N and longitude 2^0 $3^{'}$ E and 6^0 $25^{'}$ E. The State has 16 Local Government Areas and its capital is Ilorin. The State of harmony is less densely populated regions in the country, with a projected population of about 3,192,893 (National Bureau of Statistic, NBS, 2017). The topography of Kwara State is mainly plain lands. The vegetation ranges from rainforest to wooded savannah. The two main climates experienced in the state are wet and dry seasons with some cold and dry harmattan from December to January . The annual rainfall ranges between 1000mm and 1500mm; average daily temperature ranges from 30^o C to 35^o C. The state has large expanse of arable land and suitable ecological / climatic conditions which make it possible to cultivate wide varieties of crops. The vegetation cover is rain forest in the southern part, and gradually tends to reduce to Guinea Savannah as one move towards the northern part of the state (KWSG Diary, 2010).

Kwara State is one of the major producers of cashew nut in Nigeria as the crop is grown in all the sixteen Local Government Areas of the state . The State produces about 55,000 tons of cashew nut annually (Akinola, 2016). Cashew nut production, processing and marketing create job, income and wealth for the people of the state. The nut also provides foreign exchange earning to the country.

Sampling Technique and Sample Size
Kwara State Produce Dealer Association has three thousand and forty (3040) registered members across the state and they have forty-two (42) zones (Kwara State Produce Dealer Association, 2019). A two-stage sampling technique was used for sample selection. The first stage involved a random selection of twenty-five per cent of the zones in the study area, eleven zones were selected. In the second stage, three hundred and four (304) cashew farmers were randomly selected from eleven zones in proportion to their membership size.

Method of Data Collection
The data for this study was obtained from the primary source using a structured questionnaire was designed to collect required data. The data collected include socioeconomic characteristics of produce dealers such as age, household size, sex, educational level, marital status, etc. Also, data on all costs incurred in buying and selling of cashew nut.

Analytical Techniques
The descriptive and inferential statistics were used to analyse the data from the field survey. The tools employed were marketing efficiency model, binary logistic regression and Student's t- test.

Marketing Efficiency Model

The marketing efficiency formula was used to determine marketing efficiency of produce dealers in the study area. Marketing Efficiency (ME) is the ratio of net marketing margin received by the produce dealers to the total marketing cost. M E Model is expressed implicitly according to Osondu et al. (2014) as:

$$ME = \frac{\text{Output of Cashew nut Marketing}}{\text{Input of Cashew nut Marketing}} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The output of marketing was denoted by net returns from marketing activities and input of marketing was denoted by the cost of marketing activities.

$$\text{Therefore, } ME = \frac{\text{Net Marketing Margin of Cashew nut}}{\text{Marketing cost of Cashew nut}} \times 100 \ldots\ldots\ldots\ldots\ldots (2)$$

Marketing Margin (MM) was calculated by determining the price at different segment and compare them with the final price paid by the consumer. The formula for marketing margin as follows;

Marketing Margin = Seller's price – Buyer's price …….. (3)

Net Margin = Marketing Margin – Marketing cost. ……. (4)

The marketing cost is the sum of transport cost, storage cost, loading and off-loading cost, packaging cost, tax and other costs. According to Scarborogh and Kydd (1992), the marketing efficiency of 100% shows that the market is perfectly efficient because price increment is just high enough to cover the cost of marketing cashew nut. While the marketing efficiency figure below 100% is indicative of inefficiency; more is spent on value addition compared to the margin received after value addition. Marketing efficiency value of greater than 100% depicts market is highly efficient.

Levels of Participation in Group Activities among Produce Dealers

A 5-point Likert type scale was employed to determine the levels of participation in group activities among produce dealers in the study area. Produce dealers were asked to rate their level of participation in group activities on a 5-point numerical rating scale of; Always = 5, Often = 4, Sometimes = 3, Rarely = 2, Never = 1. The produce dealers were expected to select each activity according to the degree of participation. The score obtained by individual member was added and divided by 7 to get a mean score. The variables measured are payment of monthly contribution/dues, abiding by the rules of the group, attendance at the meetings, participating in group's training, contribution to group discussions, committing personal resources to group's activities and inviting new members to the association.

The level of group participation index which was further used to determine the level of participation in group activities according to Goddey and Akinloye (2016) as follows:

Participation in group activities by produce dealers with mean score greater than or equal to average mean score (3.0) were categorised as high level of group participation.

Participation in group activities by produce dealers with mean score less than average mean score (3.0) were considered as low level of group participation.

Binary Logistic Regression Model

The binary logistic regression model was employed to examine the determinants of the level of participation of produce dealers in group activities. The model is a linear regression tool with a binary response variable. The binary logistic regression is the appropriate tool when the dependent variable is dichotomous and it is used for prediction of the presence or absence of dichotomous variable based on values of a set of predictor variables (Borooah, 2002).

According to Norusis (1993), the relationship between the binary status variable (S_i) and the determinants X_i is specified as $S_i = \beta X_i + V_i$

Where S_i = Binary group participation. It takes value of 1 for high level of group participation and zero for low level of group participation.
β = Vector of the respective parameter which is estimated using maximum likelihood.
V_i = error term.
In logistic regression, the probability of an event occurring is estimated as
pro (event) = $\frac{1}{1+e^{-z}}$ ……5 Norusis (1993)

The odds that an event will happen = $\frac{\text{probability of an event occuring}}{\text{probability of an events will notoccuring}}$

Z = $\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots \beta_n$ ……..6
For this study, the event is level of group participation
= β_0 and β_1 are the estimated coefficient of the parameters

i =1, 2, 3……..n

The independent variables are: X_1 = Age (years), X_2 = Educational status (years of formal schooling), X_3 = Household size (number of people living and feeding together), X_4 = Quantity of cashew nut sold (tons), X_5 = Cashew nut marketing experience (years), X_6 = Monthly income from other sources (₦), X_7 = Benefit gained from the group (range from 1-5 in order of benefit), d_1= Gender (dummy: male = 1; female = 0),d_2 = Occupational status (dummy: full time = 1; part time = 0) and d_3 = Membership of other associations (dummy: yes = 1; no = 0).

Student's t- test of Significance
Student's t- test was used to test the difference in mean between the treatment group and the control groups. It was employed to determine the effect of level of participation in group activities on marketing efficiency of produce dealers.

The formula is given as:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{S_{X_1 X_2}\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}} \quad \ldots\ldots\ldots\ldots\ldots\ldots 7$$

$$S_{X_1\ X_2} = \sqrt{\frac{(n_1 - 1)S_{X_1}^2 + (n_1 - 1)S_{X_2}^2}{n_1 + n_2 - 2}}$$

$S_{X_1\ X_2}$ is an estimator of the common standard deviation of the marketing efficiency
Where n_1 = number of respondents with high level of marketing efficiency
n_2 = number of respondents with high level of marketing efficiency
$\overline{X}_1$ = mean of respondents with high level of marketing efficiency
$\overline{X}_2$ = mean of respondents with high level of marketing efficiency.

Results and Discussion
Socioeconomic Characteristics of the Produce Dealers in Kwara State
Details on the Socioeconomic Characteristics of the Cashew farmers as presented in Table 1.

Table 1: Socioeconomic Characteristics of Produce Dealer in Kwara State

Characteristics	Category	Frequency	Percentage
Age	20-30	45	15.79
	31-40	141	49.48
	41-50	80	28.07
	51-60	14	4.91
	>60	5	1.75
Gender	Male	193	67.72
	Female	92	32.28
Marital status	Single	39	13.68
	Married	230	80.70
	Divorced	12	4.21
	Windowed	4	1.41
Household size	1-5	149	52.28
	6-10	123	43.16
	>10	13	4.56
Level of Education	None	88	30.88
	Quranic	20	7.02
	Primary	105	36.84
	Secondary	62	21.75
	Tertiary	10	3.51
Marketing experience	1-10	114	40.00
	11-20	163	57.19
	>20	8	2.81
Quantity of cashew nut sold	≤ 5.00 ton	170	59.65
	5.01-10.00 ton	71	24.91
	10.01-15.00 ton	14	4.91
	15.01-20.00 ton	8	2.81
	>20.00 ton	22	7.72
Occupation status	Main	39	13.68
	Minor	246	86.32
Other sources of income	No other	34	11.93
	Farming	58	20.35
	Trading	152	53.33
	Artisan	17	5.97
	Civil servant	24	8.42

Source: Field Survey, 2019

As shown in Table 1, the majority (77.55%) of the produce dealers were between 31 and 50 years of age with an average age of 39 years. This reveals that the majority of the produce dealers are young and still within the productive age during which they can fully and efficiently engage in all forms of marketing activities. This is in line with the study of Oladejo (2015) that reported an average age of 40.53. The result of the study showed that 67.72% of produce dealers were male, indicating that males are more involved in cashew nut marketing than their females' counterpart. This corroborates the

findings of Farayola et al. (2013) which indicated 78.4% of the produce dealers were male. The results revealed that the majority (80.70%) of the produce dealers were married.

This means that married people were more engaged in cashew nut marketing and are likely to receive assistance from their spouses to carry out cashew nut marketing. This result similar to Salau et al. (2018) that reported 92.8% of the produce dealers were married. The result further showed the average household size of produce dealers to be 6 people with minimum household size of 2 people and a maximum of 16. This indicates that there is availability of family labour as a form of assistance in carrying out cashew nut marketing. About of seventy per cent of the produce dealers had at least primary education. Educated produce dealers are expected to be more informed about marketing issues and consequently, should be able to minimize marketing costs and maximize profit better than their illiterate counterpart. This is in line with study of Akanni and Adams (2011) that reported about 70% of cashew nut marketers were educated.

With respect to marketing experience, the result indicated that the produce dealers had 14 years as the average years of marketing experience. The years of marketing experience is expected to have a positive impact on marketing performance of the produce dealers. The result of the study showed that the majority (59.65%) of the produce dealers traded below 5 tons of cashew nuts. The average quantity of cashew nuts sold by produce dealers was 7.20 tons. This indicates that the majority of cashew nut marketers are operating at a small-scale level which could be attributed to the capital intensiveness of the enterprise. A large percentage (86.32%) of produce dealers had cashew nut marketing as their minor occupation.

This implies that most produce dealers are engaged in cashew nut marketing as their secondary sources of income. The research work shown that 53.33% of the produce dealers had other sources of income as trading while 20.35%, 5.97%, 8.42% of them had farming, artisan and civil servant as their other sources of income respectively. This indicates that people from different occupations are involved in cashew nut marketing.

Marketing Efficiency of Produce Dealers in Kwara State

Details on marketing efficiency of produce dealers in Kwara State are presented in Table 3.

Table 2: Marketing Efficiency of Produce Dealers in Kwara State

Cashew nut (Ton)	Selling Price (₦/ton)	Buying Price (₦/ton)	Marketing cost (₦/ton)	Total cost (₦/ton)	Net Margin (₦/ton)	Marketing Efficiency (%)	Efficient Produce Dealers (%)	Inefficient Produce Dealers (%)
≤5.00	202531.96	170664.97	18599.70	189264.67	13267.29	71.33	32.35	67.65
5.01-10.00	211131.55	177212.60	15339.28	192551.88	18579.67	121.13	59.15	40.85
10.01-15.00	221477.30	184460.20	16263.07	200723.30	20753.98	127.61	57.10	42.86
15.01-20.00	220224.48	182874.73	16020.99	198895.73	21328.75	133.14	65.00	35.00
> 20.00	235746.61	197586.73	12175.26	209761.99	25984.62	213.42	86.36	13.64

Source: Field Survey, 2019

The study showed that produce dealers that traded the quantity of cashew nut below or equal to 5.00 tons had an average of ₦13,267.29 and 71.33% per ton as their net margin and marketing efficiency respectively, while majority (67.65%) of produce dealers were inefficient in their marketing activities. With respect to produce dealers that sold between 5.01 and 10.00 tons of cashew nut, an average of ₦18,579.67 and 121.13% per ton were recorded as their net margin and marketing efficiency respectively. The result further indicated that the majority (59.15%) of produce dealers in this group were efficient.

The category of produce dealers that sold between 10.01 and 15.00 tons of cashew nut earned a net margin of ₦20,753.98 and had 127.61% of marketing efficiency per ton. The result also showed that most (57.10%) of produce dealers in this group were efficient. Concerning the produce dealers that transacted between 15.01 and 20.00 tons of cashew nut, an average of ₦21,328.75 and 133.14% per ton were recorded as their net margin and marketing efficiency respectively. The majority (65%) of cashew nut marketers in this group were efficient. Furthermore, the study revealed that produce dealers that sold the quantity of cashew nut above 20 tons earned a net margin of ₦ 25,984.62 and had 213.42% per ton as their marketing efficiency, while majority (86.36) of produce dealers in this group were efficient. From Table 2, it is observed that the marketing efficiency of produce dealers is increasing with increase in the quantity of cashew nut traded in the study area. In all, 44.21% of the produce dealers were efficient while 55.79% of them were inefficient, implying that the majority of produce dealers were inefficient. This result supports the position of Akanni and Adams (2011) that reported the majority of cashew nut marketers in south western Nigeria were inefficient

Level of Participation in Group Activities among Produce Dealers in Kwara State

Details on the level of participation in group activities among produce dealers in Kwara State are as presented in Table 3.

Table 3: Distribution of Produce Dealers According to their Participation in Group Activities

Activities	Always	Often	Sometimes	Rarely	Never	MS
Attendance at the meeting	84 (29.5%)	124 (43.5)	72 (25.3%)	4 (1.4%)	1 (0.4%)	4.00
Abiding by the rules of the group	64 (22.5%)	107 (37.5%)	108 (37.9%)	5 (1.8%)	1 (0.4%)	3.80
Payment of monthly dues	51 (17.9%)	98 (34.4%)	70 (24.5%)	59 (20.7%)	7 (2.5%)	3.45
Contribution to group discussions	18 (6.3%)	36 (12.6%)	80 (28.1%)	82 (28.8%)	69 (24.2%)	2.48
Participation in the group's training	18 (6.3%)	45 (15.8%)	79 (27.7%)	46 (16.1%)	97 (34.1%)	2.44
Inviting new members to the association	8 (2.8%)	30 (10.5%)	66 (23.2%)	124 (43.5%)	57 (20.0%)	2.33
Committing personal resources to group's activities	12 (4.2%)	11 (3.9%)	56 (19.7%)	146 (51.2%)	60 (21.0%)	2.19

Source: Field Survey, 2019.
MS – Mean Score.
Figure in parenthesis are percentages.

Table 4 shows the distribution of produce dealers according to their participation in group activities, mean scores are within 2.19 and 4.0 while the average mean score was 3.0. The activities with mean scores of less than 3.0 were considered as a low level of group participation while the activities with mean values of equal to or greater than 3.0 were regarded as high level of group participation.

The study revealed that at least 73% of the produce dealers often attended the association's meeting. The attendance at the meeting had a mean score of 4.00. This shows that the majority of produce dealers had regular attendance at their association's meeting. This could assist cashew nut marketers to share marketing information and address challenges facing members of the association. With respect to abiding by the rules of the group, the result showed at least 60% of produce dealers often abided by the rule of the association. The mean value of 3.8 also revealed that abiding by the rule of the association was regular activities carried out by produce dealers. The study further showed that produce dealers' level of participation for payment of monthly dues was high with a mean value of 3.27. Majority (52.3%) of produce dealers often paid their monthly dues. The implication is that most of the produce

dealers paid their monthly dues regularly and this would assist the association in carrying out their activities.

Contribution to group discussions was one of the group activities that below means value. Nineteen per cent of produce dealers made regular contributions to group discussions. This reveals that the majority of produce dealers hardly contributed to group discussions during the meeting. Concerning the participating in group training, about sixteen per cent of produce dealers often attended group training. The mean value of 2.44 showed that most produce dealers had low participation in group training. The study further showed that inviting new members to the association had a mean score of 2.33 with the majority 43.5% of produce dealers rarely invite people to join the association. With respect to committing personal resources to the group's activities, 51.2% of produce dealers rarely used their resources to group activities. The mean value of 2.19 revealed that committing personal resources to group activities was not a regular activity performed by produce dealers.

Table 4: Distribution of Produce Dealers by Mean Scores on Level of Participation in Group Activities

Level of Participation In Group Activities	Mean Score	Frequency	Percentage
Low level	0-2.90	160	56.3
High level	3.0-5.0	125	43.7

Source: Field Survey, 2019.

As shown in Table 5, 43.7% of produce dealers had a high level of group participation while 56.3% of produce dealers had a low level of group participation. This implies that majority (56.3%) of produce dealers had a low level of participation in group activities in Kwara State.

Determinants of Level of Participation in Group Activities among Produce Dealers in Kwara State

Table 5: Determinants of Level of Participation in Group Activities among Produce Dealers in Kwara State

Variable	Coefficient	Std. Err	P>|z|
Age	-0.093***	0.029	0.001
Education	0.018	0.031	0.562
Marketing Experience	0.220***	0.040	0.000
Monthly income from other sources	0.095	0.087	0.714
Household size	0.129	0.098	0.188
Marital status	0.111	0.295	0.708
Gender	0.366	0.290	0.208
Quantity of cashew nut	0.026*	0.015	0.078
Benefits from group	1.149***	0.270	0.000
Membership to other associations	0.130	0.307	0.671
Constant	-3.844	1.291	0.003

Source: Data Analysis, 2019; *** P<0.01, *P<0.10

The result of the binary logistic regression reported a pseudo R^2 of 0.4282, which shows the strength and fitness of the model. The pseudo R^2 value (0.4282) is a bit lower probably due to low sample size but it can still be adopted for the model. The model had a chi-square of 97.69 and is significant with a probability value of 0.0000. The model is statistically significant, which is an indication that the interaction effect is contributing significantly to the full model and should be retained.

The result obtained in Table 5 shows that age, marketing experience, quantity of cashew nut traded and benefits from the group were the significant factors influencing the level of participation in group activities among produce dealers in Kwara State.

The negative and significant coefficient of age revealed that the younger the produce dealers, the more the probability of produce dealers participating in group activities. This implies that young produce dealers are more likely to participate fully in group activities than their old counterpart. This is in line with the findings of Martey, Etwire, Wiredu and Dogbe, (2014) on the participation of smallholder farmers in the multi-stakeholder platform.

The coefficient for marketing experience was positive and significant (P<0.01). The implication is that the more experienced a produce dealer is, the higher the probability to participate more in group participation. This is corroborated by the study of Goddey and Akinloye (2016) on farmers' participation in community- based organizations.

The coefficient for the quantity of cashew nut sold was positive and significant (P<0.10). This depicts that the more the quantities of cashew nuts traded by produce dealers the higher the likelihood of respondents to participate more in group activities. Produce dealers that operating on a large scale are more likely to be more engaged in group participation.

The coefficient for benefits gained from the group was positive and significant (P<0.01). This implies that the more the benefits gained from the group by respondents the higher the probability of produce dealers to participate in group activities. The benefits of the group such as marketing information, joint trading and group networking will likely encourage group participation.

Effect of Level of Participation in Group Activities on Marketing Efficiency of Produce Dealers of Cashew Produce Dealer

Table 6. Effect of Level of Participation in Group Activities on the Marketing Efficiency of Cashew Produce Dealer

Outcome Variable	High level group participation	Low level group participation	Mean diff	t-value
Marketing Efficiency	163.0613	71.87296	91.18835	12.7639

Source: Data analysis, 2019.

The result of t-test shows that there is significant difference in the marketing efficiency between produce dealers with high level of group participation and low level of group participation. This implies that the high level of group participation increases marketing efficiency by 91.19%.

Conclusion and Recommendations

The study concluded that the majority of the produce dealers were inefficient in their marketing activities. The level of group participation among produce dealers was low and influenced by their socioeconomic characteristics. Participation in group activities increased the marketing efficiency of produce dealers. The implication is that members' participation would enable them to harness the group benefits which would have positive impact on their marketing efficiency.

Based on the findings of the study, the study recommends the following:

i. Benefits from involving in group activities found in this study play important role in increasing level of participation of the produce dealers in group activities. Therefore, governance of the association should design a suitable and sustainable framework to facilitate benefits from group such as prompt marketing information, group networking as well as joint trading to attract and encourage participation of their members in group activities.

ii. Quantity of cashew nut traded by produce dealers has been found to enhance level of participation of the produce dealers in group activities. There is need for produce dealer's association to engage in backward integration by providing productivity enhancing support to help cashew farmers so that large quantity of cashew nut could be guarantee.

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ECONOMIC ANALYSIS AND PROFITABILITY OF PINEAPPLE-BASED INTERCROPPING SYSTEM IN SOUTH-WEST NIGERIA

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Abstract

The economic and profitability of pineapple-pepper-cowpea based intercropping system in Akure was evaluated. The experiments evaluated the impact of time of introduction of one of the component crops, cowpea into the intercropping system on the intercrop. Sowing of cowpea into pineapple-pepper intercrop was done at the time of transplanting pepper seedlings into pineapple, at 3, 6 and 9 weeks after transplanting (WAT) pepper seedlings into pineapple while sowing of cowpea in late season planting was at transplanting and 3WAT. The sole crops of the crop components were also established. The cost of production and returns from each crop combination were aggregated. Economic returns and profitability indices showed that sole pineapple and pineapple-pepper-cowpea intercrop were profitable. Pineapple-pepper intercrop without cowpea and sole pineapple appeared as the preferred options based on their slightly higher net benefits. However, delayed sowing of cowpea into pineapple-pepper intercrop ensures the spread and diversification of produce and income to the farmer in addition to immediate satisfaction of food need of the farmer's family.

Keywords: pineapple, cost benefit ratio, intercropping, profitability, income diversification

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Introduction

Pineapple (*Ananas comosus* (L.) Merrill) is an important tropical fruit characterized by initial slow growth during establishment phase and long gestation period from planting to flowering and fruiting. Pineapple is produced in Nigeria mainly from farm edges, compound gardens or as a secondary crop in intercrop with food or cash crops. The lack of immediate returns on investment in a sole pineapple enterprise during the first year of cropping and challenges associated with management of the wide spaces between the rows of pineapple pose a lot of challenges to farmers. However, pineapple intercropping provides an opportunity for resource constraintfarmers to optimize their production by growing short duration food crops with pineapple in order to get income more quickly (Uriza *et al*., 2005). Thiswill improve crop diversity, spreads of labour and their economic profitability.

Introduction of Peppers (*Capsicum spp*), a short-term perennial crop within the rows of pineapple during the establishment phase can be practicedto maximize utilization of farm resources. Theintroduction of another short duration crop such as cowpea (*Vigna unguiculata*) can further extend the utilization of resources (space, light and water). However, the productivity of the componentsof the intercropping and the effectiveness of resource utilization will depend on timing and scheduling of the growth phases in which the component crops interact on the field and the seasons.

It is imperative to adjust cropping pattern and the timing of introduction of component crops into the pineapple-pepper intercropping system especially the timing of cowpea introduction in order to minimize competition among component crops. The responses of the component crops under different growing season can also vary based on the crop-environment-management interaction. This can influence the returns of the farmers under the different crop combination and the prevailing weather condition.

In an additive intercropping system, the introduction of the minor crop components spread the cost of production which would have been borne by the single crop of the main crop. The choice of intercrop

combination to adopt is the decision of the farmer which may be based economic profitability in addition to other perceived benefits such asinternal insurance from crop failure obtained from crop diversity and steady and continuous flow of income. The aim of the study is to (This paper) evaluate the economic and profitability of pineapple-pepper based intercropping system when cowpea is introduced at various intervals.

Methodology

The economic and profitability of pineapple-pepper-cowpea based intercropping system of four experiments conducted at two locations in Akure, humid rainforest zone of Nigeria was evaluated. The experiments evaluated were initiated during the rainy and late seasons of 2011 and 2012, respectively. The rainy-season planting comprised of two experiments carried out at the Experimental Station of the Federal College of Agriculture, Akure between April 2011 and December 2012 and April 2012 and December 2013, respectively. The late-season planting also comprised of two experiments conducted at the Teaching and Research Farm, Federal University of Technology, Akure between August 2011 and April, 2013 and July 2012 and March 2014, respectively.

The rainy-season planting comprised of four dates of sowing cowpea into pineapple-pepper intercrops namely: sowing of cowpea at the time of transplanting pepper seedlings into pineapple, sowing at 3, 6 and 9 weeks after transplanting (WAT) pepper seedlings into pineapple, pineapple-pepper intercrop without cowpea and the sole crops of pineapple, pepper and cowpea. The late-season planting comprised of two dates of sowing cowpea into pineapple-pepper intercrops at 3-weeks interval (sowing cowpea at the time of transplanting pepper seedlings into pineapple and sowing at 3 weeks after transplanting pepper seedlings into pineapple), pineapple-pepper intercrop without cowpea and sole crops of pineapple, pepper and cowpea.

The cost of productionand returns from each crop combination based on one cycle of production were aggregated. A number economic analysis tools were used to evaluate the different treatments. These include: partial budget analysis, benefit to cost ratio, rate of return on investment and profit margin.Crop enterprise budget were developed for each treatment. Crop prices and operational cost used in the budgets were averaged prices that were prevalent in the study area during the cropping seasons. Total revenues were calculated annually as the products of treatment yield and average price. Variable costs were the actual cost incurred in the production. Net benefits per hectare were calculated as the difference between total revenue and total cost. In constructing the budget, no charges were included for land.

Formulae for estimating economic indices

1. Total Variable Cost (TVC) = Labour cost + Cost of inputs + Transportation/handling
2. Total Cost (TC) = Total Variable Cost (TVC) + Fixed Cost (FC)
3. Gross return/revenue = Average yield/ha x farm gate price (₦/kg)
4. Net Benefit (NB) = Total Revenue (TR) – Total Cost (TC)
5. Rate of Return on Investment (RORI) = $\frac{\text{Net Benefit (NB)}}{\text{Total Cost (TC)}}$
6. Benefit to Cost Ratio (BCR) = $\frac{\text{Total revenue (TR)}}{\text{Total Cost (TC)}}$
7. Profit Margin (%) = $\frac{\text{Net Benefit (NB)}}{\text{Total Revenue (TR)}}$

Results

Analysis of economic returns

Gross Returns from intercropping treatment combinations

The Gross Returns of each component crops in the intercropping treatment in relation to the cost of production are presented in Fig. 1-4. The figures show the trends reduction in the gross returns from pineapple fruits associated with intercropping with cowpea and pepper. The high magnitude of reduction in Gross Return was recorded when cowpea was introduced at the time of transplanting pepper into pineapple in the rainy season of 2011 while the reduction in returns for pineapple among the plots with delayed sowing of cowpea was minimal (Fig. 4). The returns from pepper however increased progressively with

delayed sowing of cowpea into pineapple-pepper intercrop while returns from cowpea declined with the delay in sowing cowpea. The Figure also indicates that only marginal difference in the cost of production among the intercrop treatments was obtained.

The Gross Return from pineapple fruits during the rainy season experiment of 2012 was higher than return from pineapple fruits in 2011 (Fig. 1). However, the magnitude of difference between the sole pineapple and pineapple with pepper and cowpea sown simultaneously was lower. The additional returns obtained from cowpea and pepper was also low.

Fig. 2 and 3 show that the Gross Returns from pineapple declined with intercropping with pepper and cowpea in the late season of 2011 and 2012. However, a higher return was obtained from pineapple in the late season experiment of 2012. The magnitude of reduction in the Gross Returns for pineapple was high in the late season of 2012 compared with the late season 2011. However, higher returns were obtained from pepper in the late season experiment of 2012.

Budgetary analysis

Tables 1 to 4 show the enterprise budget of the different crop enterprises in the experiments. Table 5 shows the summary of economic returns under the different treatments for experiment 1 and 3 conducted in the rainy season of 2011 and 2012. The details of cost of inputs and other farm operations are shown in appendix. In the first experiment initiated in the rainy season of 2011, the net benefit for the intercropping system involving the introduction of cowpea into pineapple at pepper transplanting was -₦1, 239,943. However, positive Net Benefits were obtained with delayed introduction of cowpea. The highest Net Benefits of ₦871, 472 was obtained among the intercropped plots when cowpea was introduced into pineapple-pepper intercrop at 9WAT. Sole pepper also recorded high magnitude of Net Benefits in the rainy season experiment of 2011while Net Benefits was negative for sole cowpea.

In the rainy season experiment of 2012, positive Net Benefits were obtained except for sole pepper and cowpea with negative net benefits. The lowest Net Benefits (₦959, 961) was obtained among the intercropped plots when cowpea was introduced at the time of transplanting pepper into pineapple. Negative net benefits were obtained for pepper and cowpea in the rainy season of 2012.

Table 6 shows the summary of economic returns under the intercrop combinations in experiment 2 and 4 conducted in the late season of 2011 and 2012. In the late season experiment of 2011, positive net benefits were obtained except for the sole pepper and cowpea enterprise. The introduction of cowpea at the time of transplanting pepper resulted in the lowest positive net benefit (₦1, 401,644) while the highest net benefit (₦1, 952,126) was obtained in sole pineapple. In the late season experiment of 2012, only sole cowpea recorded negative net benefit. The lowest net benefit obtained when cowpea was sown into pineapple at the time of transplanting pepper into pineapple was similar to the trend obtained in other experiments. The highest benefits (₦3,398,472) were obtained for pineapple-pepper intercrop only. Positive net benefit was also obtained for sole pepper in late season experiment of 2012.

Table 6 presents the benefit to cost ratio (BCR) which were in general greater than 1 in experiment conducted in the rainy season of 2011 except when cowpea was sown at the time of transplanting pepper into pineapple and sole cowpea. Benefit cost ratio is greater that one (BCR>1) indicates efficient production of crop combination while BCR < 1 indicates an inefficient production. Apart from sole pepper with BCR of 2.87, a high BCR of 1.41 was obtained when cowpea was sown into pineapple-pepper intercrop at 9WAT.

In 2012 rainy season experiment, BCR were also greater than 1 except for sole pepper and cowpea. The highest BCR (1.91) which was obtained from pineapple-pepper intercrop alone (no cowpea) was not different from BCR (1.90) for sole pineapple. The introduction of cowpea into the pineapple-pepper intercrop tends to reduce the BCR.

In the late season experiment of 2011, BCR were greater than 1 except for sole pepper and cowpea (Table 6). The highest BCR (1.99) was obtained from pineapple-pepper alone. Similarly, BCR value (2.62) was

highest in pineapple-pepper plot alone during the late season of 2012. The BCR values in the late season experiment of 2012 were all better than BCR values obtained in 2011 late season experiment except for plots where cowpea was sown at the time of transplanting pepper that remained unchanged.

The BCR > 1 is indicative of efficient production from such crop combination. That is high returns are made as profit for every unit amount invested. BCR value of 1.41 and 1.91 for plots with cowpea sown at 9WAT into pineapple-pepper and pineapple-pepper alone respectively in the rainy season experiments of 2011 and 2012 means that for every ₦1 spent on the enterprise ₦0.41 and ₦0.91 were returned as profit respectively. Similarly, BCR of 1.99 and 2.62 obtained from pineapple-pepper with no cowpea introduced in the late season of 2011 and 2012 indicate that any ₦1 spent on the enterprise, ₦0.99 and ₦1.62 were returned as benefit respectively.

The rate of return on money invested in the crop enterprise follows the same trend as benefit to cost ratio. It is an indication of profitability of an enterprise; it shows the percentage of return on every unit of investment in the enterprise. The profit margins for the various crop combinations were extremely low during the rainy season experiment of 2011. However, moderate profit margins were obtained from 2012 rainy season experiment and late season experiments of 2011 and 2012. Higher profit margins were obtained in the rainy and late season experiments of 2012 when profit margin of 46.1 and 47 % was obtained in the rainy season experiment involving pineapple-pepper-cowpea intercrop at 6 WAT and pineapple-pepper alone, respectively. In the late season, sowing cowpea into pineapple-pepper intercrop at 3 WAT resulted in 57 % profit margin while 62 % profit margin was obtained from pineapple-pepper intercrop alone.

Discussion

Analysis of economic returns

The high negative Net Benefit obtained when cowpea was introduced into pepper during the time of transplanting pepper into pineapple in the rainy season of 2011 could have resulted from extremely low yield of pineapple and pepper obtained from treatment. This outcome resulted from stiff competition experienced by pepper and pineapple from cowpea which grow vigorously and shaded them. Increasing magnitude of Net Benefits followed the trend of increase in the yield of pepper recorded with the delayed sowing of cowpea since higher yield of pepper was obtained with delayed sowing of cowpea. sole pepper recorded higher magnitude of net benefit in the rainy season of 2011 due to higher pepper fruit yield resulting in revenue that outweigh the cost of production. The negative Net Benefits obtained in sole cowpea from lower return which cannot offset cost of production constituted largely by the initial cost of opening up a fallow land for the experiment. The cost can only be borne by one cycle of production in the experiment.

The least Net Benefit obtained at the simultaneous sowing of cowpea with the transplanting of pepper into pineapple could be due to lower yield and relatively lower yield obtained from the treatments. Generally, the higher Net Benefit was obtained during the rainy season of 2012 could be adduced to higher yield recorded for pineapple. This might have resulted from lower competition and subsequent higher yield that follows. The growth of cowpea and pepper were not as vigorous as in 2011 rainy season experiments. The cost of production outweighs the benefit for intercropping pepper and cowpea with pineapple in the rainy season of 2012 resulting in positive Net Benefit. Unlike rainy season experiment of 2011 when positive net benefit was recorded for pepper, negative Net Benefit was obtained for pepper in 2012 rainy season due to lower yield of pepper.

In late season experiment of 2011, lower returns obtained when cowpea was introduced into the pineapple at pepper transplanting were similar to those of other experiments where lower pineapple and pepper yield were obtained due to intense shading effect of the cowpea during the early stage of their growth. However, the highest Net Benefit obtained for pineapple could have resulted from lower pepper fruit yield obtained in the intercropped plots. This could be due to season of production which is shorter. Pepper plants have limited period of fruiting and harvest unlike extended period of harvest of pepper and subsequent higher yield during rainy season experiments.

In the late season experiment of 2012, lower Net Benefit obtained when cowpea was introduced at the time of transplanting pepper was as a result of shading effect of cowpea on growth of pepper and pineapple and subsequently reduced yield. The highest Net Benefit associated with pineapple-pepper intercrop when no cowpea was introduced was due to higher returns from pineapple and pepper frits. The higher fruit yield obtained for sole pepper resulted in positive net benefits.

Positive and high rate of return is always desirable in any enterprise. Enterprise with negative net benefit (net loss), RORI and PM should not be undertaken. The profitability ratios such as BCR, RORI and PM indicates that the intercropping of pineapple and pepper with cowpea introduced at later stage of development are all profitable. Olubode *et. al*., 2012a, 2012b reported profitability of pawpaw-okra and pawpaw-okra-cucumber intercrop. The rates are indicative of profitability of pineapple enterprise and its intercropping combination. In research involving interplanting pineapple with hot jalapeno pepper, dry beans, corn and tomato, *Uriza et al*., (2002) reported that the benefit/cost ratio was best for pineapple intercrop than when they were alone. Balasubramanian and Sekayange (1990) while citing Zandstra (1979) reported that utilizing different mechanisms in cultural manipulations could assist to maximize profit in intercropping system.

Conclusion and recommendations

Economic returns and profitability indices showed that sole pineapple and pineapple-pepper-cowpea intercrop were profitable. However sole pepper and cowpea were unprofitable (cost-benefit analysis) and this is attributable to high cost associated with seed bed preparation. Pineapple-pepper intercrop without cowpea and sole pineapple appeared as the preferred options based on their slightly higher net benefits. However, delayed sowing of cowpea into pineapple-pepper intercrop enhancedutilization of growth resources in addition to diversified produce obtained.

Pineapple-pepper intercrop combination can be practiced by farmers. However, the introduction of cowpea increased the crop diversity. The slightly higher values of return and benefit cost ratios from sole pineapple and pineapple-pepper without cowpea positioned these crop combinations as the preferred enterprise over other intercropping combinations especially treatments with delayed sowing of cowpea. Diversity is a form of internal insurance to ensure steady and continuous flow of income and prevention of crop failure that might be associated with mono-cropping. This includes the diversified sources of income and farm products from the farm, spread or distribution of income to the farmer in addition to immediate satisfaction of food need of the farmer's family and the possibility of farmers making high returns from the short duration annual crops such as pepper and cowpea intercropped at the early stage of the establishment of pineapple. This might help to offset initial cost of maintenance because most farmers are resource constrained. The appropriate time to introduce the cowpea is important. Early sowing of cowpea was more detrimental to the other component crops especially pepper. Hence, when the introduction of cowpea into pineapple-pepper intercrop is desired, cowpea should be introduced as from six weeks after transplanting pepper into the mixture during the rainy season and three weeks after transplanting pepper during the late season.

Based on the findings of the study, it can be recommended to pineapple farmers to introduce pepper into the spaces between the rows of pineapple as soon as the pineapple field is planted. Nevertheless, sowing of cowpea should be delayed up to six weeks after transplanting pepper during the rainy season planting and three weeks during the late season planting. This practice will expand income base from the minor component crops (pepper and cowpea) while the main crop (pineapple) is getting established.
It is recommended that further investigation be done to evaluate the varietal response of cowpea and pepper in pineapple-pepper-cowpea intercropping system.

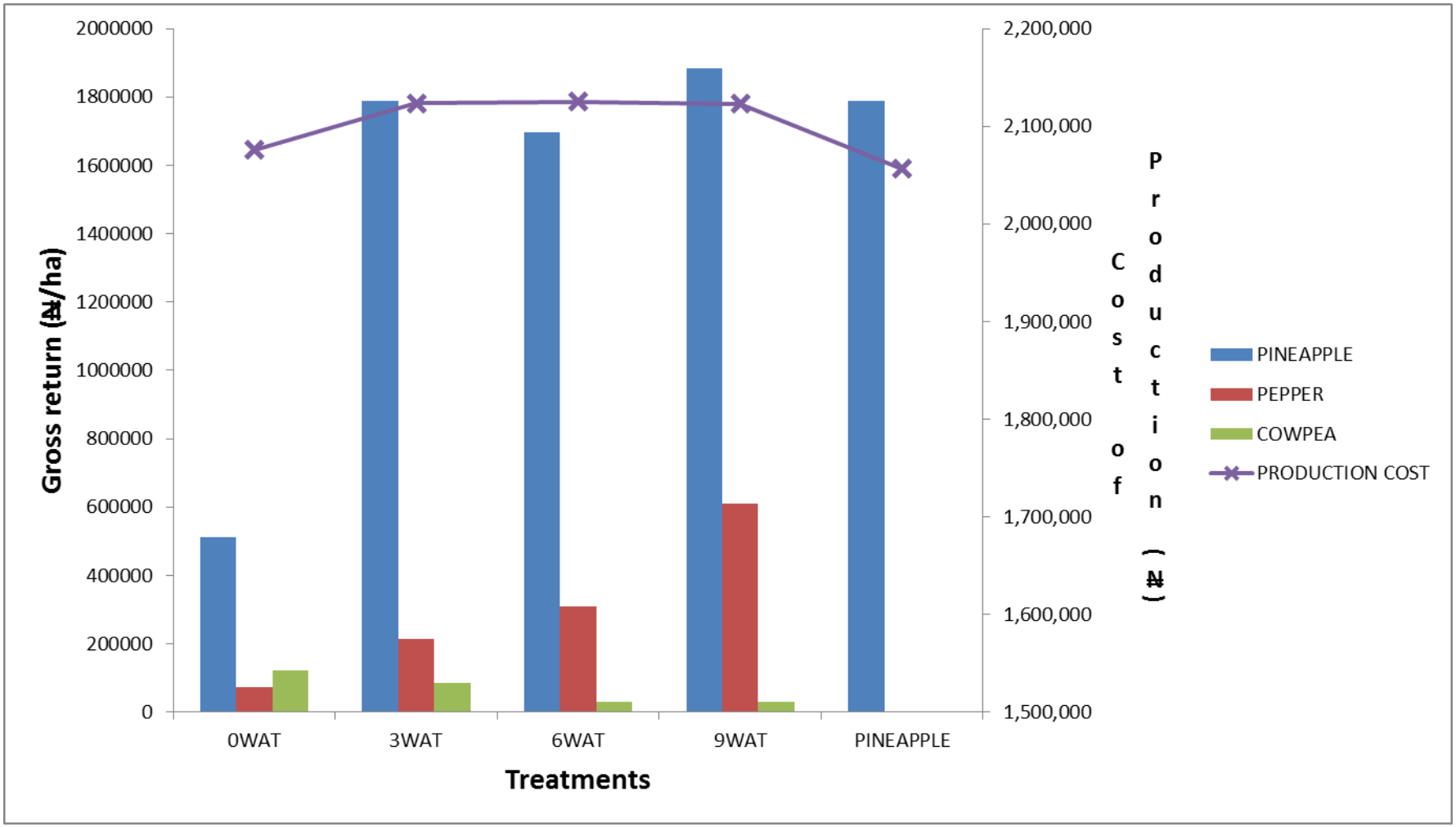

Fig. 1: Economic returns from component crops and the cost of production for each intercrop treatment (2011 rainy season experiment).

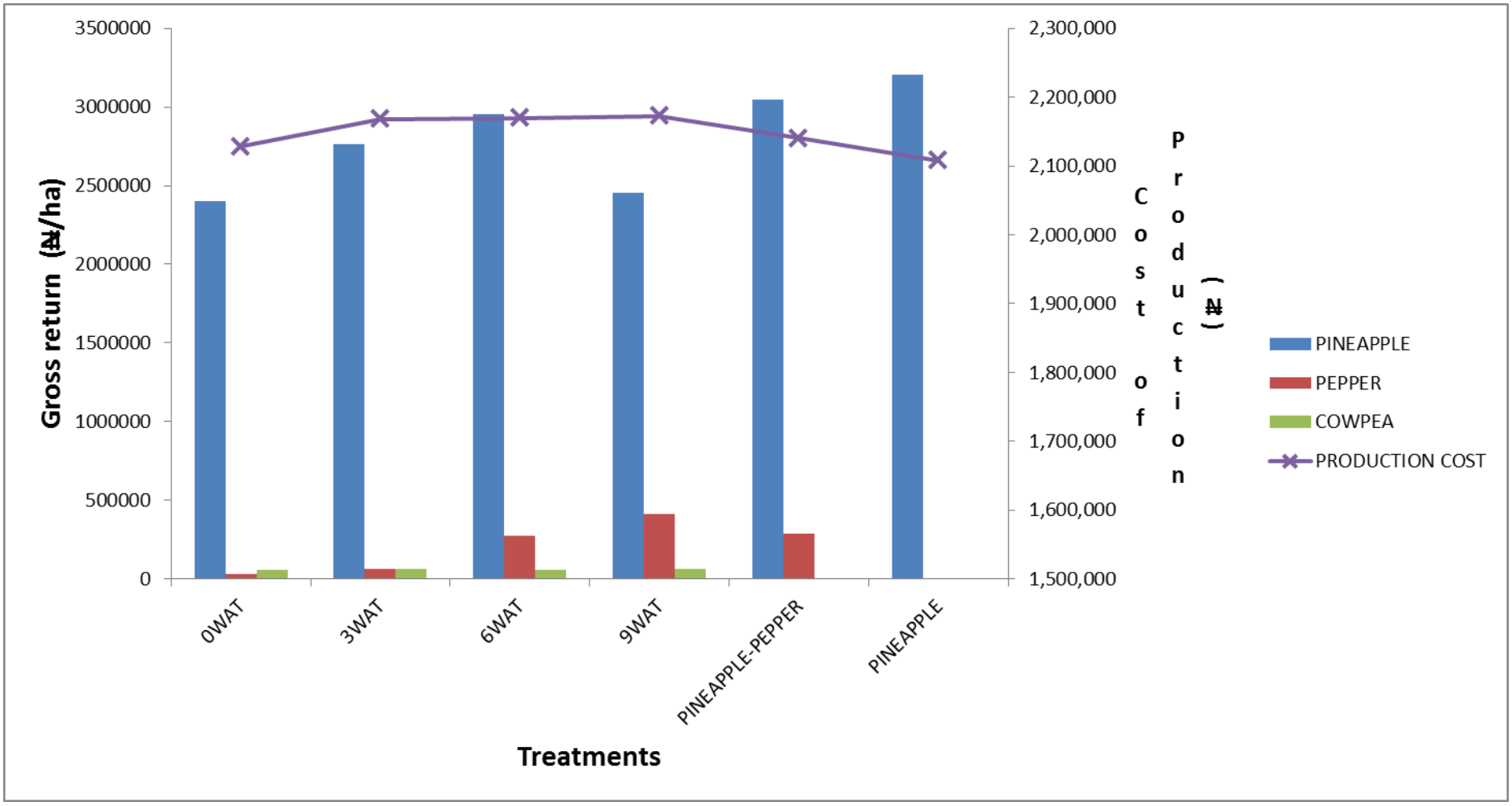

Fig. 2: Economic returns from component crops and the cost of production for each intercrop treatment (2012 rainy season experiment)

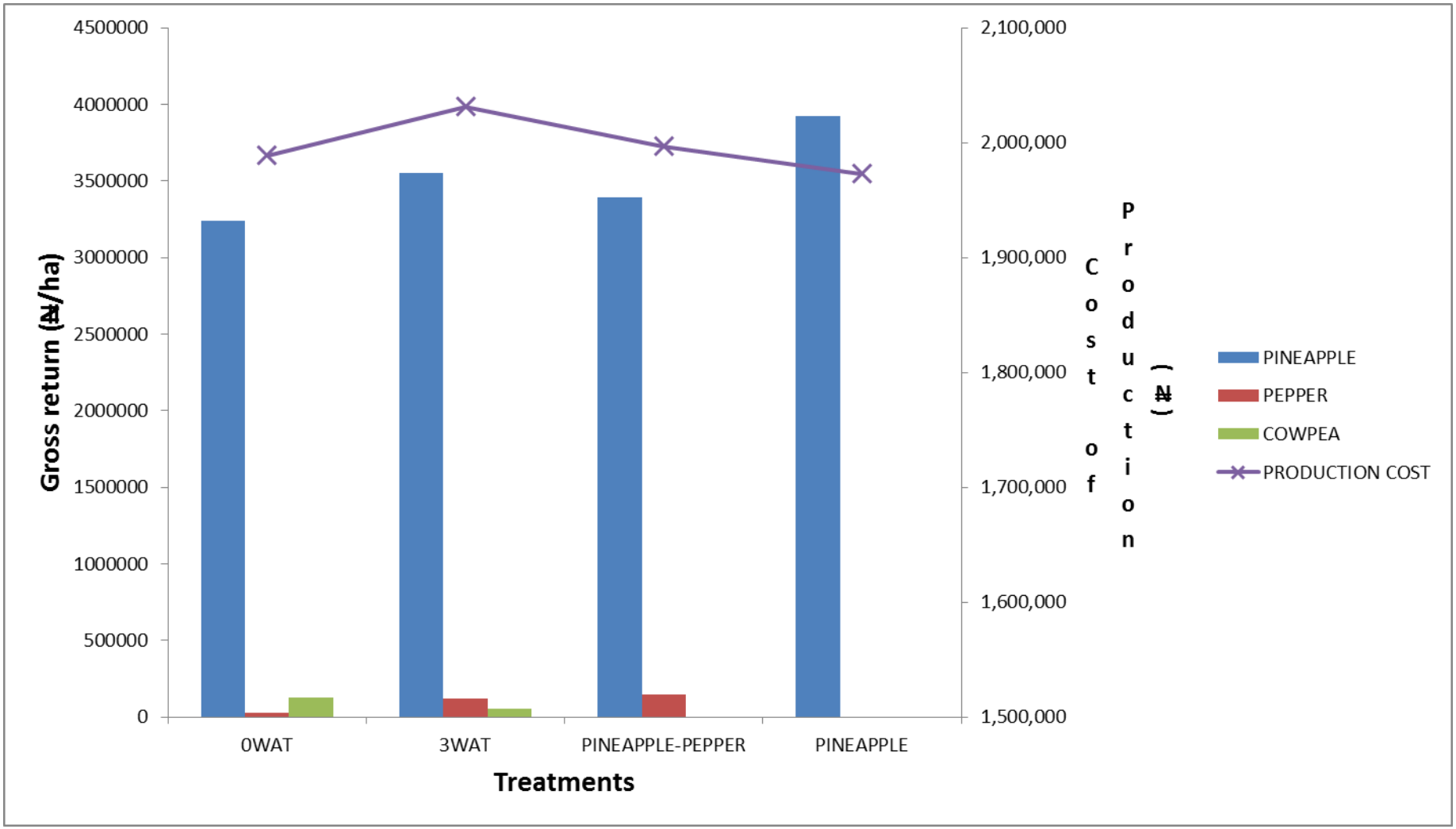

Fig. 3: Economic returns from component crops and the cost of production for each intercrop treatment (2011 late season experiment).

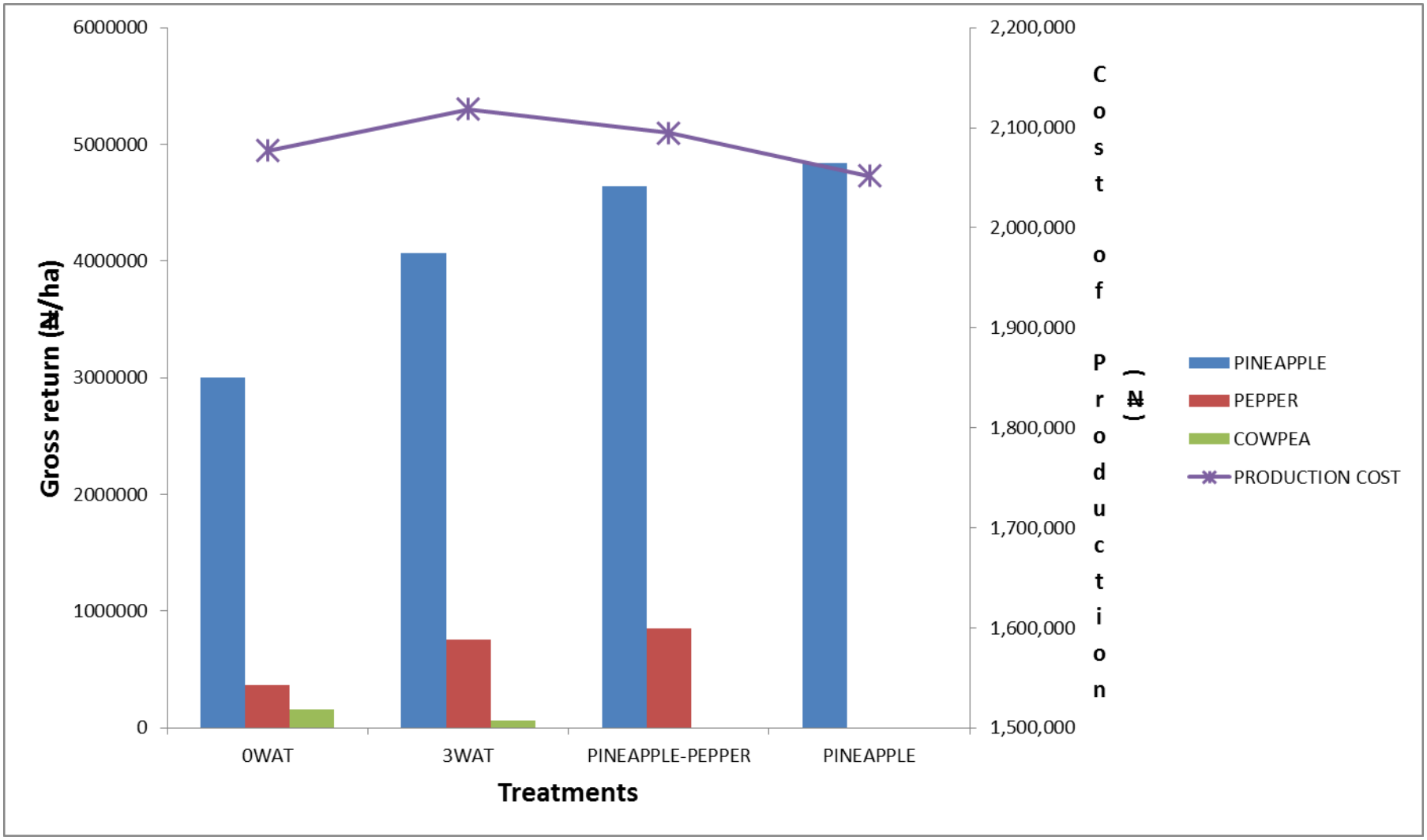

Fig. 4: Economic returns from component crops and the cost of production for each intercrop treatment (2012 late season experiment).

Table 1: Enterprise budget of different treatments in 2011 rainy season experiment

	0WAT	3WAT	6WAT	9WAT	PINEAPPLE	PEPPER	COWPEA
AVERAGE CROP YIELD (t/Ha)							
PINEAPPLE	12.79	44.68	42.39	47.09	44.7	-	-
PEPPER	0.37	1.07	1.54	3.05	-	7.36	-
COWPEA	1.02	0.72	0.25	0.25	-	-	1.24
GROSS RETURN							
PINEAPPLE @ farm gate PRICE (50/KG)	639500	2234000	2119500	2354500	2235000	-	-
PEPPER @ farm gate PRICE (200/KG)	74000	214000	308000	610000	-	1472000	-
COWPEA @ farm gate PRICE (120/KG)	122400	86400	30000	30000	-	-	148800
TOTAL REVENUE (₦/Ha)	835900	2534400	2457500	2994500	2235000	1472000	148800
LABOUR COST (N/Ha)							
land preparation (UPROOTING ETC)	300,000	300,000	300,000	300,000	300,000	300,000	300,000
planting	279,784	279,784	279,784	279,784	266,664	16,000	8,000
weed CONTROL	206,000	246,000	246,000	246,000	246,000	120,000	40,000
pest control	6000	6000	6000	6000	6000	6000	6000
induction	6000	6000	6000	6000	6000	-	-
harvesting	120714	127482	129060	123694	81272	40000	40000
COST OF FARM INPUT (₦/Ha)							
PINEAPPLE SUCKERS	1,111,100	1,111,100	1,111,100	1,111,100	1,111,100	-	-
PEPPER SEED	2700	2700	2700	2700	-	5000	-
COWPEA SEED	1875	1875	1875	1875	-	-	3000
INSECTICIDE	2000	2000	2000	2000	2000	2000	2000
HERBICIDE	7500	7500	7500	7500	7500	-	-
ETHREL	20000	20000	20000	20000	20000	-	-

TRANSPORT/HANDLING	2270	3220	3455	6475		14720	1860
TOTAL VARIABLE COST	2,065,943	2,113,661	2,115,474	2,113,128	2,046,536	503,720	400,860
FIXED COST	9,900	9,900	9,900	9,900	9,900	9,900	9,900
TOTAL COST	2,075,843	2,123,561	2,125,374	2,123,028	2,056,436	513,620	410,760
NET BENEFIT (₦/Ha)	-1,239,943	410,839	332,126	871,472	178,564	958,380	-261,960

Table 2: Enterprise budget of different treatments in 2012 rainy season experiment

		0WAT	3WAT	6WAT	9WAT	PINEAPPLE PEPPER	PINEAPPLE	PEPPER	COWPEA
AVERAGE CROP YIELD (t/Ha)									
PINEAPPLE		60.06	69.06	73.81	61.32	76.17	80.14	-	-
PEPPER		0.15	0.33	1.38	2.08	1.44	-	1.38	-
COWPEA		0.46	0.54	0.49	0.56	-	-	-	0.64
GROSS RETURN									
PINEAPPLE @ farm gate PRICE	50/KG	3003000	3453000	3690500	3066000	3808500	4007000	-	-
PEPPER @ farm gate PRICE	200/KG	30000	66000	276000	416000	288000	-	276000	-
COWPEA @ farm gate PRICE	120/KG	55200	64800	58800	67200	-	-	-	76800
TOTAL REVENUE (N/Ha)		3088200	3583800	4025300	3549200	4096500	4007000	276000	76800
LABOUR COST (N/Ha)									
land preparation (UPROOTING ETC)		350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000
planting		279,784	279,784	279,784	279,784	275,304	266,664	16,000	8,000
weed CONTROL		206,000	246,000	246,000	246,000	246,000	246,000	120,000	40,000
pest control		6000	6000	6000	6000	6000	6000	6000	6000
induction		6000	6000	6000	6000	6000	6000	-	-
harvesting		124390	124432	124362	126065	101359	83047	40000	40000
COST OF FARM INPUT (N/Ha)									

PINEAPPLE SUCKERS	1,111,100	1,111,100	1,111,100	1,111,100	1,111,100	1,111,100	-	-
PEPPER SEED	2700	2700	2700	2700	2700	-	5000	-
COWPEA SEED	1875	1875	1875	1875	-	-	-	3000
INSECTICIDE	2000	2000	2000	2000	2000	2000	2000	2000
HERBICIDE	7500	7500	7500	7500	7500	7500	-	-
ETHREL	20000	20000	20000	20000	20000	20000	-	-
TRANSPORT/HANDLING	990	1230	2595	3940	2700		5020	960
TOTAL VARIABLE COST	2,118,339	2,158,621	2,159,916	2,162,964	2,130,663	2,098,311	544,020	449,960
FIXED COST	9,900	9,900	9,900	9,900	9,900	9,900	9,900	9,900
TOTAL COST	2,128,239	2,168,521	2,169,816	2,172,864	2,140,563	2,108,211	553,920	459,860
NET BENEFIT (₦/Ha)	959,961	1,415,279	1,855,484	1,376,336	1,955,937	1,898,789	-277,920	-383,060

Table 3: Enterprise budget of different treatments in 2011 late season experiment

	0WAT	**3WAT**	**PINEAPPLE – PEPPER**	**PINEAPPLE**	**PEPPER**	**COWPEA**
AVERAGE CROP YIELD (t/Ha)						
PINEAPPLE	64.77	71.06	67.81	78.5	-	-
PEPPER	0.13	0.61	0.74	-	1.57	-
COWPEA	1.05	0.47	-	-	-	1
GROSS RETURN						
PINEAPPLE @ farm gate PRICE (50/KG)	3238500	3553000	3390500	3925000	-	-
PEPPER @ farm gate PRICE (200/KG)	26000	122000	148000	-	314000	-
COWPEA @ farm gate PRICE (120/KG)	126000	56400		-	-	120000
TOTAL REVENUE (₦/Ha)	3390500	3731400	3538500	3925000	314000	120000
LABOUR COST (₦/Ha)						

land preparation (UPROOTING ETC)	170,000	170,000	170,000	170,000	170,000	170,000
Planting	279,784	279,784	275,304	266,664	16,000	8,000
weed CONTROL	246,000	286,000	286,000	286,000	120,000	40,000
pest control	6000	6000	6000	6000	6000	6000
Induction	6000	6000	6000	6000	-	-
Harvesting	124162	126310	98656	87710	40000	40000
COST OF FARM INPUT (N/Ha)						
PINEAPPLE SUCKERS	1,111,100	1,111,100	1,111,100	1,111,100	-	-
PEPPER SEED	2700	2700	2700	-	5000	-
COWPEA SEED	1875	1875		-	-	3000
INSECTICIDE	2000	2000	2000	2000	2000	2000
HERBICIDE	7500	7500	7500	7500	-	-
ETHREL	20000	20000	20000	20000	-	-
TRANSPORT/HANDLING	1835	2045	1480		3140	1500
TOTAL VARIABLE COST	1,978,956	2,021,314	1,986,740	1,962,974	362,140	270,500
FIXED COST	9,900	9,900	9,900	9,900	9,900	9,900
TOTAL COST	1,988,856	2,031,214	1,996,640	1,972,874	372,040	280,400
NET BENEFIT (₦/Ha)	1,401,644	1,700,186	1,541,860	1,952,126	-58,040	-160,400

Table 4: Enterprise budget of different treatments in 2011 late season experiment

	0WAT	3WAT	PINEAPPLE-PEPPER	PINEAPPLE	PEPPER	COWPEA
AVERAGE CROP YIELD (t/Ha)						
PINEAPPLE	60.04	81.39	92.86	96.72	-	-
PEPPER	1.84	3.8	4.25	-	2.88	-
COWPEA	1.3	0.55	-	-	-	1.34
GROSS RETURN						
PINEAPPLE @ farm gate PRICE	3002000	4069500	4643000	4836000	-	-

(50/KG)						
PEPPER @ farm gate PRICE (200/KG)	368000	760000	850000	-	576000	-
COWPEA @ farm gate PRICE (120/KG)	156000	66000		-	-	160800
TOTAL REVENUE (N/Ha)	3526000	4895500	5493000	4836000	576000	160800
LABOUR COST (N/Ha)						
land preparation (UPROOTING ETC)	290,000	290,000	290,000	290,000	290,000	290,000
Planting	279,784	279,784	275,304	266,664	16,000	8,000
weed CONTROL	206,000	246,000	246,000	246,000	120,000	40,000
pest control	6000	6000	6000	6000	6000	6000
Induction	6000	6000	6000	6000	-	-
Harvesting	130214	130248	109204	86356	40000	40000
COST OF FARM INPUT (N/Ha)						
PINEAPPLE SUCKERS	1,111,100	1,111,100	1,111,100	1,111,100	-	-
PEPPER SEED	2700	2700	2700	-	5000	-
COWPEA SEED	1875	1875		-	-	3000
INSECTICIDE	2000	2000	2000	2000	2000	2000
HERBICIDE	7500	7500	7500	7500	-	-
ETHREL	20000	20000	20000	20000	-	-
TRANSPORT/HANDLING	3690	5585	8820		11020	2010
TOTAL VARIABLE COST	2,066,863	2,108,792	2,084,628	2,041,620	490,020	391,010
FIXED COST	9,900	9,900	9,900	9,900	9,900	9,900
TOTAL COST	2,076,763	2,118,692	2,094,528	2,051,520	499,920	400,910
NET BENEFIT (₦/Ha)	1,449,237	2,776,808	**3,398,472**	2,784,480	76,080	-240,110

Table 5. SUMMARY OF PARTIAL BUDGET ANALYSIS AND PROFITABILITY RATIOS FOR CROP ENTERPRISE DURING 2011 AND 2012 RAINY SEASON EXPERIMENT

Treatments	TVC	FC	TC	TR	NB	RORI	BCR	PM (%)
	₦/ha							
2011 rainy season								
OWAT	2,065,943	9,900	2,075,843	835900	-1,239,943	-0.60	0.40	-148.34
3WAT	2,113,661	9,900	2,123,561	2534400	410,839	0.19	1.19	16.21
6WAT	2,115,474	9,900	2,125,374	2457500	332,126	0.16	1.16	13.51
9WAT	2,113,128	9,900	2,123,028	2994500	871,472	0.41	1.41	**29.10**
Sole pineapple	2,046,536	9,900	2,056,436	2235000	178,564	0.09	1.09	7.99
Sole pepper	503,720	9,900	513,620	1472000	958,380	1.87	2.87	65.11
Sole cowpea	400,860	9,900	410,760	148800	-261,960	-0.64	0.36	-176.05
2012 rainy season								
OWAT	2,118,339	9,900	2,128,239	3088200	959,961	0.45	1.45	31.08
3WAT	2,158,621	9,900	2,168,521	3583800	1,415,279	0.65	1.65	39.49
6WAT	2,159,916	9,900	2,169,816	4025300	1,855,484	0.86	1.86	**46.10**
9WAT	2,162,964	9,900	2,172,864	3549200	1,376,336	0.63	1.63	38.78
Pineapple-pepper	2,130,663	9,900	2,140,563	4096500	1,955,937	0.91	1.91	**47.75**
Sole pineapple	2,098,311	9,900	2,108,211	4007000	1,898,789	0.90	1.90	**47.39**
Sole pepper	544,020	9,900	553,920	276000	-277,920	-0.50	0.50	-100.70
Sole cowpea	449,960	9,900	459,860	76800	-383,060	-0.83	0.17	-498.78

TABLE 6. SUMMARY OF PARTIAL BUDGET ANALYSIS AND PROFITABILITY RATIOS FOR CROP ENTERPRISE DURING 2011AND 2012 LATE SEASON EXPERIMENT

Treatments	TVC	FC	TC	TR	NB	RORI	BCR	PM (%)
	----------	----------	₦/ha	----------	----------			
2011 late season								
OWAT	1,978,956	9,900	1,988,856	3390500	1,401,644	0.70	1.70	41.34
3WAT	2,021,314	9,900	2,031,214	3731400	1,700,186	0.84	1.84	45.56
Pineapple-pepper	1,986,740	9,900	1,996,640	3538500	1,541,860	0.77	1.77	43.57
Sole pineapple	1,962,974	9,900	1,972,874	3925000	1,952,126	0.99	1.99	49.74
Sole pepper	362,140	9,900	372,040	314000	-58,040	-0.16	0.84	-18.48
Sole cowpea	270,500	9,900	280,400	120000	-160,400	-0.57	0.43	-133.67
2012 late season								
OWAT	2,066,863	9,900	2,076,763	3526000	1,449,237	0.70	1.70	41.10
3WAT	2,108,792	9,900	2,118,692	4895500	2,776,808	1.31	2.31	56.72
Pineapple-pepper	2,084,628	9,900	2,094,528	5493000	3,398,472	1.62	2.62	61.87
Sole pineapple	2,041,620	9,900	2,051,520	4836000	2,784,480	1.36	2.36	57.58
Sole pepper	490,020	9,900	499,920	576000	76,080	0.15	1.15	13.21
Sole cowpea	391,010	9,900	400,910	160800	-240,110	-0.60	0.40	-149.32

Appendix : FIXED COST FOR THE CROP ENTERPRISE

Fixed cost for the project	Cost(₦)
land rent	-
cutlasses	1200
hoes	1200
Rainboot	3400
knapsack sprayer	3500
Gloves	600
Total Fixed cost	9900

The economic and profitability of pineapple-pepper-cowpea based intercropping system in Akure, humid rainforest zone of Nigeria was evaluated. The experiments evaluated the impact of timing of introduction of one of the component crops, cowpea into the intercropping system on the productivity of the intercropping systems. For early season planting, sowing of cowpea into pineapple-pepper intercrop was done at the time of transplanting pepper seedlings into pineapple, at 3, 6 and 9 weeks after transplanting (WAT) pepper seedlings into pineapple while sowing of cowpea in late season planting was at transplanting and 3WAT. The sole crop of the crop components was also established. The cost of production and returns from each crop combination based on one cycle of production were aggregated. A number economic analysis tools were used to evaluate the different treatments.

Economic returns and profitability indices showed that sole pineapple and pineapple-pepper-cowpea intercrop were profitable. Pineapple-pepper intercrop without cowpea and sole pineapple appeared as the preferred options based on their slightly higher net benefits. However, delayed sowing of cowpea into pineapple-pepper intercrop ensures the spread and diversification of produce obtained.

Pineapple-pepper intercrop combination can be practiced by farmers. However, the introduction of cowpea increased the crop diversity. The slightly higher values of return and benefit cost ratios from sole pineapple and pineapple-pepper without cowpea positioned these crop combinations as the preferred enterprise over other intercropping combinations especially treatments with delayed sowing of cowpea. Diversity is a form of internal insurance to ensure steady and continuous flow of income and prevention of crop failure that might be associated with mono-cropping. This includes the diversified sources of income and farm products from the farm, spread or distribution of income to the farmer in addition to immediate satisfaction of food need of the farmer's family and the possibility of farmers making high returns from the short duration annual crops such as pepper and cowpea intercropped at the early stage of the establishment of pineapple.

It is recommended that further investigation be done to evaluate the varietal response of cowpea and pepper in pineapple-pepper-cowpea intercropping system.

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COST AND BENEFITS ANALYSIS OF *CLARIAS GARIEPINUS* (CATFISH) PRODUCTION IN IDO LOCAL GOVERNMENT AREA, IBADAN, OYO STATE NIGERIA

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Abstract

The study analyzed the cost and benefits of Clarias gariepinus (catfish) production in Ido local government area of Oyo State. Multistage sampling procedure was employed to carry out the study. A total number of sixty (60) well-constructed questionnaires were administered to fish farmers in Ido local government area of Oyo state. The socio-economic characteristics of the respondents were analyzed using descriptive statistics while the profitability was measured using gross margin and net income. Results revealed that fish farming is predominantly the occupation of the male gender (86.7%) while 13.3% of the respondents were female. Also, 51.7% sell their fish fresh while 28.3% sell them in frozen form and 20% smoked them before selling. It was further revealed that lack of capital, transportation and land acquisition issues were the major problems faced by the respondents in the study area. The total revenue from the business was ₦253,791,000.00K and the total cost was ₦158,637,000.00K giving a gross margin of ₦126,101,000.00K and a net profit of ₦95,154,000.00K/annum. Benefit cost ratio revealed that 59K was realized from every ₦1 invested in the business. It was recommended that the government should reduce the rate of interest on loans and taxes, and provide good road network while farmers should be encouraged to form co-operative groups to facilitate their business.

Keywords : Profitability , Catfish, Production Cost and Benefit analysis

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Introduction

The awareness on the potential of aquaculture to contribute to domestic fish production has continued to increase in the country. Aquaculture sub sector is said to contribute between 0.5% and 1% to Nigeria domestic fish production (Awoyemi and Adereti, 2011). Fish farming is the fastest growing animal-based food production sector, particularly in the developing countries - mainly from Asian countries (Greenfacts, 2004). In Africa, the government of the continent under the tutelage of the Africa Union, have identified the great potential of fish farming and are determined to encourage private sector investments (Nathan, 2005).

Fish is said to be an important source of both food and income to many people in developing countries. For instance, in Nigeria as much as 10% of the population, some 14 million people depend wholly or partly on the fish on the fisheries sector for their livelihood. (FAO 2005). The fish sector is also believed to provide income for over 10 million people engaged in fish production, processing and trading. Corroborating this view, the low level of capture fisheries which represent one of the major aspects of fish production in Nigeria has also seem to have reached their natural limits as a result of environmental degradation and over fishing, the consequence of this is over exploitation of many fish species from the

wild sources. These fishes which were once considered to be vast and endless, are now being over fished and labeled as unsustainable in their present state (Eyo, 2003). Similarly, the demand for fish in the country has been on the rise with demand far exceeding supply.

The Nigerian government has recognized the importance of the fishery sub-sector and it made several attempts over the years to increase their productivity through institutional reforms and various economic measures. According to Adeogun *et al*., (2006), Nigeria derived over 90% of fish caught from the coastal zone. Fish farming or culture is believed to be the way of in bridging the gap in the short fall between total domestic fish production and the total domestic demand. Taking this situation into consideration the low level of production, Nigeria needs to rise beyond the level of subsistence to higher level of profitability through more efficient use of their production resources. It is against this background that the study intended to examine the cost benefit, level of operation and constraint of catfish farming in some villages in Ido local government of Oyo state.

Methodology

The study was conducted in Ido Local Government Area of Ibadan, Oyo state, Nigeria. Ido Local Government Area in Oyo State has its headquarters in the town of Ido. It is located between latitude $6^0$45N and $9^0$41N and longitude $2^0$30E and $5^0$15E. It occupies a land mass of 865,49km^2 with about 57% of the total land being used for agricultural purposes. The people who dominate this area are predominantly farmers. Data were collected through interview with the aid of well- structured questionnaire. Ido Local Government was purposefully selected for the study due to occurrence of floods in the area during raining season.

Sampling techniques and procedure

Multistage sampling procedure was used. Five wards were purposively selected. Five communities were randomly selected from the wards (Apete, Apata, Ijokodo, Ido town, Omi Adio). 60 questionnaires were randomly selected among the fish farmers from the selected communities. However, thirteen (13) copies of questionnaires were administered to the respondents in Omi Adio village, seventeen (17) questionnaires was administered to respondents in Apete village, while ten (10) questionnaires was administered to fish farmers in Ijokodo village while ten (10) questionnaires to the respondents in Apata and ten (10) questionnaires to the respondents in Ido town. Primary data were used for the study. The primary data were obtained through interview guide and structured questionnaires to elicit information from farmers that are practicing.

The data were analyzed using descriptive statistic; the descriptive statistics used were simple frequency and percentage. These were used in analyzing the socio-economic characteristics of the respondents as well as constraints while the gross margin and benefit cost ratio were used for the profitability on the production of catfish.

Gross Margin (GM) =TR – TVC
Where
TR= Total Revenue
Total Variable Cost (TVC) = (transport cost, water cost, feeding cost, stocking cost, land cost)
Benefit Cost Ratio (BCR)
BCR= TR/TC
TR= P × q

TR= price per unit to catfish × quality of catfish sold

Results and discussion

Table 1: Socio-economic characteristics of the respondents

Variable	Frequency	Percentage%
Age		
20-30	12	20.0
31-40	10	16.7
41-50	23	38.3
50 and above	15	25.0
Total	60	100.0
Gender		
Male	52	86.7
Female	8	13.3
Total	60	100.0
Marital status		
Single	22	36.7
Married	19	31.7
Divorced	8	13.3
Widow/widower	11	18.3
Total	60	100.0
Household size		
1-3	13	21.7
4-6	23	53.3
7-9	15	25.0
Total	60	100
Occupation		
Farming	60	100
Educational status		
No formal education	32	53.3
Primary	9	15.0
W.A. S. C./G. C. E.	15	25.0
O. N. D./ N. C. E./B.Sc.	4	6.7
Total	60	100
Years of farming experience	**Frequency**	**Percentage**
1-10	12	20.0
11-20	10	16.7
21-30	23	38.3
31 and above	15	25.0
Total	**60**	**100.0**

The result from Table 1 shows that 20% of the respondents were between the age ranges between 20-30 years while 16.7% were between the age ranges between 31-40 years. Also 41-50 years of age had 38.3%

while 25% were between the age bracket of 51 years and above. This showed that older ones are more engaged in fish business.

The Table further revealed that 86.7% of the respondents were male while 13.3% were female. This implies those males are more engaged in fish farming while few of the female were involved in processing and packaging according to the findings of Anthony and Akinwunmi (1991).

The Table above further revealed that 36.7% of the respondents were single while 31.7% of the respondents were married. And also 13.3% of the respondents were divorced while 18.3% of the respondents were widower. It was revealed that majority (53.3%) had households size ranging between 4-6 people. This is line with the similar work of Tunde *et al., 2015* who reported that majority of the respondents (about 56 percent) have an average household size of between 1-5. Also, it was revealed that all the respondents (100.0%) take farming as their major occupation in the study area. The table also showed that majority (53.3%) of the respondents had no formal education. In term of experience, larger respondents (38.3%) had 21-30 years of farming experience and strictly follow by 25% of the respondents who had 31 and above farming experience.

The chart indicted that majority (55%) of the respondents purchased their land while 25% of the respondents were using family land, 20% of the respondents rented the land.

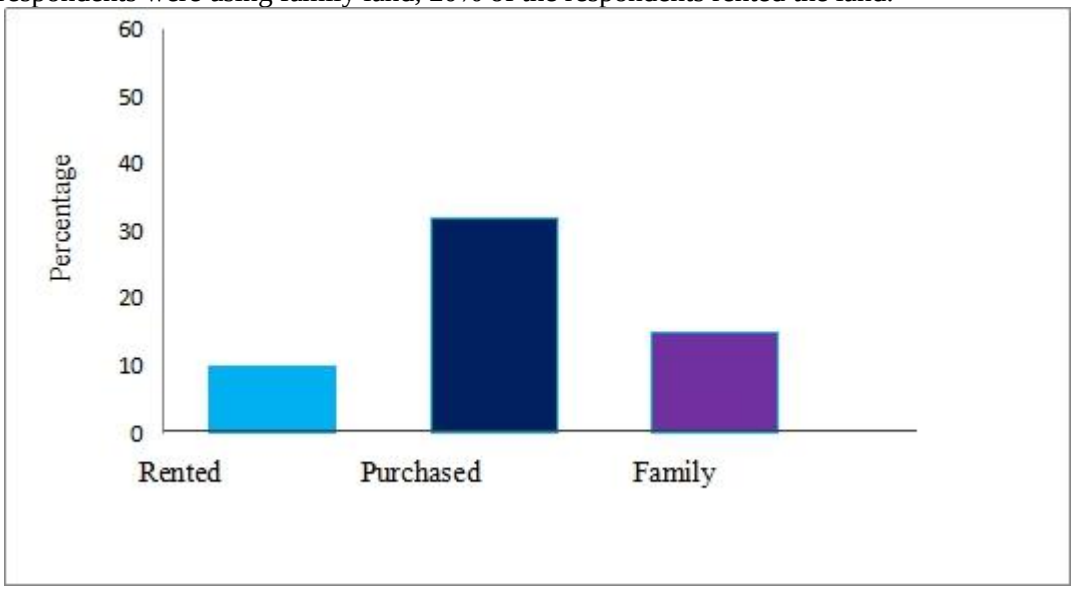

Fig 1: Distribution of respondents based on sources of land

The result of fig 2 below showed that 63% of the respondents hired labor for fishing practices and maintenance while 37% of the respondents used family labor for fishing practices

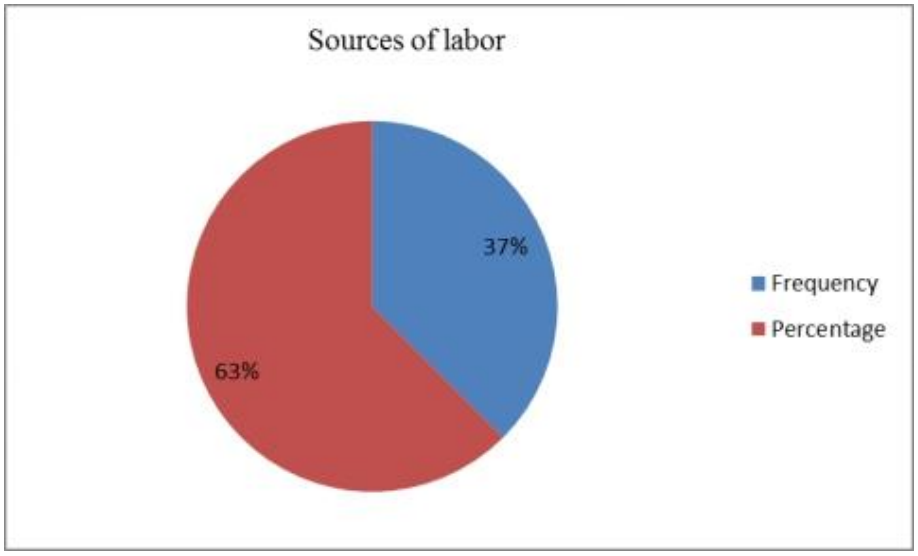

Fig 2: Distribution of the respondents based on sources of labor

The chart below showed that majority (51.7%) of respondents sells the fish fresh while 28.3% of the respondents freeze it before selling and 20% of the respondents smoked it before selling.

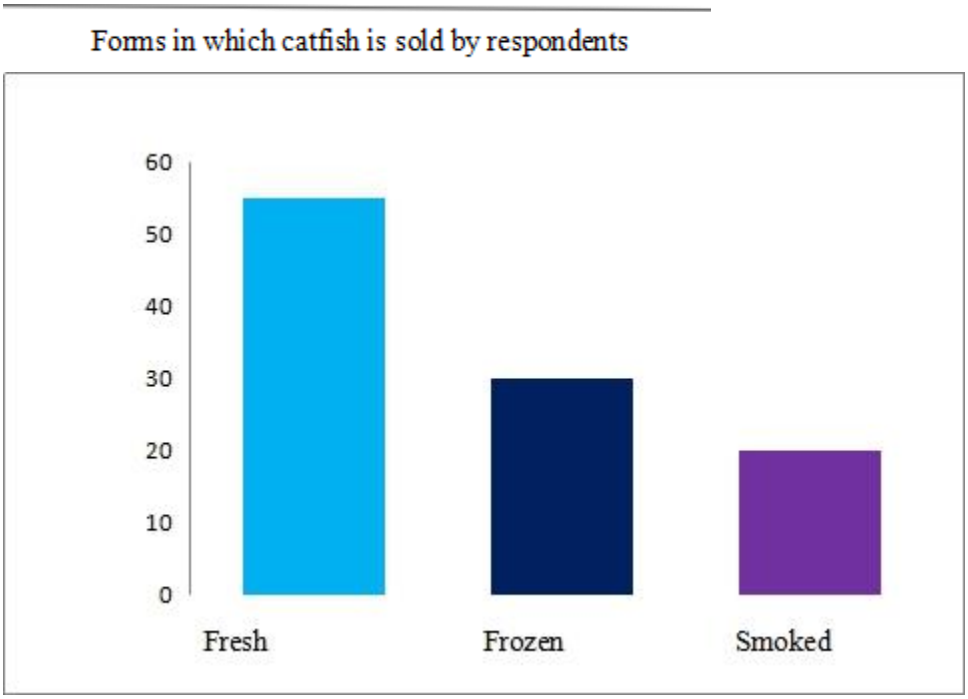

Fig 3: Distribution based on forms the respondents sell catfish

Table 2: Distribution based on the level of operation

Stages of purchasing catfish	Frequency	Parentage
Fingerlings	26	43.3
Juvenile	34	56.7
Total	**60**	**100.0**
Pond used in rearing catfish		
Earthen pond	41	68.3
Concrete pond	19	31.7
Total	60	100.0
Method of harvesting		
Net	50	83.3
Hook and line	10	16.7
Total	**60**	**100.0**
How often extension agents visit		
Once in a month	11	18.3
Twice in a month	1	1.7
Never	48	80
Total	**60**	**100.0**

Source: Field Survey, 2020

The result revealed that 56.7% of the respondents purchased their fish at juvenile stage while 43.3% of the respondents purchased their fish at fingerlings stage. Majority (68.3%) of the respondents used earthen ponds for rearing while 31.7% of the respondents used concrete pond.

The table also shows that all the respondents in the study area used river as the sources of water.
The table in the study also observed that 83.3% of the respondents used net as their harvesting tools because this enables the respondents to catch the fish alive while 16.7% of the respondents used hooks and lines in catching the fish. This table reveals that the respondents (18.3%) claimed that extension agents come once in a month while 1.7% of the respondents said extension agents comes twice in a month. Also, some said (80.0%) they have never come across the extension agents.

Table 3: Constraint of catfish production in the study area

Transportation	Frequency	Percentage (%)
Yes	37	61.7
No	23	38.3
Total	**60**	**100.0**
Land acquisition		
Yes	42	70.0
No	18	30.0
Total	**60**	**100.0**
Sales		
Yes	15	25.0
No	45	75.0
Total	**60**	**100.0**
Storage facility		
Yes	42	70.0
No	18	30.0
Total	**60**	**100.0**
Access road		
Yes	28	46.7
No	32	53.3
Total	**60**	**100.0**
Total	**60**	**100.0**
Electricity		
Yes	42	70.0
No	18	30.0
Total	**60**	**100.0**
Lack of capital		
Yes	50	83.3
No	10	16.7
Total	**60**	**100.0**

The table above indicated that 61.7% of the respondents had transportation problem while 70% of the respondents had issue on acquisition of land for fish farming in the study area. It was revealed that majority (75%) of the respondents had no problem in selling their produce This implies that market is readily available for fish in the study area and nationwide. Furthermore, as reported, 70% had problem with storage facilities properly due to lack of power supply in which majority (70%) reported electrical problem as one of the issues facing in the business.

Majority (83.3%) of the respondent in the table above complain about the lack of capital which is the major constraint faced by the majority of the fish farmers in the study area. This is in line with Kudi et al (2008) reported that lack of capital is a major problem encountered in fish production in Nigeria,

Table 4: Cost and revenue of catfish per production

Variables	Price (₦)
Total fixed cost	4,850,000
Total cost	620,600,000.00
Transportation cost	665,000.00
Cost of construction	643,000.00
Cost of land	151,750,000.00
Cost of stocking	729,000.00
Gross Margin	TR- TVC
TVC	127,690,000.00
TR	253,791,000.00
TC	158,637,000.00
GM	253,791,000 – 127,690,000
GM	126,101,000.00
Net profit	TR – TC
NP	95,154,000
BCR.	TR÷TC. 253,791,000/ 158,637,000 = 1.59

From the analysis derived, the profitability of the total revenue as ₦253,791,000.00k, the Total Cost was ₦158,637,000.00k, the Gross Margin was ₦126,101,000.00k, the Net profit was ₦95,154,000 and also the benefit cost ratio was 1.59.

Conclusion

The study assessed the socio-economic characteristics of the fish producers and the profitability of catfish production in the study area. It revealed that majority of the respondents are males between the ages of 41 and 50 years and are married while a few are single. They are mainly Christians while few of them were Muslims with a household size of 4-6. It was observed that many of these farmers invest a lot of money in their catfish production at the range of 800 thousand to 2 million naira. It was also observed that the major problem the farmers are facing road and tax problem. It was further shown that Catfish production is a profitable venture in the study area, because the benefit cost ratio was greater than one. It was recommended that the farmers should be enlightened on the importance of the co-operatives and be advised to come together and create one in their various villages.

Recommendation

Based on the findings of the study, the following policy recommendations are given in order to improve the production efficiency of catfish in Ido Local Government Area, Oyo State, Nigeria;

i. Government should provide good road networks to aid easy movement without accident to the farmers when transporting their catfish to the farm.

ii. Farmers should be enlightened on the importance of the co-operatives and advised to come together and create one in their various villages.

iii. Given the high amount of tax imposed on the farmers and the amount they spend to establish the farm, the Government should be considerate and reduce the rate interest on loan and reduce (if possible) the tax.

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AWARENESS OF SMALL-SCALE FARMERS TOWARDS DOMESTICATED SNAIL REARING IN IBADAN METROPOLIS, OYO STATE, NIGERIA

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Abstract
The study investigates awareness of small-scale snail farmers towards domestication of snails in some selected local Government areas in Ibadan Metropolis, Oyo State Nigeria. Eighty-eight (88) respondents were randomly selected using snowball techniques. Data were collected through interviewed scheduled with the aid of well-structured questionnaires and analyzed using descriptive and inferential statistics (Chi –square). It was revealed that 72.7% of the respondents were male, 29.5% had National Diploma certificate while 56% were fully involved in the business. It was further revealed that majority (72.7%) believed that snail rearing is highly lucrative while majority still believed that snail rearing required training. Significant relationship existed between the Age and level of Awareness (x^2 = 10.115, p= 0.039). The study therefore Public awareness programme to enlightening farmers on importance and benefit attached to snail rearing.

Keywords : Snail , Domesticated , Small Scale , Awareness , Farmer

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Introduction

Snail is one of micro livestock that has recently attracted attention among farmers in Nigeria. Rising of micro livestock such as snail by households in Nigeria has gradually gaining ground due to need to diversify household's source of income. According to Ajibefun, (2000) micro livestock's rising also assisted in the area of bridging the gap between protein requirements and actual protein consumed by the people which are not sufficiently supplied by crop production. Sericulture which is an act of rearing and management of edible land snails has necessitated a radical shift from total dependence on government for job to self-employment in the country.

It had been reported that Nigeria's per capita daily protein intake is estimated to be 45.4 g as against the FAO minimum 53.8g (Iyangbe and Orewa, 2009). It is obvious that animal protein intake in Nigeria is low and the conventional sources of animal protein supply in the country like beef, pork, goat meat and poultry are getting out of reach of the common populace due to the economic down-turn. Therefore, there is a need to look inward and integrate into our farming system some non-conventional meat sources. The challenge thus falls on the micro livestock in which Nigeria is richly endowed.

In spite of the considerable external and local demand, commercial snail farms such as those in Europe, South-East Asia and the Americas do not exist in West Africa. In Nigeria and Ghana, where snail meat is particularly popular, snails are gathered from the forest. However, wild snail population is declining rapidly due to indiscriminate hunting of snails before they reach maturity, bush burning, use of agro chemicals, deforestation and change in weather (Efarmspro,2006). From the above observation, it is

therefore important that snail farming (sericulture) . In view of the above problems, there is the need to analyze the economics of snail production in Ibadan zone of Oyo State, Nigeria.

In Nigeria, there is an increasing demand of food, thus, the demand for animal protein such as beef, pork, chicken and even fish have become so high that they are out of reach of average citizen. Hence, this calls for domestication of snail production. Therefore, there is need to evaluate awareness of small-scale farmers towards domesticated snail rearing in Ibadan metropolis, Oyo state, Nigeria.

Methodology

The study was carried out in Ibadan, the capital of Oyo State. It is situated in the South-western part of Nigeria. It is located on latitude $7^{0}23^{1}$ and $7^{0}39^{1}$ North and longitude $3^{0}55^{1}$ and $3^{0}91^{1}$ East. Agricultural activities in Ibadan metropolis are characterized by mostly secondary and quaternary services; there are still features of primary functions such as farming in the metropolis. In most of the urban periphery where there is availability of large expanse of land areas, farming activities are usually practiced in form of settlement farm, livestock rearing of plantation agriculture. (Aluko and Adejumo, 2015).

Data were collected with the aid of structured questionnaire while snow ball technique was used to select the respondents, because complete list of snail farmers could not be ascertained. This formed an appropriate sample frame in which 88 respondents was randomly selected. The Statistical tools used for the research work included descriptive statistical tools such as frequency table, simple percentile while the inferential statistical tool was Chi-square

Result and Discussion

Table 1: Socio Economic Characteristics of Respondents

Variable	Frequency	Percentage (%)
Gender		
Male	64	72.7
Female	24	27.3
Total	88	100.0
Age		
Below 20 years	11	12.5
20-30 yrs	36	40.9
31-40 years	31	35.2
41-50 years	8	9.1
Above 50 years	2	2.3
Total	88	100.0
Education Background		
No schooling	4	4.5
Primary six	10	11.4
O' Level	24	27.3
Diploma ND	26	29.5
HND/BSC	24	27.3
Total	88	100
Practical Knowledge of Farming on Snail		
Not at all	8	9.1
Partially	37	42
Inherited	17	19.3
Fully	26	29.5
Total	88	100.0
Occupation		
Full time into snailery	25	28.4
Part time in snailery	56	63.6
Others	7	8.0
Total	88	100.0

Source: Field Survey, 2020

The result shows that the male is more involved in snail rearing in the study area. Only 27.3% of the respondents are female while 72.7% of them are male. This shows that the male is more interested in rearing snail than their female counterpart. This might due to the low level of enlighten, awareness in taking risks or the hazardous situation involved in snail farming. (Amusan and Omidiji 1999) The results further revealed that the respondent between the age range of 20-30 years old are much more involved in snail rearing. From the results, 12.5% of respondent fall below 20 years, 40.9% of them are between 20-30 years, 35.2% of them are between the ages of 31-42 years, 9.2% of them are between the ages of 41-50 years and 2.3 present of them are above 50 years old. It had shown that majority of the respondent are youth which could be attributed to the managerial attributes in rearing snail. This supported the work of (Adegbola 1998.) who said that 52% of snail farmers are youth in Oyo state.

Also as presented in the Table above, results further shows that the respondents with National Diploma are much more involved in snail rearing, 27.3% of respondents are University graduate, 4.5% of them did not have any formal education, 11.4% of respondents had primary Six Certificate, while 27.3% of

respondents had O/ level certificate. It shows that most people that engaged in snail rearing are mostly educated. Also, from the table 3, results shows that there is no need for special training before going into the snail rearing, 42% of respondents had partially knowledge and 19.3% inherited, 9.1% of respondents have no any practical knowledge of snail rearing, while 29% had practical full knowledge of snail rearing.

Table 1 also revealed that snail rearing can be combine with another business because it does not require much monitoring in which 63.6% of respondents are part time snail farmers while 28% of respondents are fully involved in snail rearing. The Table further shows that majority of the respondents reared snails for commercial purpose, while sum is reared for personal consumption.

Table 2: Awareness Statement of Respondents In Ibadan Metropolis

Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Domesticating business is a lucrative one.	64(72.7)	17(19.3)	4(4.5)	3(3.4)	0(0.0)
Training is needed to establish a domesticated snail farm.	28(38.8)	43(48.9)	5(5.7)	11(12.5)	1(1.1)
Establishment of a snail farm is capital intensive.	13(14.8)	22(25.0)	9(10.2)	43(48.9)	1(1.1)
Domesticated snail foundation stock can only be purchase in the market	6(6.8)	23(26.1)	5(5.7)	47(53.4)	7(8.0)
There is high mortality rate in domesticated snails farm	8(9.1)	26(29.5)	14(15.9)	29(33.0)	11(12.5)
Domesticated snails can eat plant such as lettuce, pineapple and pawpaw.	64(72.7)	13(14.8)	4(4.5)	4(4.5)	3(3.4)
Household waste can also be used for snail feeding e.g. maize chaff, soya bean residues.	71(80.7)	14(15.9)	2(2.3)	0(0.0)	1(1.1)

They can feed on pill of cassava, potato, cocoyam, pawpaw and mango.	62(70.5)	22(25.0)	3(3.4)	1(1.1)	0(0.0)

Source: Field survey data 2018

Percentage parenthesis

Majority of the respondent (72.7%) agreed that snail rearing is a very lucrative business in the study area. This is in line with Ogogo et al, (2011) who reported in their study that farmers reared snail due to high prolific rate It was further revealed that majority (87.7%) agreed and strongly in support of the statement that snail rearing requires training in establishment of snail farming system.

This is supported by the findings of Ahaotu et al, (2019) who reported that farmers conceded that the training by research institutes helped them to broaden their understanding of husbandry aspects of the snails namely feeding, handling, general sanitation and crossing. This could be attributed to the fact that snail farming nowadays goes beyond hand picking in an environment. Also, half of the respondents (50%) believed that establishment of domesticated snails is capital intensive. This might be attributed to the fact that in establishment require housing and atimes special feed formulation. Ahaotu et al, (2019) reported that high cost of snail housing was ranked as the most critical problem of snail farming in Nigeria. It was revealed that only 9.1% of the respondents believed that high mortality rate is possible in the rearing of snail in the study area.

Furthermore, majority (72.7%) of the farmers strongly agree that domesticated snails can eat plants such as lettuce, pineapple and pawpaw without depending on formulated feeds. It was also revealed that household wastes can also be used for snail feeding. This is supported by Akintomide (1997) who stated that Snails feed on a wide variety of food mostly in the night at dusk, snails are nocturnal and crepuscular.

Hypothesis Testing

Table 3: Relationship between Selected Socio-Economic Characteristics and Level of Awareness of the Respondents to Domesticated of Snail in the Study Area

Variabes	X^2	Df	P Value	Decision
Age	10.115	4	0.039	S
Education	2.412	4	0.660	NS
Occupation	0.578	2	0.749	NS

Source: Field Survey. 202

There is no significant relationship between the social-economic characteristics of the farmers and their level of awareness. This was analyzed using the chi-square as the statistical tool.

As shown in the Table (x^2 =10.115 and $p \leq 0.039$) indicates that there is significant relationship between age and level of awareness of the respondents. This indicates that people from age of 20-30years are much more involved in the snail rearing, although people from age of 31-40years are also involved but not much as the age of 20-30 years. Also Testing the relationship between educational background and level of awareness of the snail farmers revealed that there is no significant relationship (x^2 = 2.412, p=0.660) between educational background and level of awareness of the respondents. This implies that qualification determines the level of awareness on domestication of snails. Snail rearing is common among the elite people.

Furthermore, Testing the relationship between educational background and level of awareness of the snail farmers revealed that there is no significant relationship (x^2 = 2.412, p=0.660) between educational background and level of awareness of the respondents. This implies that qualification determines the level of awareness on domestication of snails. Snail rearing is common among the elite people. From the table (x^2 = 0.578, p=0.749) reveals that there is no significant relationship between the occupation of the respondents and the level of awareness on snail domestication. This implies that the occupation does not affect the level of awareness of the respondents i.e., snail rearing can be combined with other professions.

Conclusion

Despite the apparent value of snail in human diet, little effort has so far been made to raise people's interest in the rearing of snail. This is supported by the result of this project which revealed that majority of the snail farmers are youth. The result of this project also indicated that educational background determines the level of awareness of snail rearing which made it common among the elite people. The involvements of the learner people in snail based on the outcome of this study are as results of its nutritive value. The slow rate in the snail production can be contributed to the fact that people are not taking the venture as a full-time business.

Recommendations

These following are the recommendation made base on the findings of the study

1. Public awareness programmes should be organized by Agricultural Development Project in the zone to enlightening farmers on importance and benefit attached to snail rearing
2. Training of snail farmers on new methods of domesticating snail should be organize regularly to update and improve the farmers knowledge on snail keeping

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MULCHING MATERIALS AND ITS INFLUENCE ON SOIL PROPERTIES IN ENHANCING GROWTH AND YIELD OF MAIZE *(ZEA MAYS)* IN SOUTH WEST NIGERIA

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Abstract

An experiment was carried out at the Teaching and Research Farm of Federal College of Forestry Jericho Ibadan on the effect of mulching materials on the growth and yield of Zea mays. This was to evaluate the effect of the mulching material on soil properties and its capacity to improve maize yield. The treatments were organic mulching (Gmelina arborea T1), synthetic nylon (T2) and a control (T3). The experimental unit measured 3m by 3m, seeds were sown at a spacing of 75 by 50cm at 2cm depth and two seeds per hole. Each experimental unit was covered with designated mulching materials and control plots were left uncovered. The experiment was laid out in a Randomized Complete Block Design (RCBD), replicated three times. A composite pre- and post-cropping soil samples were obtained from each experimental plot (0-15cm) to analyze for soil physical and chemical properties in the laboratory using the standard procedure Data were collected at 2weeks interval on plants height (cm), numbers of leaves, stem diameter (cm) and grain yield. Data were subjected to analysis of variance (ANOVA) and significant means were separated using Duncan Multiple Range Test (DMRT) at p≤0.05. The result showed that control had the tallest plant (9.12 cm) although without significant difference in synthetic (6.88 cm) and organic mulch (8.70 cm) plant height at 2 weeks after sowing (WAS). Similar trend was observed across the period of observation except at 6 WAS where control (66.58cm) plant was significantly taller than treatments. The number of leaves did not differ significantly across the treatment throughout the period of observation. There was no significant difference in the stem across the treatment except at 8 WAS. Organic mulch gave the highest stem diameter of 5.68 cm which was significantly higher than control 3.79 cm. Organic mulch gave the highest yield of 5.07 t/ha which was significantly higher than control (2.40 t/ha). The yield result showed that organic mulching materials had a positive effect on growth and yield of maize, therefore its use should be encouraged.

Key words: Mulching, Plant growth, Soil properties, Yield, *Zea mays*

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Introduction

Maize *(Zea mays)*, belongs to family *Poaceae*, it is a cereal crop that is grown widely throughout the world in a wide range of agro ecological environments. It is now the third most important cereal crop in the world and maize is produced annually than any other grain. (Olasantan, 2007). The grains are rich in vitamins A, C and E, carbohydrates, and essential minerals, and contain 9% protein. They are also rich in dietary fiber and calories which are a good source of energy. In industries, maize is largely used as livestock feed and as a raw material for industrial products, such as corn ethanol, corn starch and corn syrup.

Mulch is a layer of material applied to the surface of soil so as to conserve soil moisture, improving fertility and health of the soil, reducing weed growth, regulate soil temperature, and enhancing the visual appeal of the area among others. Many materials are used as mulches, these can be organic or synthetic (Orkwor and Ekanyake 1998). Basically, mulching creates a micro-climate for the plant to grow and perform better in an area that has regulated moisture content, suitable temperature, humidity, carbon-dioxide and proper microbial activity within the soil. Organic mulching materials include: Woodchips, pine needles, dry grasses, paddy straw, dry leaves, saw dust, grass clipping etc. They

get decomposed easily and need frequent replacements. Synthetic mulching materials are: rubber mulch from recycled rubber tires, plastic mulch, photo-degradable plastic mulch. The impact of mulching is greatly felt in rain-fed areas to conserve moisture, in areas that need irrigation as mulching reduces the frequency of irrigation. It is also very useful in greenhouses to maintain the soil temperature and to reduce deceases spread in areas with soil borne diseases, Mulching is needed for solarisation. In heavy rainfall areas, it reduces the impact of rain and prevent soil erosion. Mulching is also desirable in lands where high value crops are being cultivated.

Soil microorganisms play important role in maintaining soil quality. Major amount of soil organic matter is derived from the vegetation that is either deposited on the soil surface as an organic layer or incorporated into the soil as mulching materials. Litter decomposed is by the action of soil organisms under the condition of high air temperature and soil moisture. Also, the occurrence of wet- season- dry spells which may last for a few days to more than three weeks is another serious limiting factor to agricultural production in South Western Nigeria. Incidence of wet season dry spells particularly during the full vegetative stage when evaporative demand is high can lead to retardation of yield formation. The damage is more severe for field crops with shallow root system like maize. (Inyang, 2005) since maize is planted between the period extending from around the cessation of the rains in a given year to the time of onset in the succeeding year, it implies therefore that as soon as germination starts, soil moisture become critical, hence the need for efficient soil moisture conservation strategy in other to optimize soil physical condition affecting the crop yield. Therefore, this study was carried out to determine the effect of mulching materials on the growth and yield of maize as affected by soil properties

Materials and Methods

The experiment was carried out at the Teaching and Research Farm of Federal College of Forestry, Jericho Ibadan, Oyo State. The climate of the area is dominated by rainfall pattern ranging from (1400-1500mm). The average temperature is about 32^0C and relative humidity of about 80-85%. There are two distinct season namely dry season usually commence (November – March) and rainy season from (April – October) (FRIN, 2017). The treatments were organic mulching i.e., liters or leaves of *Gmelina arborea* (T1) *were used to cover the surfaces of designated pots according to treatment*, Synthetic nylon i.e. nylon (T2) were used and control (T3) served as treatment where no mulching materials was used. Each experimental unit measured 3m by 3m had fifteen seedlings at a spacing of 75cm by 50cm given a total plot size of 10m by 10m ($100m^2$.The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replicates

The seed of maize (*Zea mays*) was procured from Institute of Agriculture Research and Training (I.A.R &T) Ibadan. Planting was done at a spacing of 75 by 50cm at 2cm depth and two seeds per hole. Weeding was carried out with the use of hoe at two weeks interval throughout the period of the experiment. Three maize plants were selected randomly from mid row of each experimental plot and was used for data collection on: plant height, this was measured using tape rule from soil level to terminal bud at 2, 4, 6, and 8 weeks after planting (WAS). Three plants from the mid-row of the experimental unit were selected for measurement. Number of leaves: number of leaves per plant was determined by visual counting for each plant at 2, 4, 6, and 8 weeks after sowing (WAS). Stem diameter: Stem diameter per plant were measured using veniercaliper at 2, 4, 6 and 8 weeks after sowing (WAS) and weight of grain was recorded

Prior to planting, soil samples were collected randomly from 0-10cm top soil from the experimental plots which was analyzed for physical and chemical properties. Before collecting the soil samples, soil surface plant litter was carefully removed. The soil samples collected was packed into a well labeled polythene bags and sealed for transportation to the laboratory to determine; bbulk density by core-sampling method (Baruah and Barthakur, 1997), particle size distribution using hydrometer method (Bouyoucos, 1962), saturated hydraulic conductivity by core-sampling method (Soil Science Society of America, 2002; Oshunsanya, 2016), soil pH using pH meter (Udo and Ogunwale, 1986), organic carbon using Walkley Black wet oxidation method (Udo and Ogunwale, 1986), total nitrogen using khadjahl method (Kjeldahl, 1883; Fenton, *et. al*., 2016), available phosphorus with spectrophotometer using Mehlich 111 as extractant (Mehlich, 1984) method, exchangeable bases (K, Ca, Na and Mg) with atomic absorption spectrometer, exchangeable acidity and extractable Micronutrient (Fe, Mn, Cu and Zn) with atomic absorption spectrometer.

Post planting soil were also collected as done prior to planting to determine the post planting soil analysis after harvesting. Data collected were analysed statistically using Genstat Statistical Software package and were subjected to Analysis of variance. Means were separated using Least significantly difference (LSD) at 5% level of significance.

Results and Discussion

Pre planting typical physical and chemical properties of soil of the experimental site is as presented in table 1. The soils at the experimental site have been classified as an Alfisol (Smyth and Montgomery, 1962) with its distinctive characteristics. The data in Table 1 further confirms this assertion and also reveals that the soils are low in zinc and phosphorous. Organic carbon and total nitrogen content of the soil were 9.5 and 0.08 g kg^{-1} respectively which is below the critical range (Adeoye and Agboola, 1985), nearly neutral ph. The soil bulk density was 1.2 g cm^{-3} with sandy loam texture. Saturated hydraulic conductivity value of 12.84 cm hr^{-1} indicated a well-drained soil suitable for growing maize.

Influence of mulching materials on plant height (cm) of *Zea mays* (maize) is as presented in table 2. The result obtained from plant height showed that there was no significant difference among all the treatments used, at 8 (WAS) organic mulch (89.19 cm) had the highest plant height followed by inorganic mulch (75.2 cm) and least by control (71.56 cm).

Influence of mulching materials on number of leaves of maize is as presented in table 3. Number of leaves of maize increases appreciably across the treatment, but does not differ significantly (p=0.05) across treatments from 2^{nd} to 8^{th} weeks after sowing. At 8^{th} weeks after sowing, Organic mulching plot (10) had the highest number of leaves followed by inorganic mulching plot (9) and the least by control plot (8).

Influence of mulching materials on stem diameter of maize is as presented in table 4. There was no significant deference in stem diameter (p=0.05) across treatments between 2^{nd} and 6^{th} weeks after sowing. At 8^{th} weeks after sowing, Organic mulching plot (5.68cm) had the highest diameter followed by inorganic mulching plot (4.62cm) and the least by control plot (3.79 cm)

Influence of mulching materials on weight yield of maize is as presented in Table 5.
Result obtained shows that mulching had a positive effect on weight yield of maize, plot covered with organic mulch gave the highest weight yield of 5.00 t/ha which was significantly higher than control. This was followed by inorganic mulch (4.67 t/ha) although, this was not significantly different from weight yield when compared to control plot (2.40 t/ha)

Table 1: Pre planting typical physical and chemical properties of soil of the experimental site

PARAMETERS DETERMINED	VALUE
PH (H_2O)	6.7
Organic Carbon (g/kg**)**	9.5
Available Phosphorus (mg//kg**)**	8
Total Organic Matter (g/kg**)**	16.38
Total nitrogen (g/kg**)**	0.08
Exchangeable Bases (Cmol/kg)	
Na	0.26
K	0.66
Ca	0.14
Mg	0.16
Extractable Micro Nutrients (mg/kg)	
Mn	0.03
Fe	0.18
Cu	0.01
Zn	0.15
Particle size distribution (g/kg**)**	
Silt	235
Sand	700
Clay	65
Textural Class	Sandy Loam
Bulk density	1.2
Saturated hydraulic conductivity	12.8

Table 2: Influence of mulching materials on plant height (cm) of *Zea mays* (maize)

Treatment	Weeks After Planting (Wap)			
	2	4	6	8
Organic mulching	8.7a	30.11a	63.94a	89.19a
Inorganic mulching	6.88a	24.47a	45.83a	75.2a
Control	9.12a	31.67a	66.56b	71.56a

Means in the same column having the same alphabet are not significantly different from each other at 5% level of significance

Table 3: Influence of mulching materials on number of leaves of maize

Treatment	Weeks After Planting (Wap)			
	2	4	6	8
Organic mulching	4a	5a	8ab	10a
Inorganic mulching	4a	5a	7a	9a
Control	4a	4a	9a	8a

Means in the same column having the same alphabet are not significantly different from each other at 5% level of significance.

Table 4: Influence of mulching materials on stem diameter (cm) of maize

Treatment	Weeks After Planting (Wap)			
	2	4	6	8
Organic mulching	1.73a	3.44a	4.06a	5.68b
Inorganic mulching	1.24a	3.48a	4.02a	4.62ab
Control	1.47a	3.47a	3.73a	3.79a

Means in the same column having the same alphabet are not significantly different from each other at 5% level of significance.

Table 5: Effects of mulching materials on weight of grains (t/ha)

Treatment	weight of grain
Organic	5.066b
Inorganic	4.67ab
Control	2.40a

Means in the same column having the same alphabet are not significantly different from each other at 5% level of significance.

Table 6: Post planting typical physical and chemical analysis of soil properties on the types of mulching

Parameters determined	Control	Organic Mulch	Inorganic Mulch
pH	6.50	6.60	6.55
Organic Carbon (g/kg)	8.91	8.98	8.87
Total Nitrogen (g/kg)	0.07	0.05	0.06
Available Phosphorus mg/kg	6.40	6.26	6.30
Organic Matter (g/kg)	15.47	15.06	8.87
H^+	0.09	0.08	0.08
Exchangeable Bases (cmol/kg)			
Na	0.28	0.25	0.26
K	0.66	0.61	0.63
Ca	0.12	0.10	0.12
Mg	0.14	0.10	0.13
Extractable micro nutrients (mg/kg)			
Fe	0.16	0.14	0.16
Zn	0.14	0.11	0.12
Mn	0.02	0.01	0.01
Cu	0.01	0.01	0.01
Cation Exchange capacity	1.27	1.13	1.17
Percentage base Saturation	93.34	92.86	92.96
Textural class	Sandy loam	Sandy loam	Sandy loam
Silt (g/kg)	23.55	23.01	23.48
Sand (g/kg)	68.84	67.23	68.7
Clay (g/kg)	7.60	7.80	7.78
Bulk density (g/cm^3)	1.14	1.13	1.13

Conclusion and Recommendation

The results showed that mulching has a positive effect on growth and yield of maize. It could be observed from the result obtained that there was an increase in plant height, number of leaves, stem diameter and yield. The use of mulch can be adopted in maize production as maize yield was significantly higher with the use of organic mulch obtained from *Gmelina arborea* leaves

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EFFECT OF PAWPAW LEAVES, PALM KERNEL CAKE AND POULTRY MANURE ON THE GROWTH PERFORMANCE OF AFRICA GAINT LAND SNAILS (*ARCHACHATINA MARGINATA)*

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Abstract
The study investigated the effect of Palm Kernel Cake (PKC) and poultry manure on the growth performances of Africa giant land snails, (Archachatina maginata). A total number of thirty-six (36) snails were used for the experiment. There were three (3) treatments, three (3) replicates consisting of four (4) snails each. The experiment was laid out in a Complete Randomized Design (CRD). The treatments were snails fed with pawpaw leaves (control), snails fed with diet containing 65% Palm Kernel Cake (PKC) (T_2) and snails fed with diet containing 65% Poultry manure (PM) (T_3). Data were obtained for the following parameters to measure growth performance: feed intake, weight gain, shell length and shell circumference. Data obtained were subjected to Analysis of Variance (ANOVA). The results obtained showed that snail fed on poultry manure (T_3) had the highest weight gain of 122.4g, shell length 2.9 and shell circumference 2.8cm while those fed on palm kernel cake (T_2) had the highest feed intake 124.75g. The least weight gains 45.1g and feed intake 103.63g were recorded in the treatment fed on the control diet. This shows that poultry manure and palm kernel cake had the best performance on the growth of the snails, and can be recommended to be used by snail farmers for feeding their snails.

Keywords: Performance, growth, poultry manure, palm kernel and snails

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Introduction

Snails are derived from the wild life bank. They are use as food, feed or sources of revenue in given part of world. The Africa giant snail is a common gastropod mollusc in the high forest and in the Derived Guinea Savannah region in West Africa (Yoloye, 1994). The two main areas where of snail consumption in the world are Western Africa and Western Europe (Ademola *et al*, 2005)

In Africa, the feasibility of raising snail production started in the early 1970 in West Africa (Alexander, 1999), where they were raised in a small pen in many areas within the sub-region and currently in Nigeria. *Archachatina marginata* is one of the commonest species of snails in West Africa. It prefers primary rain forest habitat, where its population is largest during the rainy season and they collected in large quantities by the rural dwellers (Akintomide, 1997). *Archachatina marginata* is the largest of all Archachatina snails and are found in West Africa. It appears to be a mainly terrestrial snail in West Western Africa (Cameroon) through Democratic Republic of the Congo (Smith, 2009).

It can be found aestivating i.e., snail spend a dry season in a prolonged state of dormancy) having a closed aperture, sealed with a solid calcareous white epiphragm. During the day light, they hide themselves inside soil or dark place because they are active at night than during the day. Aside, picking snail from the forest, they can be gotten from snail farmers and the village market (Akinnusi, 1997). Snails are invertebrates with soft bodies that are covered with hard calcareous shell. Snails belong to the phylum of animals known as mollusc. Most species of edible land Snails are recognized but the popular species of economic interest in the West Africa giant snail *Archachatina marginata* and *Achatina achatina*.

They are prolific in nature and cheap to produce as a result of the small amount of capital that is needed for the commencement of its production and they can survive on various types of feeds which include breadfruit, coconut, sweet potatoes, tuber, leaves, drink, agricultural by products etc. Ajayi *et. al*, (2002) worked on the preference of snail for different feed materials including leaves, fruit and supplement feeds, it is reported that the snail have special preference for succulent leaves and fruit material and problem facing farmers in rearing snail is non-availability of food that will meet the nutrient requirement of snails (Akintomide, 2004).

Palm kernel cake (PKC) is an important oil palm by product. Malaysia has been the world largest producer and exporter of PKC and palm oil in the recent past. In the year 2001, Malaysia produced 1-53 million tonnes of palm kernel oil and 1.78 million tonnes of PKC (FAO, 2012; USDA, 2013).

Palm kernel cake (PKC) is obtained from the kernel after the oil has been extracted. The kernel is the endosperm of white cellular mass coated by a tough black membrane or testa, which is encased in a thick shell or endocarp. The kernel contains 50% fats, 9% crude protein and significant amounts of digestible starches, sugars and cellulose (Pickard, 2015; Chin, 2001, FAO, 2012).

Palm kernel cake (PKC) is a high energy feed with moderate amount of crude protein and fibre. It contains 52% nitrogen free extract (NFE), 31% acid detergent fibre (ADF), and 72% neutral detergent fibre (NDF). The copper (Cu) content is between 20-30ppm. In the total cell wall, mannose is the principal neutral sugar (56.4%), followed by glucose (11.6%), xylose (3.7%) and galactose (1.4%) (Mustaffa *et al.* (1987), Chin (1991), Miyashige *et al*. (1987).

Poultry manure is known to be an excellent source of organic matter that can be utilized for the growing of crops. According to (Iwena 1994), poultry generally produce manure of higher nutrient quality than large animals which usually have high fibre contents that are not easily decomposed. Poultry manure originally consists of excrement and waste of fowl, the differences in quality is largely due to the quality of feed fed to the birds. Akinyeye, (1986) reported that poultry manure contains about 2-4% of nitrogen, and readily restores the fertility of an excavated soil and enriches a naturally poor soil. It contributed directly to the soil by supplying nutrient to the plant or indirectly by reacting chemically or bacteriological on substance already present in the soil, this renders it more penetrating to the root of growing crops.

Poultry manure as snail feed (*Archachatina maginata*) has a high amount of protein, it increases their weight shell circumference, and the shell length on the other hand. Snail on poultry manure has less total manure composition. Elbously and Vendor Poel (1984) started that uric from poultry manure could inhibit microbial synthesis of vitamins or another mineral nutrient being essential to the host.

The high concentration of iron and presence of other vital minerals like Ca, Mg and Zn may be responsible for the intake of snail's hoemoloymph by pregnant women as reported by (Adeyeye, 1996).

Objectives of the study

(i) To determine the effect of pawpaw leaves, palm kernel cake (PKC) and poultry manure (PM) on the growth performances of *Archachatina marginata*.
(ii) To examine the weight gain of snails fed with Pawpaw leaves, Palm kernel cake (PKC) and Poultry manure (PM) based diets.
(iii) To examine the effect of Pawpaw leaves and Palm kernel cake (PKC) and Poultry manure (PM), diet on the shell length, and shell circumference of the snail's animal.

Materials and Method

Experimental Site

The experiment was carried out at Agricultural Extension and Management Teaching and Research farm, Federal College of Forestry, Jericho, Ibadan, Oyo state. The College is situated at latitude 7^0 5^{11}N and longitude 3^0 9^{11}E, the climatic condition of the area is tropical with an annual rainfall range of 1430-2000m (FRIN, 2006).

Materials used for the experiment

Thirty-six (36) juvenile snails
Rearing cages (hutch boxes)
Loamy soil
Water
Compounded feed (cassava peel, oyster shell, bone meal, mineral/vitamins)
Thread
Ruler
Sensitive scale
Kitchen scale
Feeding trough
Experimental diets (palm kernel cake and poultry manure)
Pen/biro
Field Book

Experimental animals

Thirty-six (36) pieces of African giant land snail's species (***Archachatina marginata***) were used for the experiment. The snails were purchased from One market in Ibadan metropolis.

Experimental layout

The experimental layout was laid out in a completely randomized design (CRD), and there were 3 treatments of 12 snails each. Each treatment replicated thrice at 3 snails per replicate. Snails on T1 were feed solely on pawpaw leave and served as control. Snails in T2 < T3 were fed feeds containing Palm kernel cake (PKC) and Poultry manure (PM) respectively. Treatment –

T_1R_1 **T_1R_2** **T_1R_3**

T_2R_1 **T_2R_2** **T_2R_3**

T_3R_1 **T_3R_2** **T_3R_3**

KEYS:

T —— Treatment
R —— Replicate
T_1 —— Paw-paw leaves (Control)
T_2 —— Palm kernel cake (P.K.C)
T_3 —— Poultry manure (P.M)

Experimental Diets

Three experimental diets were prepared i.e., compounded feed with inclusion of fresh Pawpaw leaves, palm kernel cake and poultry manure.

Fresh Pawpaw leaves were collected from nearby bushes within and outside the College premises, Palm kernel cake (P.K.C.) were purchased Olunloyo market Ibadan and Poultry manure was collected from nearby farm in Idi-ishin. The feeds were compounded at shalom feed mill Amuloko Ibadan.

Table 1Percentage composition of experimental diet

	Diet 1 Paw-paw leaves	**Diet** 2 palm kernel cake	**Diet** 3 poultry manure
Paw- paw leaves	100	—	—
Palm kernel cake	—	65	—
Cassava peel	—	31.03	31.03
0yster shell	—	1.50	1.50
Bone meal	—	1.50	1.50
Mineral/ vitamins	—	0.97	0.97
Poultry manure	—	—	65
Total	100	100	100

Source: Field Survey, 2020

Parameters assessed

Feed intake
Weight gain
Shell length

Method of parameter assessment

Feed offered were weighted with kitchen scale at 100g and the snail were feed twice in a day (morning and evening) and recorded per week and the left-over feed were measured. The shell length and shell circumference were measured using the thread and ruler and also the snail was weighed weekly to note the differences in weight.

Feed Intake— The amount of feed eaten by snails per treatment was determined weekly by subtracting the amount of feed left in the trough from the total feed served.

Thus: $\frac{\text{Quantity given (g)} — \text{Quantity left (g)}}{\text{7 days}}$

Weight Gain— The body weight gain was measured weekly and was calculated by subtracting the weight of each replicate.

Thus – BWG – initial weight (g) — final weight (g)

Shell Length— This was done by using thread and ruler to measured from the tip to the groove of each snail, the summation per replicate was divided by four to get the average.

Shell Circumference— This was calculated by using thread and ruler to measure the circumference of each snail in a replicate. The total sum of four snails that constituted a replicate was divided by four to have the common average of the shell circumference.

Proximate Analysis of Experimental Diets
The diets samples were analysed to their chemical composition according to the method of A.O.A.C (Association of Official Analytical Chemists (1990)

Results And Discussion
The proximate analysis of fresh paw-paw leaves, palm kernel cake and poultry manure was done in I.A.R&T Ibadan.

Table 1: PROXIMATE ANALYSIS OF THE EXPERIMENTAL DIETS

Sample	%Protein	%Cfibre	%Mc	%Fat	%Ash	%Carbon
A	12.17	2.07	6.28	2.10	8.32	71.06
B	17.86	2.96	8.94	21.79	11.48	36.97
C	33.95	3.07	11.05	4.27	9.73	37.06

Source: Field Survey, 2020

A — Paw-Paw Leaves
B — Palm Kernel Cake
C — Poultry Manure

In Protein, sample C has the highest while sample A has the lowest protein. In Crude fibre, sample C has the highest while sample A has the lowest. In Moisture content, sample C has the highest while sample A has the lowest. In Fat, sample B has the highest while sample A has the lowest. In Ash sample B has the highest while sample A has the lowest. In carbohydrate, sample A has the highest while sample B has the lowest.

Table 2Mean Feed Intake of the Snail for Eight (8) Weeks (Grams)

Treatments	wk1	wk2	wk3	wk4	wk5	wk6	wk7	wk8	total	mean
T1	90	104	117	100	134	113	100	97	855	106.88
T2	117	124	137	147	122	145	108	98	998	124.75
T3	83	106	108	102	105	123	84	118	829	103.63

Source: Field Survey, 2020

T1 Fresh Paw-paw Leaves
T2 Palm Kernel Cake P.K.C.
T3 Poultry Manure

From table 4.2 Treatment 2 has the highest mean feed intake with a value of 124.75g. This is followed by Treatment 1 with a mean value of 106.88g. Treatment 3 has the least feed intake with a mean value of 103.63g. This relates with the research work of okorie and okere (1994) who demonstrated the predilection for palm kernel cake by Archachatina marginata.

Analysis of variance (ANOVA) result showed that there is significances difference ($p>0.05$) among the treatments used on the feed intake of the snails at 5% level of probability. Since the f.cal (22.6361) is greater than f.tab (9.55), we therefore accept the alternate hypothesis H_A and reject the Null hypothesis (H_o) (Appendix 1)

Table 3Mean of Body Weight gain of Snails for Eight (8) weeks (gram)

Treatments	wk1	wk2	wk3	wk4	wk5	wk6	wk7	wk8	weight gain
T1	161.6	167.7	167.1	187.5	180.5	193.8	212.9	212.5	50.9
T3	137.6	106.8	158.4	181.3	204.0	214.6	237.5	260.0	122.4
T2	152.8	161.9	167.9	164.6	148.4	183.4	195.9	197.9	45.1

Source: Field Survey, 2020

T1 Fresh Paw-paw Leaves
T2 Palm Kernel Cake P.K.C.
T3 Poultry Manure

Table 3 shows the body weight gain of the snails in each treatment this is achieved by subtracting the initial reading (week 1) from the final reading (week 8). From the result obtained, treatment 3 (poultry manure) has the highest body weight gain with a value of 122.4g. This is followed by treatment 1 (fresh paw-paw leaves) with a value of 50.9g. Treatment 2 has the least body weight gained with a value of 45.1g. This agrees with the research work of Okorie and Okere (1994) that the weight of the snails depends on the amount of food taken. The higher their feed intake the higher their weights gain. The reason for this pattern of result cannot be explained. It can only be deduced that difference in the crude protein content of the feed does not have effect on weight gain.

The result of analysis of variance shows that, since F.tab (5.14) is greater than F.cal (5.000504), there is no significance difference in the body weight gain of the snails at 5% level probability. We therefore accept the null hypothesis (H_o) and reject the alternate hypothesis (H_A) (Appendix2)

Table 4Mean of shell length of snails for Eight (8) weeks (cm).

Treatments	wk1	wk2	wk3	wk4	wk5	wk6	wk7	wk8	increase
T1	13.0	13.2	13.4	13.5	13.7	13.8	13.7	13.6	0.6
T2	12.4	12.7	12.9	13.0	13.1	13.2	13.2	13.2	0.8
T3	12.6	12.9	13.0	13.4	13.7	13.7	15.1	15.5	2.9

Source: Field Survey, 2020

T1 Fresh Paw-paw Leaves
T2 Palm Kernel Cake P.K.C.
T3 Poultry Manure

Table 4 shows the shell length of the snail in each treatment. Treatment 3 (poultry manure) has the highest increase in shell length when the initial reading is subtracted from the final reading with a mean increase of 2.9cm. This is followed in relation by treatment 2 with a mean increase of 0.8cm. Treatment 1 has the least increase with a value of 0.6cm.

The result of analysis of variance shows that since F.tab (5.14) is greater than F.cal (1.253289), there is no significance difference in the shell length of snails at 5% level probability. We therefore accept the null hypothesis (H_o) and reject the alternate hypothesis (H_A) (Appendix3).

Table 5Mean of shell circumference of snails for Eight (8) weeks (cm)

Treatments	wk1	wk2	wk3	wk4	wk5	wk6	wk7	wk8	increase
T1	17.7	18.3	18.2	18.3	18.5	18.7	18.6	18.6	0.9
T2	17.7	17.9	18.3	18.3	18.3	18.4	18.4	18.3	0.6
T3	17.7	18.0	18.4	18.8	18.7	19.2	19.8	20.5	2.8

Source: Field Survey, 2020

T1 Fresh Paw-paw Leaves
T2 Palm Kernel Cake P.K.C.
T3 Poultry Manure

Table 5 shows the shell circumference of the snail in each treatment. Treatment 3 has the highest level of increase in shell circumference when initial reading is subtracted from the final reading with a value of 2.8cm. This is followed in relation by treatment 1 with a value of 0.9cm. Treatment 2 has the least level of increase with a value of 0.6cm. This is in conformity with the works of Ademolu and Idowu. (2005) who recommended the inclusion of poultry manure in the rations of African giant land snail due to the presence of high concentration of nutrients and minerals which improve the shell width.

Analysis of variance result shows that since the F.tab (5.14) is greater than F.cal (1.467354), there is no significance difference ($p<0.05$) in the shell circumference of the snails at 5% level probability.

Conclusion and Recommendation

Snails on poultry manure performed better than those on palm kernel cake as it has appreciable influence on weight gain, shell length and shell circumference of the snails. Snails on palm kernel cake performed better than those on poultry manure as it has appreciable influence on their feed intake. Snail farmers could be encouraged to make use of poultry manure and palm kernel cake in feeding their snail. That palm kernel cake and poultry manure is good feedstuff that could be use in replacement of maize, paw-paw leaves in snail diets. Palm kernel cake and poultry manure could be used as original feed diet up 100% as it does not have any deleterious effects.

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RESOURCE-USE EFFICIENCY AMONG SMALLHOLDER MAIZE FARMERS IN OYO STATE, NIGERIA.

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Abstract

The study examines the efficiency of resource inputs used in maize production in Oyo State, Nigeria. A cross sectional survey of 188 smallholder maize farmers were selected through multi-stage random sampling technique using a well-structured questionnaire to elicit the required information. Analytical techniques included descriptive statistics, budgetary analysis and Cobb-Douglas production function. Results showed that 90.4% of the sampled were male. The mean age, years of education and farming experience were 51.54 years, 7.64 years and 23.39 years respectively. Average household size and land area cultivated for maize production was 7 persons and 1.15 hectare respectively. Average gross margin and net farm income earned per hectare were ₦96,737.27 and ₦80,502.47 respectively. Result revealed further that maize output was significantly influenced by fertilizer, pesticide, labour, land area and capital used in production. Estimated return to scale of 1.21indicates increasing returns to scale, suggesting there are potential for expansion as the efficiency of maize production is sub-optimal. Result showed that maize farmers in the study are were not efficient in the utilization of any of the inputs used in production. To achieve optimal production in maize agriculture in the study area, farmers should increase the quantities of seed, fertilizer, pesticide, land area and capital while reducing the quantity of labour used. Policies focus should be directed at subsidizing the farm inputs, diversification of farm work activities to off/non-farm work to diffuse excess labour force in farms and effective training and improved service deliveries by extension workers to increase farmer's efficiency in resource allocation.

Key words: Efficiency, Resource-use, smallholder, maize, optimization, Cobb-Douglas

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1.0 Introduction

Maize is one of the crops that will continue to dominate global food security in the present century (CIMMYT, 1999). The CIMMYT report also states that, in the next decade, global demand for maize would rise by 47%. With the growing economic importance of maize worldwide, it has become the number one staple and cash crop for a great number of farmers (Manyong et *al*, 2000). For over nine hundred million poor people and over one-third of all malnourished children, maize is the number one staple. In addition to this is the fact that the demand for maize in developing countries was projected to increase by 72% between 1997 and 2020. This increase in demand represented 213 million metric tonnes of maize for the period (James, 2003). Projection showed that by 2025, maize would become the crop with the greatest production volume worldwide (CIMMYT and IITA, 2010). Worldwide production of maize is 785 million tons, with the largest producer, the United States, producing 42%. Africa produces 6.5% and the largest African producer is Nigeria with nearly 8 million tons (IITA, 2014). According to the FAO, about 4.7 million tonnes of maize were produced on the average between 1990 and 2015 in Nigeria and the contribution of maize to total grains produced in Nigeria increased from 8.7% in 1980 to about 22% in 2003. Maize production in Nigeria stood at 10.7 million metric tons in 2015 (FAO, 2017) and 10.5 million metric tons in 2017 (Mundi Index, 2018). According to the Mundi Index, maize consumption in Nigeria in 2017 stood at 10.9 million metric tonnes (Olaniyan, 2015). With increasing population, demand for maize will continue to be on the higher side and expected rise in demand for maize requires a continuous increase in maize production occasioned by increase in maize productivity (CIMMYT and IITA, 2010). The trend of maize productivity in Nigeria shows a steady rise in total yield from 1.268t/ha in 1986 to 1.640t/ha in 1988, then exhibiting a declining trend to 1.500t/ha in 2003 and subsequent rise reaching its peak of 2.196t/ha in 2009. It was further declined to 1.59t/ha in 2017 and maintained a balance of 1.69 ton/ha in year 2018 and 2019 respectively (FAOSTAT, 2013; Knoema, 2019). Empirical evidences suggest that improving the productivity of smallholder farmers is important for economic development because smallholder farmers provide a source of employment and a more equitable distribution of income (Bravo-Ureta and Evenson, 1994).

In view of the economic importance of Maize in Nigeria, it has not been produced to meet food and industrial needs of the country and this could be attributed to low productivity from maize farms or that farmers have not adopted improved technologies for maize production (Onuk *et al.,* 2010). Major motivations for productivity are profitability and efficiency. Efficiency is a very important factor of production growth in an economy where resources are scarce and opportunities for new technology are lacking. The traditional notion of efficiency started from the Farrell's influential works which proposed that technical, allocative and economic efficiencies constitute the main components of efficiency. The ability of farmers to achieve a maximum output given similar input levels measure their technical efficiencies whilst the optimum use of these inputs up to the level at which their marginal value of productivity is equal to the marginal factor cost is referred to as allocative efficiency. Economic efficiency on the other hand is the ability of a farm to maximize profit. Both technical and allocative efficiencies are the main components of economic efficiency. Efficiency of resource use is the relative performance in transforming given input into output (Umeh *et. al.,* 2016). Resource use denotes the allocation of resources between

competing alternative geared towards achieving maximum returns from given resources. These resources are relatively scarce to the farmers and have to be organized efficiently given the many alternative uses to which they can be used (Ajibefun and AbdulKadir, 2004). Productivity and resource allocation are important aspect of increased food production (Udoh and Falake, 2006). The efficient allocation of resource at the farm level has great implication for national development. It is worrisome that most households in Nigeria farming system remains food insecure despite various government interventions and support programmes in agricultural development. In assisting maize farmers to improve productivity, the emphasis should not only be on whether or not they have used productivity-enhancing technologies, but also on whether or not they are making the best use of the technologies or inputs available to them. This necessitates determining the efficiency of resource use in Nigerian smallholder maize production. Specifically, the study sought to describe the socioeconomic characteristics of the sampled farmers, examine the costs and returns in maize production, determine the efficiency of input resources used in maize production and determine the level of divergent of resource inputs to achieve optimization. The results of this study will enable the government and other stakeholders interested in investing in maize production to decide what levels of production inputs should be used to achieve desired output.

2.0 Materials and methods

2.1 Study area

Data for this study were collected from a cross-sectional survey of maize farms in Oyo state, Nigeria. It is located in the southwestern part of the country. Oyo state covers approximately a land area of 28, 584 square kilometers and a population of 5,591,589 (Wikipedia, 2008). It lies between latitude $2°38^1$ and $4°35^1$ east of the Greenwich meridian. The major occupation in the state is agriculture and it is suited for the cultivation of export crops such as cocoa, cashew, palm tree. Arable crops, such as maize, yam, cassava, millet and rice are also cultivated. Other occupations include trading, hunting and civil service. The climate is tropical with distinct dry and wet seasons with relatively high humidity. The dry season lasts from November to March while the wet season starts April and ends in October. The annual mean rainfall is 300 mm. Average daily temperature ranges between 25 ^oC and 35 ^oC almost through-out the year.

The Oyo State Agricultural Development Programme (OYSADEP) has four zones namely, Saki, Oyo, Ogbomoso and Ibadan - Ibarapa Zones.

2.2 Type and Sources of Data

The study employed primary data. Primary data were collected with the aid of structured questionnaires. Data were collected on different household and farm characteristics of smallholder maize farmers. Household characteristics include age, education, farming experience, marital status, gender of the head of household, farm income and non-farm income. Farm characteristics include farm size, area of land planted for maize, the labour used for farm activities and their costs, the quantities of maize harvested, consumed and sold and their costs and various costs of inputs such as seeds, fertilizer and herbicides/pesticides, institutional factors include access to extension services and access to credit.

2.3 Sampling procedures

The study employed a multi-stage random sampling technique for the selection of the representative samples. The first stage involved random selection of two zones out of the four

OYSADEP zones. The selected zones are Ibadan and Saki zones. From each zone two Local Government Areas (LGAs) were randomly chosen i.e Akinyele and Egbeda from Ibadan zone; Saki-west and Atisbo LGAs were selected from Saki zone. The third stage involved a random selection of five villages from each LGA making a total of 20 villages or rural communities. The final stage was a random selection of 200 smallholder maize-based farmers. The sample size in each, Zone, LGAs and Villages were determined by probability proportional to size of farming households in each sampling unit respectively. Although a total of 200 questionnaires were administered on the respondents, 12 of these were found unsuitable for analysis and consequently, data from 188 questionnaires were analyzed for the study.

2.4 Analytical technique

The data collected were analyzed using Descriptive statistic, Budgetary technique and Inferential statistic.

(i). Descriptive statistics: the simple descriptive statistic used includes mean and percentages. This was used to analyze the socio- economic and farm characteristics of the respondents, input and output variables and the distribution of profit efficiency levels.

(ii). Budgetary technique: This was used to analyzed the costs and returns structure of smallholder maize farmers. It includes the use of gross margin analysis. Gross margin is taken as the difference between the total values of production and the total variable cost of production.

GM = TR - TVC

TC = TVC + TFC

NFI = TR - TC

ROI = NFI/TR

Where; GM = Gross Margin, TR = Total Revenue, TVC = Total Variable Cost, TFC= Total Fixed Cost, TC = Total Cost, NFI = Net farm income, ROI = Returns on investment

(iii). Multiple regression analysis: It involved the use of Cobb-Douglas production function model which stipulates the technical relationship between inputs and output in any production process. In addition, coefficient of input resources used under the Cobb-Douglas specification model are estimated and these were used to examine the resource-use efficiency and to estimate the return to scale value.

Cobb-Douglas production function was used to compute marginal value product (MVP) in order to determine the optimum, underutilization and overutilization of resources following Gujarati (2009).

$$Y = aX_1^{\beta 1}X_2^{\beta 2}X_3^{\beta 3}X_4^{\beta 4}X_5^{\beta 5}X_6^{\beta 7}e^{\mu} \quad \text{.....(1)}$$

The explicit form of the Cobb-Douglas model is specified as:

$$InY = \beta_0 + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 InX_3 + \beta_4 InX_4 + \beta_5 InX_5 + \beta_6 InX_6 + \varepsilon \quad \text{.....(2)}$$

Where:

Y= Output of maize (kg);

X_1= Seed (kg);

X_2= Fertilizer (kg)

X_3= Pesticides (lt)

X_4= Labour (man-day)

X_5= land area cultivated for maize (ha)
X_6= Capital (Depreciation on tools & equipment) (₦)
β_1 ..... β_6 are elasticity of response of inputs to output respectively
ε = Error term

For maize farmers to be efficient in their use of production resources, their resources must be used in such a way that their marginal value product (MVP) is equal to their marginal factor cost (MFC) under perfect competition. Marginal value product (MVP) is the value added to maize output due to the use of an additional unit of input while Marginal factor cost (MFC) is the per unit cost of input resource. Therefore, the resource use efficiency parameter was calculated using the ratio of MVP of inputs to the MFC.

$$r = \frac{MVP}{MFC} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

where *r* = efficiency coefficient
MVP = marginal value product
MFC = marginal factor cost of inputs.

$$MFC = p_x \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Where P_{xi} = price per unit of resource input used

$$MVP_x = MPP_x . p_y \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

MPPx = marginal physical product of input x
Py = unit price of maize output.

$$MPP_x = \frac{dY}{dX} = \beta_x \frac{Y}{X} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

where Y = mean value of output, X = mean value of input employed in the production of a product, β_x = regression coefficient

$$MVP = \frac{\partial Y}{\partial X} . p_y = \beta_x \frac{Y}{X} . p_y \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

MVP is calculated by the product of output elasticity of that input, the ratio of mean output to mean input values and the unit output price.
Decision rule:
r = 1, it implies the input was used efficiently.
r > 1, it implies the input was underutilized and therefore both output and profit would be increased

if more of that input is employed.

r < 1, it implies the input is overutilized and therefore both output and profit would be maximized if less of that input is employed.

Optimization of resources

The relative percentage change in MVP of each resource required to obtain optimal resource allocation, that is r = 1 or MVP = MFC, was estimated using equation (6 or 7) below:

$$D = \left(1 - \frac{MFC}{MVP}\right) X100 \quad \ldots\ldots 6$$

or

$$D = \left(1 - \frac{1}{r}\right) X\ 100 \quad \ldots\ldots 7$$

Where, D = Absolute value of percentage change in MVP of each resource

3.0 Results and Discussion

Table 1 presents the socioeconomics characteristics of sampled maize farmers in the study area. Results shows that 90.4% of the maize farmers were male and 9.6% were female. This indicates that men dominated maize farming in the study area. This result reaffirmed the findings of Okoruwa *et. al.*, 2009; Zongoma *et. al.*, 2015, Awunyo-vitor *et. al.*, 2016. Majority (61.7%) of the respondents were within the age 41-60 years, 23.4% of the respondents were above 60 years of age and 14.9% of the respondents were within the age 20-40 years. The mean age of the respondents was 51.54 years. This result showed that maize farming activities are in the hand of ageing population which may hinder increased maize output in the study area. Marital status of the sampled respondents shows that 93.6% were married and 6.4% were single/Divorcee. This indicates an increase in the supply of family labour to increase maize production in the study area. Majority (48.9%) of sampled have household size between 6-10 persons, 37% of the respondents have household size between 1-5 persons and about 13.9% have household size above 10 persons. The mean household size of the sampled was 7.52 persons. This result supports the findings of Sadiq *et. al.*, 2013 who reported an average of 7 persons per household in maize farms in Niger state. Education of the household head shows that 28.7% had no formal education, this supports the findings of Zongoma *et. al.*, (2015) who reported 37.4% lack of formal education among small-scale maize farmers in Borno State, 36.7% had primary education, 24.5% had secondary education and 10.1% had tertiary education. The mean years of education was 7.64 years. This indicates that majority of the sampled household head had formal education which can aid efficient utilization of farm resources in maize production. The level of education may indicate productivity potential in farming enterprise. Household head years of farming experience shows that 54.2% of the respondents had above 20 years farming experience, 30.9% of the respondents had between 11-20 years farming experience and 14.9% had less than 10 years farming experience. This indicates that majority of the farming households have been practicing farming for long which may enhance their ability to efficiently allocate farm resources, handle production risk and uncertainty in farming with great dexterity. This supports the findings of Abdulai *et al.*, 2013, Coster and Adeoti (2015), Awunyo-vitor et. al., 2016, Wognaa and Awunye (2017) that experienced farmers could predict appropriate agronomic practices for efficient maize production. Results shows that 81.9%

of sampled farmers had access to extension agents twice in a month, 10.6% of the farmers had contact with extension agents thrice in a month and 7.9% had access to extension agent once in a month in their farms. The mean number of contacts with extension agent was 2.26 times in a month which is in agreement with recommendation of Training and Visit system (T&V) of extension which required that extension agents should visit the farmer once in two weeks (fortnightly). Increased access to extension services could have positive effect on the resource use efficiency of maize production in the study area since extension agents normally disseminate information on new innovations and production technologies that improved farming. Results revealed that 59.6% of the respondents had between 0.1-1.0ha of cultivable land for maize production, 18.1% of the respondents cultivated between 1.1-2.0ha of farmland for maize production and 13.8% and 8.5% of the respondents cultivated between 2.1-3.0ha and 3.1-4.0ha of farmland respectively for maize production.

The average farmland cultivated for maize production in the study area was 1.15ha. This reaffirmed that majority of the sampled farmers were smallholder maize producers. Respondents access to credit revealed that majority (61.7%) of the sample had access to credit and 38.3% had no access to credit supports from government or NGOs in course of farming activities. It is believed that availability of credit eases the cash constraint of the farmers thus enables them to make inputs purchases and transaction costs associated with various farming activities which they cannot afford from their owned resources. This will have positive effect on resources use efficiency of maize farmers in the study area.

Table 1. Socioeconomic characteristics of Smallholder Maize Farmers.

Variable	Frequency	Percentage	Mean	S.D
Gender				
Male	170	90.4		
Female	18	9.6		
T**otal**	**188**	**100.0**		
Age (years)				
20-40	28	29.7	51.54	11.17
41-60	116	19.6		
>60	44	5.1		
Total	**188**	**100.0**		
Marital status				
Married	176	93.6		
Single/Divorcee	12	6.4		
Total	**188**	**100.0**		
Household size (number)				
1-5	70	37.2	7.52	4.23
6-10	92	48.9		
>10	26	13.9		
Total	**188**	**100.0**		
Education (years)				
No formal	54	28.7	7.64	6.22
Primary	69	36.7		
Secondary	46	24.5		
Tertiary	19	10.1		
Total	**188**	**100.0**		
Farming experience (years)				
1-10	28	14.9	24.39	12.81
11-20	58	30.9		

20-40	102	54.2		
Total	**188**	**100.0**		
Extension contact (no. of visit)				
Once	14	7.5	2.26	0.75
Twice	154	81.9		
Thrice	20	10.6		
Total	**188**	**100.0**		
Access to credit				
Yes	116	61.7		
No	72	38.3		
Total	**188**	**100.0**		
Land area cultivated for maize(hectare)				
0.1-1.0	112	59.6	1.15	1.10
1.1-2.0	34	18.1		
2.1-3.0	26	13.8		
3.1-4.0	16	8.5		
Total	**188**	**100.0**		

Source: Field survey, 2019

3.2. Costs and returns of maize production

The costs and returns analysis of maize production per sample farmer per hectare in the study area is presented in Table 2. The average total cost of maize production per hectare was ₦94,879.14 and average total revenue realized per hectare was ₦179,283.85. Among the total cost of production, labour cost took the largest share ₦47,835 (48.4%). This supports the findings of Zongoma et. al., (2015), Baruwa and Familusi (2018) who reported that labour constituted the single most important cost item on the average in crop farming. Closely followed is the cost of fertilizer (16.6%), fixed costs (16.4%) and transportation cost (10.8%). The gross margin of ₦96,737.27 and Net farm income of ₦80,502.47 was realized per hectare during the production period. The calculated benefit-cost ratio for the production year was 1:1.81 which indicates a return of 81 kobo on every ₦1.00 invested. The analysis above indicates that maize production is economically viable and profitable in the study area.

Table 2. Costs and returns of maize production per hectare

Items	Quantity	Unit price (₦)	Total (₦)
Total revenue			
Maize output(kg/ha)	1558.56	115	179,283.85
Variable Cost			
Seed(kg/ha)	21.02	200	4,204.00
Fertilizer(kg/ha)	126.17	130	16,402.10
Pesticides (lt/ha)	2.87	1,204	3,455.48
Labour (man-day/ha)	31.89	1,500	47,835.00
Transportation			10,650.32
Capital (Depreciation)			5,360.37
Land (rent)			10,874.43
Total Variable Cost (TVC)			82,546.58
Total cost (TVC + TFC)			98,781.38
Gross margin (GM)			96,737.27
Net Farm Income (NFI)			80,502.47

Source: Field survey, 2019

3.3. Summary statistics of variables used in Cobb-Douglas production model.

The summary statistics of the variables used in Cobb-Douglas production function is presented in Table 2. Result showed the mean output of maize harvested was 1792.34kg during the production year. However, the average yield of maize for the sampled farmer in the study area was 1,558.6 kg/ha. This is relatively low when compared to 6.3 metric tonnes/ha obtained by Abdulai and Abdulai (2016) for Zambian maize farmers. The observed seed rate per hectare was 21.02kg/ha which is lower than the standard seed rate for maize production of 25kg per hectare. Average fertilizer used per hectare was estimated as 126.17kg which is lower than the recommended usage of 400kg/ha application level for effective optimum growth and yield of maize (Law-Ogbomo, 2009). Average pesticides used per hectare was 2.87lt respectively. This invariably showed that farmers in the study area relied on the use of crude implements and indigenous knowledge to control weed, pest and diseases. Result revealed further that average labour used in farming operations was 31.89 man-day per hectare. The average farm size of the farmers was 5.49 hectares. However, the proportion of land area allocated for maize production was 1.15 hectares which indicates that farmers in the study area allocated 20.9% of their land holding to maize production. The implications of farmers not making effective use of productive input resources in farming operations may result in production inefficiencies.

Table 3. Summary statistics of variables used in regression model

Variables	Min	Max	Mean	Std. Deviation
Seed (kg/ha)	1	100	21.02	20.98
Fertilizer (kg/ha)	0	500	126.17	104.69
Pesticides (lt/ha)	0	16	2.87	2.15
Labour (man-day)	6	120	31.89	28.74
Capital (~~₦~~)	200	12,800	5360.37	3689.96
Land area cultivated for maize (ha)	1	4	1.15	1.10
Farm size(hectare)	3	40	5.49	4.59
Maize output(kg)	140	8,000	1792.34	1905.14

Source: Field survey, 2019

Table 4 present the results of Cobb-Douglas production function used to estimate allocative efficiency of maize producers in the study area. The coefficient of determination R^2 was 0.7655 indicating that about 76.55% variation in the maize output in the study area were explained by the explanatory variables included in the model. The adjusted R^2 (0.7597) is a little lower than R-squared but not too much suggesting that the model do not have a serious over fitting problem. The F-statistic ($F = 98.49$ $p<0.01$) indicates that the overall model is significant at 1%. The estimated co-efficient of Cobb-Douglas production function also represented the elasticity of production. Results showed that maize output was significantly influenced by fertilizer, pesticides, labour, land area, and capital used in production. Though quantity of seed used in production was positive but not significant to influence the quantity of maize output. This is in agreement with the findings of Awuyo-victor *et. al.*, (2016) but contrary to the findings of Sapkota *et. al.*, (2018), Zongoma *et. al.*, (2015). Quantity of fertilizer used in maize production was positive and significant (0.1296 $p< 0.05$). This implies that increase in the use of fertilizer by 1% will lead to 12.96% increase in maize output. This is in agreement with the findings of Zongoma *et. al.*, 2015, Awunre-victor *et. al.*, 2016 and Sapkota *et. al.*, (2018). Pesticides i.e herbicides and insecticides used to control weed and pest infestation on maize farm positively and significantly (0.0495 $p< 0.01$) influenced maize output in the study area. This implies that 1% increase in the quantity of

pesticides use will result in 4.95% increase in maize output. Increase in the unit of labour employed to work on maize farm will lead to 15.64 % increase in the quantity of maize output at 10% probability level. This result is in line with the findings of Sapkota *et. al*., (2018). Similarly, increases in the unit of land area cultivated for maize production and capital employed by 1% increases maize output by 44.1% and 47.1% respectively. Similar results were reported by Awunye-victor *et. al.,* (2016) who found positive and significant relationship between land area cultivated, capital and maize output in Ghana. The estimated returns to scale for maize farmers in the study area (1.28) indicates increasing returns to scale which implies that maize production for the period under study (2018/2019 season) was in stage 1 of the production function. This suggests that there are potentials for maize output expansion in the study area as the efficiency of maize production in the study area is sub-optimal. Stage I of production can be regarded as the sub-optimal stage where the fixed resources are abundant relative to the variable resources (Reddy *et al*., 2004). This result is in agreement with the findings of Sanusi *et. al.*, (2015), Awunyo-Victor *et. al*., (2016) and it was contrary to the findings of Sapkota *et. al.,* (2018) who found a decreasing return to scale (0.861) for maize seed production in Palpa district of Nepal.

Table 4. Regression results of Cobb-Douglas production function

Variables	Coefficient	Standard Error	T-value
Seed (X_1)	0.0327	0.0728	0.45
Fertilizer (X_2)	0.1296**	0.0146	2.03
Pesticides (X_3)	0.0495***	0.0147	3.38
Labour (X_4)	0.1564*	0.0825	1.89
Land area cultivated for maize (X_5)	0.4408***	0.0834	5.29
Capital (X_6)	0.4710***	0.0452	10.43
Constant	1.2026***	0.2268	5.30
No. of observation	188		
F(6, 181)	94.49		
Prob > F	0.0000		
R2	0.7655		
Adj. R2	0.7577		
Root MSE	0.2292		
Return to scale	1.28		

Source: Field survey, 2019

Table 5 presents the estimate of resource-use efficiency in maize production in the study area. The values of marginal physical product revealed that maize farmers in the study area utilized land more efficiently than any other resources. This suggests that if additional one hectare of land is available for cultivation; it would result to an increase in maize output by 597.4 kg. Similar result was obtained by Sanusi *et. al.* (2015), Awunyo-victor *et. al.* (2016) who reported that farmers are more technically efficient in the use of land. Result shows that productive input resources i.e seed, fertilizer, pesticides, land and capital items used by farmers for maize production in the study area were under-utilized while labour was overutilized. Yusuf *et. al.*, (2010), Sanusi *et. al*., (2015), Awunyo-victor *et. al.*, (2016), Sapkota *et. al.*, (2018) reported underutilization of farm size, seed, fertilizer and herbicides in their respective studies. This study reported underutilization of capital which supports the findings of Sanusi *et. al*. (2015) and contrary to the findings of Awunyo-victor *et. al*., (2016) that reported overutilization of capital input in their study. Labour resource was found to be overutilized by farmers in this study which is similar to the findings of Oluwatayo *et al.* (2008), Sanusi *et. al*. (2015), Zongoma *et. al.*, (2015), Awunyo-victor *et. al.*, (2016), Sapkota

et. al., (2018) and contrary to the findings of Gani and Omonona, (2008) who reported underutilization of labour in their study. Overall, this study showed that maize farmers were not efficient in the utilization of any of these resources. Even though, these resources were under-utilized, the fact that their MVP's were not negatives is an indication that these resources were being used within economically rational range but not optimally used.

Table 5. Estimated Resource-efficiency

Variables	Elasticities	MPP	MVP	MFC	r (MVP/MFC)	
Seed	0.0327	2.42	278.3	200	1.39	Under-utilization
Fertilizer	0.1296	1.60	184	130	1.42	Under-utilization
Pesticides	0.0495	26.88	3,091.12	1,204	2.57	Under-utilization
Labour	0.1564	7.64	878.6	1,500	0.59	Over-utilization
Land	0.4408	597.4	68,701	9,500	7.23	Under-utilization
Capital	0.4710	92.34	10,619.1	674.5	15.74	Under-utilization

Computed from field survey, 2019

Table 7 presents the required adjustment level (% Divergent) needed to achieve optimization of resources used by maize farmers in the study area. Optimum utilization of inputs requires that marginal value product be equal to inputs unit price (i.e MVP =MFC). Results revealed that resources, i.e seed, fertilizer, pesticides, land and capital should be increased by 28.1%, 29.6%, 61.1%, 86.2% and 93.6% respectively while labour should be reduced by 69.5% for optimum allocation of resources to ensure improved maize productivity

Table 6. Required Adjustment for optimization of resources

Variable inputs	Percentage adjustment required
Seed	28.1
Fertilizer	29.6
Pesticides	61.1
Labour	69.5
Land area	86.2
Capital	93.6

Computed from field survey, 2019

Conclusion and Recommendation

The study revealed that maize production is economically viable and profitable in the study area. Maize output was significantly influenced by productive inputs such as fertilizer, pesticides, labour, land and capital. Among the resource inputs used in maize production, land is more efficiently utilized given its MPP's value. The estimated returns to scale show increasing returns to scale which indicates sub-optimal production. Resource-use efficiency of maize production in the study area revealed that all the input resources employed in maize production except labour were underutilized while labour was overutilized, suggesting that all inputs were not efficiently utilized during the production period. To achieve optimal allocation of resources for improved productivity and profitable maize production in the study area, farmers need to increase the quantity of seed, fertilizer, pesticides, land and capital items while reducing the quantity of labour. Policies focus should be directed at subsidizing the farm inputs to make it affordable at lower costs to rural farmers, this would help in increasing maize output; diversification of farm work activities to off and non-farm work to reduce excess labour supply in farms; encouraging and motivating the

extension officers to increase their number of visit and improved the service delivery to farmers through effective training methods of resource combination and uses.

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EFFECTIVENESS OF *OCIMUM GRATISSIMUM, JATROPHA CURCAS* AND *CHROMOLAENA ODORATA* POWDER IN THE MANAGEMENT OF *SCUTELLONEMA BRADYS* INFECTING FIVE YAM VARIETIES IN KOGI STATE NIGERIA

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Abstract

Scutellonema bradys, a phyto-parasitic nematode is reputed for its symptomatic infections in many varieties of yam. Colossal losses have been attributed to its infection on yam where the land is endemic with S. bradys. Studies were conducted on the effects of Ocimum gratissimum, Jatropha curcas and Chromolaena odorata in the management of Scutellonema bradys infecting five yam varieties in the study area in 2014 and 2015 cropping season. The trials involved three organic material treatments (powders of Ocimum gratissimum, Jatropha curcas, Chromolaena odorata) and the control was factorially combined with the five yam varieties and inoculation of Scutellonema bradys. The cultivars used as test crops were Okunmodo, Kerege and Sebukere as (white yam), Ewura (Water yam) and Olo (Yellow yam). The yam nematode, Scutellonema bradys caused lateral lesions, necrosis and dry rot of yam on the white yam, water yam and yellow yam. The results of this research showed that white yam is susceptible to S. bradys, while water yam and yellow yam cultivars proved to be resistant to S. bradys. The findings indicated that S. bradys in screenhouse and field experiments significantly affected yam growth and yield. All the plant materials; powdered leaf of Ocimum gratissimum, Jatropha curcas, and Chromolaena odorata had significant bio- pesticidal effects on S. bradys as they caused reduction in population both in the screenhouse and field experiments compared to the control. It is therefore advised that yam growers should not plant white yam cultivars on areas of land that are endemic to S. bradys.

Keywords: Nematode, Yield, Jatropha, Chromolaena, gratissimum

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Introduction

The crop yam (*Dioscorea spp*) is one of the common food crops in the tropics and plays vital roles in food security as a staple food in the regions where it is being cultivated (Maroya *et al*, 2012). *Dioscorea spp* occur in Asia, East Africa, the Caribbean, India and Tonga Kingdom, south pacific as well as West Africa (Okigbo, 2004). Maroya *et al*. (2012) estimated that yam consumption yearly is over a 48 million tonnes globally. Out of the 48million tons of yam (95% global supply) that are produced on 4million hectares annually, Nigeria alone produces 67.7% of the global yam supply (FAO, 2010). Yam is the most predominant basic starch in sub-saharan Africa specifically called West African Belt (Fu *et al*; 2011; Demuyakor *et al*; 2013). This makes Nigeria the highest consumer of this staple crop after Cassava and Maize. However, demand for this commodity is increasing as

incomes increase consumers shift from substitutes to yam especially when the price of yam relative to price of its substitutes declines (Maroya *et al.*, 2012). Yam plays an outstanding function in the

social cultural lives of some producing regions like the celebrated Moon festival and also the popular Yam festival in West Africa, a well-observed act. In Nigeria for instance, the meals offered to 2 deities and associates consist mainly of mashed yam (Ogunleye, 2005). Yam storage in comparison with some other staple crops has a relatively longer life span, so stored tuber symbolizes stored wealth, which can be sold throughout the year by the marketers. Also, tuber yam in West Africa particularly Nigeria can be converted into different staple transitional and end product forms (Okaka and Aajekwu, 1990; Okaka *et al.*, 1991) which can be consumed by human beings and animals, used as the essential ingredient of snacks and flour that is now used in instant puree making (Okaka and Okechukwu, 1987). Yam can be eaten in a variety of ways as it can be roasted, fried, grilled, baked, barbecued, smoked and most commonly boiled. Yam is also used as food for livestock. Tuber yam can be dried, ground into flour and stored for use.

However, in Nigeria, a country known to produce a large percentage of yam around the globe, it is believed that the supply of yam tuber is lower than its high demand, a problem currently facing the country (Ogundana, 1971; Okigbo *et al*, 2000; Okigbo and Emoghene, 2004; Okigbo and Ogbonnaya, 2006). Tuber yam, among many other staple foods, is susceptible to postharvest diseases caused by bacteria and fungi under poor storage conditions. In Nigeria, pathogens constitute the major factor to rot in yam production (Nari, 2004). Losses caused by pathogens attack vary from 20-30% generally in some crops (Park *et al*., 2008). The presence of plant-parasitic nematode could constitute serious impediments to the growth and yield of yams in Kogi State. Plant-parasitic nematode infection is an important factor that affects the quality and yield of yam in both field and store. These nematodes especially the *Scutellonema bradys* are capable of causing lateral lesions, necrosis, cracking of yam tuber and dry rot of yam on the white yam, water yam and yellow yam (Coyne *et al* 2007). In a survey carried out in twelve Local Government Area of Kogi State, Nigeria, soil-borne nematodes *S. bradys* caused a great reduction in size and qualities of yam produced on infected soil and even caused great damage to the inner part of yam (Hinmikaiye., *et al*., 2016).
The objective of this study is therefore to determine the effectiveness of *Ocimum gratissimum*, *Jatropha curcas* and *Chromolaena odorata* in the management of *scutellonema bradys* infecting five yam varieties.

Materials and Methods

The experiment was carried out in a section of the Teaching and Research Farm of Kabba College of Agriculture, Ahmadu Bello University, Nigeria during the cropping seasons of 2014 and 2015. The site is located on the latitude of 07^0 35'N and longitude 06^0 08E and is 435m above sea level, in Southern Guinea Savanna Agro-Ecological Zone of Nigeria. Rainfall spans between April to November with the peak in June. The dry season extends from December to March. The mean annual rainfall is 1570mm per annum with an annual temperature range of 18°-32°. The mean relative humidity (RH) is 60% (College of Agriculture Meteorological data, 2011). The major soil under within the experimental site is Ultisoils (Babalola, 2010; Ajiboye and Ogunwale, 2010).
The main vegetation of the area is; tall grasses, shrub, some trees, plantains, oil palm, etc. Some parts of the site are used such as cowpea, cassava, maize and tomato being planted.

Screenhouse and field experiment

Seeds of five different yam types were bought from Kabba/Bunu Local Government Areas of Kogi State. The experimental design was a 5x4x2 factorial experiment fitted into Randomized Complete

Block Design (RCBD). This involves five yam varieties. White yam (Okunmodo, Kerege and Sebukere), water yam (Ewura), and yellow yam (Olo); the plant materials (powdered leaf of *Ocimum gratissimum, Jatropha curcas, Chromolaena odorata*), control and nematodes treatment (i.e.

Scutellonema bradys). This means three factors (i.e. yams, plant materials and nematodes). A total of 40 treatment combinations were replicated three times each (120 observations).

Experimental procedure

In the screen house, five yam types between 120-130g were planted in April 2014 in 11 litres capacity experimental pots. Each white yam, water yam and yellow yam was inoculated with 44.4g of *S. bradys* infected yam peel containing 1000 *Scutellonema bradys* juveniles. At the field, 12 heaps of 0.5 by 0.5m and about 1m high were made per plot. The size of each plot is 10 by 4 m; the experimental heaps in each of the five different yam varieties were inoculated with 181.8 g of infected yam peel containing 2000 *S. bradys* at the adult stage which were carried out in the field. Each white yam, water yam and yellow yam were inoculated at sprouting stage. Mulching, staking and weeds were controlled through manual hoeing and subsequently by hand pulling as the yam vines spread and covered the pots and heaps to thus suppress weed growth. Initial and final soil nematode population was taken for nematode bio-assay test

Data collection

Data were collected from the experimental pots in screenhouse and field 2 months after planting. Subsequently, data were collected at monthly interval based on the following parameters: Number of leaves per plant, vine length and stem girth, Stem girth was measured at 5cm above the ground level in the screenhouse/field using vernier calliper. At harvest (10 months after planting) data were collected on number of tubers, weight of tubers, number of edible tubers and number of rotten tubers. Symptoms manifested on parts below ground and above ground level were also observed.

Data analysis

Data collected from both screenhouse and field experiments were subjected to the analysis of variance (ANOVA) using the SPSS version 21 and where there was a significant difference in their means. The New Duncan's Multiple Range Test (NDMRT) was used to separate them at a 5% level of significance.

Results

Effects of species, inoculum type and plant materials on growth Parameters of yam in Screenhouse/field experiment

Results of the effects of treatments on growth parameter of yam are presented in Tables 1 to 3 which shows the main effects of variety, inoculum and plant materials used on the vine length, number of leaves and stem girth at 5% level of significance of the treated plant for the two years 2014 and 2015 cropping season. Table 1 shows that there is significant difference in the vine length of yam varieties. Vine length was significantly taller in *D. cayenensis*, (yellow yam) throughout the months of the experiment for 2014 and 2015 respectively. *D. rotundata* (white yam) (wk), (wo) and ws are significantly different from each other in terms of vine lengths during 2014 cropping season but not significantly different in vine length during 2015 cropping season. The result shows that all yam varieties used in the fieldwork were significantly taller in vine length compared to the screenhouse experiment.

Table 2 shows the effect of species, inoculum type and plant materials used on mean of number of leaves revealed that yam variety *D. rotundata* white yam (wk) and (wo)) respectively was significantly higher in number of leaves both in the screenhouse and field regardless of nematode infection. *D. rotundata* white yam (wo, ws and wk) are not significantly different from each other in

number of leaves in 2014 and 2015 cropping season respectively, but significantly higher in number of leaves compared to non amended yam variety.

Table 3 shows effect of species, inoculum type and plant materials used on mean stem girth of yam shows that *D. rotundata* (wk) was significantly thicker in stem girth throughout the five months of the study in the screenhouse, while *D. cayenensis* (ca) (2.23cm) was significantly thicker in stem girth in August in the field experiment. The result revealed that stem girth in the field study was significantly thicker compared to that of screenhouse experiment.

Table 4 presented the effect of variety, inoculum type and plant materials on selected yield attributes of yam for both 2014 and 2015 cropping season respectively. Table 4 revealed that in all the growth parameters studied the best performance in terms of number of tubers was recorded in *D. rotundata*, white yam(wo) Okunmodo and white yam (wk) kerege having the values of 1.33 and 1.44 for both 2014 and 2015 respectively compared to other yam varieties. Table 4 further shows that *D. alata*; water yam (al) ewura was significantly different among other yam varieties in terms of weight of tubers with the values of 229.78g and 260.01g for both 2014 and 2015 cropping season. All the yam varieties in terms of number of edible tubers are not significantly different from each other in the 2014 screenhouse experiment, while *D.rotundata* white yam(wk) (1.44) was significantly different from other yam varieties in the number of edible tubers in fieldwork. Table 4 further shows that *D. cayenensis*, yellow yam (olo) was significantly different from other yam varieties in terms of the number of rotten tubers in the 2014 cropping season meaning that only *D.cayenensis* was rotten. All yam varieties are not significantly different in terms of the number of rotten tubers in 2015 fieldwork indicating that there was no rotten tuber in all the yam varieties.

Table 5 shows the effects of variety, inoculum type and plant materials used on mean final number of nematode (*Scutellonema bradys*) population on yam for 2014 and 2015 cropping season. Table 5 shows that among all the yam variety, *D. cayenensis*, yellow yam (ca) (olo) was significantly different with (20.14) value meaning that *D.cayenensis* was susceptible to nematode infection in 2014 screenhouse experiment. Table 5 further revealed that *D.alata*, water yam (al) (Ewura) was significantly different from other yam varieties having (120.53) value for the 2015 field experiment. This implies that *D.alata* was susceptible to nematode infection.

Table 6 Shows the results of the phytochemical screening of *Jatropha curcas, Ocimum gratissimum* and *Chromolaena odorata* shows the phytochemical analysis which contains the following constituents. The result shows that *Jatropha curcas* has the presence of constituents in high concentration in alkaloids, saponnin, flavonoid, moderate concentration in phenols, low concentration in tannin, and absence of constituents insteriod, phlobatannin, terpenoid and and anthraquinone. This is followed by *Ocimum gratissimum*, which has the presence of constituents in moderate concentration in tannin, presence of low concentration in saponnin, phlobatannin, flavoid and absence of constituents in alkaloid, steroid, terpenoid, cardiac glycoside, phenols and anthraqunone. *Chromolaena odorata* has the presence of constituents inlow concentration in tannin,

saponnin, terpenoid, flavonoid and absence of constituents in alkaloid, phlobatannin, cardiac glycoside and phenols.

Discussion

The findings of this study showed that both growth and yield parameters were significantly increased in treatments with plant materials whether infected or not with *Scutellonema bradys* compared to the plant that were untreated with botanicals. The study supports the findings of other researchers who

reported the importance of various soil amendments in reducing plant-parasitic nematodes population to build up resulting in an increase in plant yield (Abolusoro and Oyedunmade, 2008; Izuogu *et al*., 2015, 2016). This type of observation could be due to the possibility that the powdered leaf of

Ocimum gratissimum, Jatropha curcas and *Chromolaena odorata* added to the soil nutrient upon biodegradation, which the plants then used for better growth and yield.

The finding of the study indicated that *Scutellonema bradys* caused a considerable reduction in growth and yield as well as a quality reduction (roughness and rottenness) of unamended tubers with *Ocimum gratissimum, Jatropha curcas* and *Chromolaena odorata* both in screenhouse and field (Karssen, 2002).

The study revealed that all the plant materials used had significant bio-pesticidal effects on *Scutellonema* as they caused a reduction in population both in the screenhouse and field compared to control. This is in line with the reports of some earlier researchers who reported an effective reduction in nematode population by botanicals. Some of the organic materials of botanical origin that showed antinematode properties includes; *African marigold, Ocimum gratissimum, Azadirachta indica, Chromolaena odorata* and Sugar cane bagasse (Saravanapriya and Sivakumar, 2005., Hayat *et al*., 2012., Onyeke and Akueshi, 2012).

Conclusion

Scutellonema in the screenhouse and field experiments was found to significantly affect yam growth and yield as they caused reduction to non amended yam variety. All organic materials i.e., powdered leaf of *Ocimum gratissimum, Jatropha curcas* and *Chromolaena odorata* have significant bio-pesticidal effect on *Scutellonema* as they caused reduction in their population both in screenhouse and field in 2014 and 2015 cropping season respectively compared to the control. The efficacy of the dry powdered form of *Ocimum gratissimum, Jatropha curcas* and *Chromolaena odorata* in the management of *Scutellonema bradys* infecting yam has been established from this study. We therefore recommend that the active chemicals in these botanicals be synthesized by agro-chemists as portable, durable and easily applied forms that will be accessible to farmers. Where population density is high, use of *Ocimum gratissimum, Jatropha curcas* and *Chromolaena odorata* will provide a better option for obtaining higher yield. Besides, further research should also be carried out based on the phytochemical analysis of various plant materials at various seasons, localities and at different soils to ascertain their effective range of bioactive agents.

Table 1. Main effects of variety, inoculum type and plant material used on mean vine length (cm) of yam (*Dioscorea* spp) 2014/2015 cropping season in screenhouse/field

Variety	2014 VltJun	2014 VltJul	2014 VltAug	2014 VltSept	2014 VltOct	2015 VltFeb	2015 VltMar	2015 VltApr	2015 VltMay	2015 VltJun	2015 VltJul	2015 VltAug
Al	**77.75 ab**	**100.58 b**	**123.64b**	**140.22 bc**	**153.14d**	**119.67b**	**178.78 b**	**196.44b**	**209.36b**	**217.78b**	**224.36b**	**226.33b**
Ca	**78.86 a**	**114.69 a**	**137.94a**	**155.58 a**	**171.06a**	**209.86a**	**258.67 a**	**270.44a**	**282.75a**	**293.11a**	**299.61a**	**298.67a**
Wk	**73.78 ab**	**96.97b**	**119.94bc**	**140.92 b**	**159.19b**	**123.00b**	**177.14 b**	**188.75b**	**203.64b**	**211.00b**	**217.19b**	**218.61b**
Wo	**66.78 c**	**98.03b**	**123.99a**	**141.17 b**	**158.83bc**	**139.83b**	**175.92 b**	**186.81b**	**199.08b**	**207.86b**	**214.22b**	**215.67b**
Ws	**72.64 b**	**95.72b**	**117.28c**	**135.97c**	**154.64cd**	**118.75b**	**170.81 b**	**183.92b**	**196.19b**	**207.44b**	**312.56b**	**214.08b**
SE	**1.87**	**2.07**	**1.82**	**1.62**	**1.50**	**6.98**	**6.05**	**6.05**	**6.11**	**6.24**	**6.15**	**6.41**
Inoculum	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sc	**78.07 a**	**109.82 a**	**131.48a**	**149.43 a**	**165.42a**	**128.20b**	**184.22 b**	**196.32b**	**208.60b**	**219.42b**	**224.17b**	**224.30b**
Nn	**74.02 a**	**101.57 b**	**126.17b**	**146.30 a**	**162.35a**	**145.50a**	**188.25 b**	**199.53b**	**211.47b**	**21987 b**	**226.32b**	**227.95b**
SE	**1.45**	**1,61**	**1.40**	**1.25**	**1.62**	**5.41**	**4.69**	**4.68**	**4.73**	**4.83**	**4.76**	**4.97**
Material	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Co	**80.44 a**	**115.02 a**	**138.36a**	**157.02 a**	**176.16a**	**170.51a**	**225.33 a**	**237.44a**	**249.56a**	**258.40a**	**265.11a**	**264.33a**
Jc	**76.36 ab**	**103.09 b**	**129.38b**	**148.62 b**	**164.22b**	**164.87a**	**223.04 a**	**233.60a**	**246.11a**	**256.44a**	**260.44a**	**262.38a**
Og	**75.09 b**	**101.29 b**	**127.22b**	**146.47 b**	**162.96b**	**160.78a**	**211.93 a**	**224.04a**	**236.29a**	**245.18a**	**252.42a**	**253.91a**
Non	**63.95 c**	**84.40c**	**102.49c**	**118.98 a**	**134.16c**	**72.73 b**	**113.53 b**	**126.00b**	**140.87b**	**149.73b**	**156.38b**	**158.07b**
SE	**1.67**	**1.86**	**1.62**	**1.45**	**1.34**	**6.24**	**5.41**	**5.41**	**5.46**	**5.58**	**5.50**	**5.73**

Means with the same letter(s) in any one segment of a given column are not significantly different at p=0.05

Key: Al – *Alata*, Ca – *Cayenensis*, Wk – White yam Kerege, Wo – White yam Okunmodo, Ws – White yam Sebukere, Mi – Sc – *Scutellonema*, Nn – No nematode, Co – *Chromolaena odorata*, Jc – *Jatropha curcas*, Og – *Ocimum gratissimum*, Non – Control, Vlt- Vine length

Table 2. Main effects of variety, inoculum type and plant material used on mean number of leaves of yam (*Dioscorea* spp) 2014/2015 cropping season in screenhouse/field.

Variety	2014	2014	2014	2014	2014	2015	2015	2015	2015	2015	2015	2015
	VltJun	VltJul	VltAug	VltSep	VltOct	VltFeb	VltMar	VltApr	VltMay	VltJun	VltJul	VltAug
Al	**33.75 d**	**60.58 d**	**90.44 c**	**102.11d**	**111.72d**	**63.49 c**	**169.89a**	**184.81a**	**197.50a**	**209.36a**	**223.00a**	**224.81a**
Ca	**38.08 cd**	**71.72 c**	**101.19c**	**116.75c**	**124.28c**	**71.75 bc**	**146.64b**	**160.28b**	**175.64b**	**192.44b**	**205.06b**	**206.97b**
Wk	**57.17 a**	**99.92 a**	**153.31a**	**154.56a**	**158.67a**	**82.19 b**	**164.39a**	**178.64a**	**194.42a**	**206.44a**	**217.89ab**	**218.14ab**
Wo	**47.64 b**	**86.22 b**	**122.69b**	**143.42b**	**148.69b**	**96.11 a**	**176.53a**	**190.00a**	**204.50a**	**215.11a**	**226.28a**	**226.39a**
Ws	**43.17 bc**	**91.72 ab**	**129.69b**	**142.67b**	**151.42b**	**72.78 bc**	**167.14a**	**179.31a**	**192.97a**	**206.33a**	**217.47ab**	**219.33ab**
SE	**2,32**	**3.33**	**5,72**	**2.48**	**2.48**	**4.35**	**4.66**	**5.04**	**4.82**	**4.48**	**4.49**	**4.45**
Inoculum	-	-	-	-	-	-	-	-	-	-	-	-
Sc	**45.50**	**75.55 b**	**111.53b**	**130.38b**	**135.77b**	**83.23 b**	**162.00a**	**178.00a**	**188.25a**	**202.18a**	**213.73b**	**216.63a**
Nn	**42.05**	**87.80 a**	**131.95a**	**138.45a**	**145.13a**	**72.13 a**	**163.82a**	**175.90a**	**193.33a**	**204.47a**	**215.67ab**	**215.48a**
SE	**1.79**	**2.58**	**4.43**	**1.92**	**1.92**	**3.37**	**3.61**	**3.90**	**3.73**	**3.47**	**3.48**	**3.45**
Material	**NS**	-	-	-	-	-	-	-	-	-	-	
Co	**47.11 b**	**86.64 a**	**130.47a**	**139.11b**	**146.27a**	**90.82 a**	**191.73a**	**205.69a**	**218.98a**	**232.07a**	**243.67a**	**244.82a**
Jc	**53.73 a**	**94.53 a**	**129.18a**	**143.00ab**	**149.67a**	**88.02 a**	**185.80a**	**199.91a**	**211.47a**	**224.93a**	**236.78a**	**237.62a**
Og	**43.91 b**	**87.24 a**	**129.98a**	**147.00c**	**152.76a**	**89.49 a**	**190.27a**	**204.69a**	**219.64a**	**230.84a**	**241.60a**	**242.91a**
Non	**31.09 c**	**59.71 b**	**88.24 b**	**98.49 c**	**107.13b**	**49.09 b**	**91.87 b**	**104.13b**	**121.93b**	**135.91b**	**149.71b**	**151.16b**
SE	**2.07**	**2.98**	**5.12**	**2.22**	**2.22**	**3.89**	**4.17**	**4.51**	**4.31**	**4.01**	**4.02**	**3.98**

Means with the same letter(s) in any one segment of a given column are not significantly different at p=0.05

Key: Al – *Alata*, Ca – *Cayenensis*, Wk – White yam Kerege, Wo – White yam Okunmodo, Ws – White yam Sebukere, Sc – *Scutellonema*, Nn – No nematode, Co – *Chromolaena odorata*, Jc – *Jatropha curcas*, Og – *Ocimum gratissimum*, Non – Control, Vlt- Vine length

Table 3. Main effects of variety, inoculum type and plant material used on mean stem girth (cm) of yam (*Dioscorea* spp) 2014/2015 cropping season in screenhouse/field

Variety	2014	2014	2014	2014	2014	2015	2015	2015	2015	2015	2015	2015
	VltJun	VltJul	VltAug	VltSep	VltOct	VltFeb	VltMa	VltAp	VltMay	VltJun	VltJul	VltAug
Al	**0.61b**	**0.69ab**	**0.80c**	**0.79d**	**0.75c**	**0.64b**	**0.84c**	**1.07c**	**1.39c**	**1.76b**	**2.08bc**	**2.09b**
Ca	**0.64a**	**0.676a**	**0.91ab**	**0.94ab**	**0.85b**	**0.61b**	**0.88c**	**1.29a**	**1.61a**	**1.88a**	**2.21a**	**2.23a**
Wk	**0.64a**	**0.72ab**	**1.00a**	**1.03a**	**0.79a**	**0.78a**	**0.96b**	**1.18b**	**1.45b**	**1.77b**	**2.02cd**	**2.08b**
Wo	**0.68a**	**0.77a**	**0.84bc**	**0.90bc**	**0.82bc**	**0.85a**	**1.05a**	**1.23ab**	**1.47b**	**1.74b**	**1.98d**	**2.01c**
Ws	**0.55b**	**0.67b**	**0.76a**	**0.82cd**	**0.81bc**	**0.78a**	**0.99ab**	**1.21b**	**1.51b**	**1.81ab**	**1.10b**	**2.13b**
SE	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.02**	**0.03**	**0.02**	**0.02**
Inoculum	-	-	-	-	-	-	-	-	-	-	-	=
Sc	**0.56b**	**0.66b**	**0.83**	**0.87**	**0.82**	**0.69b**	**0.90b**	**1.14b**	**1.45b**	**1.77a**	**2.04b**	**2.05b**
Nn	**0.64a**	**0.73a**	**0.87**	**0.91**	**0.86**	**0.76a**	**0.94ab**	**1.22a**	**1,51a**	**1.81a**	**2.11a**	**2.14a**
SE	**0.02**	**0.02**	**0.03**	**0.03**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0,02**
Material	-	-	**NS**	**NS**	**NS**	-	-	-	-	-	-	-
Co	**0.72a**	**0.82a**	**0.79a**	**1.01a**	**0.96a**	**0.78a**	**1.03a**	**1.31a**	**1.61a**	**1.92a**	**2.19a**	**2.22a**
Jc	**0.65b**	**0.76a**	**0.93a**	**0.96a**	**0.90a**	**0.81a**	**1.05a**	**1.28a**	**1.56a**	**1.86a**	**2.16a**	**2.19a**
Og	**0.67ab**	**0.78a**	**0.96b**	**0.99a**	**0.92a**	**0.80a**	**1.05a**	**1.32a**	**1.59a**	**1.87a**	**2.18a**	**2.20a**
Non	**0.45c**	**0.52b**	**0.60b**	**0.62b**	**0.58b**	**0.55b**	**0.66b**	**0.88b**	**1.18b**	**1.52b**	**1.78b**	**1.82b**
SE	**0.02**	**0.03**	**0.03**	**0.03**	**0.03**	**0.02**	**0.02**	**0.03**	**0.02**	**0.02**	**0.02**	**0.02**

Means with the same letter(s) in any one segment of a given column are not significantly different at p=0.05

Key: Al – *Alata*, Ca – *Cayenensis*, Wk – White yam Kerege, Wo – White yam Okunmodo, Ws – White yam Sebukere, Sc – *Scutellonema*, Nn – No nematode, Co – *Chromolaena odorata*, Jc – *Jatropha curcas*, Og – *Ocimum gratissimum*, Non – Control, Vlt- Vine length, NS – Not significant

Table 4. Main effects of variety, inoculum type and plant materials on selected yield attributes of yam (*Dioscorea* spp) 2014/2015 cropping season screenhouse/field

	2014	2014	2014		2015	2015	2015	
2014	2014				2015			
Variety	Mean number of tuber/s	Mean weight of tuber/s (g)	Mean number of edible tuber/s	Mean number of rotten tuber/s	Mean number of tuber/s	Mean weight of tuber/s (g)	Mean number of edible tuber/s	Mean number of rotten tuber/s
Al	**1.22a**	**229.78a**	**1.17a**	**0.00b**	**1.28ab**	**260.01a**	**1.28ab**	**0.00a**
Ca	**1.00b**	**120.22b**	**0.58b**	**0.31a**	**1.00c**	**223.00b**	**1.00c**	**0.03a**
Wk	**1.19ab**	**210.67a**	**1.19a**	**0.00b**	**1.44a**	**221.13b**	**1.44a**	**0.00a**
Wo	**1.33a**	**199.28a**	**1.22a**	**0.06b**	**1.14bc**	**231.12b**	**1.22abc**	**0.06a**
Ws	**1.14ab**	**225.31a**	**1.08a**	**0.06b**	**1.17bc**	**218.21b**	**1.14bc**	**0.00a**
SE	**0.07**	**12.21**	**0.08**	**0.04**	**0.09**	**0.08**	**0.08**	**0.02**
Inoculum	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Sc	**1.18ab**	**214.50a**	**1.18a**	**0.03a**	**1.17a**	**2.21b**	**1.17a**	**0.03a**
Nn	**1.28a**	**215.65a**	**1.07ab**	**0.10a**	**1.25a**	**2.45a**	**1.27a**	**0.00a**
SE	**0.06**	**9.46**	**0.07**	**0.03**	**0.07**	**0.8**	**0.06**	**0.02**
Material	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Co	**1.24a**	**205.87**	**1.13a**	**0.09a**	**1.20a**	**2.74a**	**1.22a**	**0.00a**
Jc	**1.24a**	**222.18a**	**1.18a**	**0.04a**	**1.24a**	**2.75a**	**1.27a**	**0.04a**
Og	**1.16a**	**212.73a**	**1.00ab**	**0.07a**	**1.20a**	**2.89a**	**1.18a**	**0.00a**
Non	**1.07a**	**147.42b**	**0.89b**	**0.13a**	**1.18a**	**0 .84b**	**1.20a**	**0.02a**
SE	**0.06**	**10.92**	**0.08**	**0.03**	**0.08**	**0.07**	**0.07**	**0.02**

Means with the same letter(s) in any one segment of a given column are not significantly different at p=0.05

Key: Al – *Alata*, Ca – *Cayenensis*, Wk – White yam Kerege, Wo – White yam Okunmodo, Ws – White yam Sebukere, Sc – *Scutellonema*, Nn – No nematode, Co – *Chromolaena odorata*, Jc – *Jatropha curcas*, Og – *Ocimum gratissimum*, Non – Control, Vlt- Vine length

Table 5. Main Effects of variety, inoculum type and plant materials on initial and mean final nematode population in Screenhouse/field for 2014/2015 cropping season

Variety	2014 Initial nematode population in the pots	2014 Final nematode population number /100mls of soil	2015 Initial nematode population in the pots	2015 Final nematode population number /100mls of soil
Al	**1000**	**15.11b**	**2000**	**120.53a**
Ca	**1000**	**20.14a**	**2000**	**109.61b**
Wk	**1000**	**15.17b**	**2000**	**99.78c**
Wo	**1000**	**12.50b**	**2000**	**73.61d**
Ws	**1000**	**15.42b**	**2000**	**103.00bc**
SE	**-**	**1.58**	**-**	**3.31**
Inoculum	**-**	**-**	**-**	**-**
Sc	**1000**	**17.73b**	**2000**	**164.95a**
Nn	**0.00**	**0.00c**	**0.00**	**0.00c**
SE	**-**	**1.23**	**-**	**2.57**
Material	**-**	**-**	**-**	**-**
Co	**1000**	**16.49b**	**2000**	**73.56b**
Jc	**1000**	**11.18c**	**2000**	**58.27c**
Og	**1000**	**11.29c**	**2000**	**69.13b**
Non	**1000**	**23.71a**	**2000**	**204.27a**
SE	**-**	**1.42**	**-**	**2.96** **-**

Means with the same letter(s) in any one segment of a given column are not significantly different at p=0.05

Plants	Alkaloids	Tannin	Saponnin	Steriod	Phlobatannin	Terpenoid	Cadiac Glycoside	Phenols	Anthtro quinone
Jatropha curcas	+++ve	+ve	+++ve	-ve	-ve	-ve	-ve	++ve	-ve
Ocimum gratissimum	-ve	++ve	+ve	-ve	+ve	-ve	+ve	-ve	-ve
Chromolaena odorata	s-ve	+ve	+ve	+ve	-ve	+ve	-ve	-ve	+ve

Table 6. Results of the phytochemical screening of *Jatropha curcas, Ocimum gratissimum* and *Chromolaena odorata*

Key: Al – *Alata*, Ca – *Cayenensis*, Wk – White yam Kerege, Wo – White yam Okunmodo, Ws – White yam Sebukere, Sc – *Scutellonema*, Nn – No nematode, Co – *Chromolaena odorata*, Jc – *Jatropha curcas*, Og – *Ocimum gratissimum*, Non – Control, Vlt- Vine length

N.B: +++ve = Presence of constituents in high concentration

++ve = Presence of constituents in moderate concentration

+ve = Presence of constituents in low concentration

-ve = Absence of constituents

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AN INVESTIGATION OF SOIL DEVELOPMENT WITH MORPHOLOGICAL PROPERTIES IN KABBA, SOUTHERN GUINEA SAVANNAH ZONE OF NIGERIA

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Abstract
The study of soil development and genesis is germane for better understanding of the nature of soil, it is the foundation for the identification of the potentials and limitations of soils. On this basis, soil development in a landscape at Kabba, Kogi State was studied. Morphological evidences were used to describe soil development and processes at three identified aspects (upper P1, middle P2 and lower P3 slopes) of topographical positions in the landscape. The soils were formed from residum (in-situ) and alluvium (deposition by water) parent materials. Ferrugination, plinthization, argilization, podolization and redox reactions were the identified soil development processes in the soils. The shallow depth at the crest (P1) and middle slope (P2) is a limitation to root development while the coarse texture and weak structure could occasion erosion in the soils. Sustainable practice involving minimal disturbance of soil, maintenance of soil vegetative cover and incorporation of plant residues and organic manure are recommended.

Keywords: Pedology, Soil development, slope, morphological, parent materials,

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Introduction

Soil is a collection of natural bodies on the earth surface contains living matter or supporting or capable of supporting plants. Soils include all horizons differing from the underlying rock materials as a result of interaction through time climate, living organism, parent material and relief (Esu, 2010). Variations in the environment give rise to variation in soils since both the duration and the rate of the process responsible for soil development are controlled by the environment. The concept of variability of soil properties caused by the parent material and environment was recognized (Babalola *et al*., 2007; Lawal *et al.*, 2014).

Relationship between landscape angle position and hydraulically and geomorphic process has been established for many landscapes (Wysocki *et al*., 2001; Tsui *et al.*, 2004; Babalola *et al*., 2007;

Rose, 2013). In the West African sub-region, particularly in the southern area rainforest and derived savannah zone which the study area belongs to, strong association exists between topography and soil properties (Moorman 1981, Ogunkunle 1993). Smyth and Montgomery (1962) classifying soils of central western Nigeria on the basis of geology and subdivided each association by topography position into: sedimentary soils formed in situ at crest/upper slopes and draft soils formed at the lower slopes/valley by transportation and deposition of materials.

Different topography positions influences run off, drainage, soil temperature, soil erosion, hence soil formation is affected (Babalola *et al.*, 2007; Buol *et al.* 2011; Rose, 2013). Consequently, along a variable slope there would be encountered an entire sequences of soil types, each having different profile features and soil processes. The differences in soil processes will have influence on the soil properties and resultant effect on water and nutrient availability and crop production. Therefore, there is need to study soil development as a basis for better understanding of the nature of soil and sustainable land utilization.

The study was carried to identify prominent parent materials and soil development processes in the study location with morphological properties.

Materials and Method

Description of Study Area

This study was carried out at Kabba in the southern guinea savannah zone of Nigeria. The area is located on: Latitude 7.867631°, 7.856302° and 7.852604°. Longitude 6.001877°, 6.005223°. It has maximum elevation of 532m and minimum of 358 m. The area has a humid tropical climate and belonged to the basement complex geology of Nigeria. There are intensive agricultural activities in the study area. Crop grown include all cereals, legumes such as cowpeas and groundnuts, cotton, yam *Discorea rotundata* (white yam) maize *Zea mays*, Cassava *manihot spp.* Production of leafy vegetables during dry season is done at the valley bottom because it is a fadama soil.

Field Study

Profile pits were sited at three (3) topographical positions identified; upper, middle, and lower slopes along the landscape and described. The following morphological properties were described: soil colour using munsell colour chat, texture by hand feel method, structure, consistence, mottles. Individual horizons identified in each profile were sampled for laboratory analysis.

Laboratory Analysis

Soil samples were air-dried sieved to separate fine earth. A total of 11 samples were collected and taken to the laboratory and analyzed particle size distribution (% sand % clay % silt).

Data interpretation

Data obtained were interpreted following the description of Esu (1999)

Results and Discussion

The soil sequence was from the upland position (crest) P1, through the middle slope P2 down the lower slope P3 (Table 1). Soil in P1 was formed in-situ after removal of the material therefore the parent material is residuum. Soil in P2 was formed from hill wash material, while the soil in P3 was formed as a result of deposition of alluvial wash therefore the parent material is alluvium. These indicated that topography played a significant role in soil processes and development in the study location. Similar findings were reported by Esu *et al.,* (2008) in a hillslope soil of Afikpo, South Eastern Nigeria.

There was progressive reddening of soil colour (Table 1) from predominate 10YR hue to 5YR and 7.5YR hue at the three positions, this is evidence of the role of iron in colour formation and evidence of ferrugination a pedogenic process. The factors (iron and water) that determine soil colour were predominantly present.

In P1 and P2 (Table 1) there was iron pan at 53cm soil depth and this is evidence of plinthization a laterization soil development process (Esu, 1999). There has been accumulation through years of fluctuating of ground water table; it has hardened into a hard iron pan

occasioned by the occurrence of oxidation-reduction reactions enhanced by the long-term exposure of the soils. This was confirmed by the evidence of mottles at the three positions and iron-manganese concretions at P1 and P2. The hard pan will also be a restriction to the penetration of plant roots, most especially deep feeder crops and tree crops.

The P2 and P3 (Table 1) were granular and blocky at the surface and angular blocky down the profile this indicates that the surface of the soils can be easily tilled, well drained with good permeability of water, air and roots but also susceptible to removal soil materials through erosion due to weak aggregation. Also, this could also be a pointer to the deposition of fine and coarse soil materials from P1.

At the surface horizon, the consistence was slightly sticky at the three positions and slightly plastic at P3. This indicate that there was moderate cohesion and adhesion in the soils and tillage operation immediately after rains is not advisable as there will be disturbance to the movement of tractor and disintegration of the soil materials. Stickiness and plasticity increase down the soil depth, this could be attributed to the increase in the clay content.

The soil texture was sandy loam (P2 and P3) and sandy clay loam (P1) at the surface horizons and sandy clay loam, sandy clay and clay at the subsurface horizons (Table 1). There was accumulation of clay down the profiles and this was evident with the increase in percentage clay from the surface (16-31%) to the subsurface horizons (21-40%). The increase in clay down the profile indicates the presence of argillic horizon formed from argilization a lessivage soil development process (Esu, 2010, Lawal *et al.*, 2014). The sand fraction is from 41 to 70% and it was strongly expressed in the textural classification. There was cutans (clay skins) at P1 and P3, this is a direct indication of an argillic horizon and the presence of Fe-oxhydroxide and humus. It is also a pointer that there is spodic horizon and the onset of podsolization soil development process in the soils (Akamigbo, 2010)

Conclusion

The landscape studied is developing in response to the action of environmental factors acting upon the parent materials. The drainage and slope positions influenced the movement and deposition of materials. The landscape is a typical top sequence with difference processes such as

ferrugination, plinthization, argilization, podolization and redox reactions taking place simultaneously. Sustainable management practices such as minimal tillage, maintenance vegetative cover and incorporation of plant residues and organic manure are recommended. Further studies on natural and technical soil classification are also suggested, using this study as a baseline.

Table 1: Soil properties at the three positions

Depth (cm)	Colour	Mottles	Pores	Structure	Consistence	Cutans	Sand %	Silt %	Clay %	Texture	Inclusion and other Observation
Upper slope (P1) Latitude 7.867631° longitude6.001877° Elevation 532m Residum											
0-10	10YR 3/2	few	few	mab	Ssnp	-	63	6	31	SCL	Roots, Fe-Mn
10-18	10YR 5/4	few	few	mab	Sssp	Present	60	9	31	SCL	Roots, Fe-Mn
18-42	10YR 6/4	many	few	fab	Vsvp	present	50	15	35	SC	
42-53	5YR 7/6	many	few	fab	Vsvp	Present	41	19	40	C	Presence of hard pan
Middle slope (P2) Latitude 7.856302° and longitude 6.005223°, Elevation 471 m Alluvium											
0-12	10YR 3/3	-	many	cogr	Ssnp	-	70	13	17	SL	Roots, Fe-Mn
12-31	7.5YR 4/4	many	few	cogr	Ssssp	-	69	10	21	SCL	Roots, Fe-Mn
31-38	5YR 3/4	many	few	coab	Vsvp	-	57	5	38	SC	Fe-Mn, hard pan at 38cm
Lower slope (P3) latitude 7.852604° longitude 6.013270° 358 m Alluvium											
0-14	10YR 4/3	-	many	cocr	Sssp	-	68	16	16	SL	Roots
14-45	10YR 5/4	few	few	cosab	Ssssp	present	63	18	19	SL	Roots
45-80	5YR 4/6	few	few	coab	Vsvp	Present	60	11	29	SCL	
80-150	5YR 5/8	few	few	coab	Vsvp	present	55	11	34	SC	Water table at 150cm

Structure: m-medium, co-corase, f-fine, ab-angular blocky, sab-sub-angular, gr-granular, cr-crumbs; consistence: ss-slightly sticky, vs-very sticky, sp-slightly plastic, vp-very plastic; Texture: SL-sandy loam, SCL-sandy clay loam, SC- sandy clay, C-clay; FE-Mn- iron and manganese concretions.

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PERFORMANCE OF TWO EARLY MAIZE VARIETIES AS INFLUENCED BY DIFFERENT TILLAGE METHODS IN SOUTHERN GUINEA SAVANNAH OF NIGERIA

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Abstract
The experiment was carried out to determine the performance of two early maize varieties as influenced by different tillage methods at the Agronomy Section of the Kabba College of Agriculture, Kogi State in the Southern Guinea Savannah of Nigeria. Two factors were considered: factor "A" treatment consist of two maize varieties namely TZE Y POP STR 41 cultivar and Sammaz 15 cultivar, while factor "B" consist of three different tillage preparation methods as namely Mechanical, Manual and No-till methods. The treatments were replicated three times. Data were collected on the basis of agronomic traits such as plant height, number of leaves, leaf area, stem girth, cob length, cob weight, yield per plant, yield per plot, and yield per hectare. The result obtained from the study indicated that cultivar Sammaz 15 performed better than TZE Y POP DT STR 41 cultivar in both growth and yield characters, while the mechanical tillage plots recorded better growth and yield of maize than either manual or no-till plots.

Keywords: Tillage, Soil, Maize growth, Yield, Guinea Savanah, Nigeria

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Introduction

Maize (*Zea mays*) is among the most arable and cereal crops produced in the Southern Guinea Savanna agro-ecological zone of Nigeria. It is a tropical grass that is well adapted to a wide range of environmental conditions and is cultivated in all agro-ecologies of West and Central Africa, having many climates with varieties of wide maturity between 70 days and 210 days (Stephanie and Brown, 2008). It is known in Africa as among the crops grown by the vast majority of rural households and widely consumed by throughout the continent. Production has been increasing overtime due to vast usefulness.

Suitability for maize production is determined mainly by the length of the growing season determined by the amount of rainfall, distribution and temperature (Apraku *et al.,* 2012). However, it is grown globally from 50^0N and 40^0S and from sea level up to 400m altitude. Plessis (2003)

discovered that maize is a warm weather crop and not grown in areas where the mean daily temperature is less than 19^0C or where the mean of the summer months is less than 23^0C. According to Stephanie and Brown (2008), Maize can grow and yield with as little as 300mm but prefers 500mm to 1200mm rainfall requirement per annum as the optimum range. A deep loamy soil, high in organic matter and nutrients is the best for its production but with proper management and fertilizer practices, a variety can be grown successfully on any soil from loamy sand to clay under any soil type having pH ranging from slightly acidic to slightly alkaline (5.8 – 7.5). The soil should be free from salinity and water logging (ATA, 2013; Chowdhury and Hassan, 2013).

Maize as one of the most important cereal crops in the world's agricultural economy both as food for man and animal feed, has also been known as the leading crop of the world after rice and wheat. In a processed form, its food products are corn meal, corn flakes, popcorn etc (Singn *et al.,* 2002) and also as fuel (alcohol or ethanol) and corn starch (dextrose), glucose, corn oil, corn syrup etc. Its cultivation is extremely profitable even in the face of high costs of production and price fluctuations in the markets. Maize grain contains protein (10%), carbohydrate (70%), oil (4%) albuminoides (10.40%) crude fibre (2.3%) and ash (1.4%) (Chandrase *et al.,* 2010) and its nutrients value is higher in comparison to rice and wheat (Chowdhury and Hassan, 2013)

Regardless of the importance of maize to the economy, the attention to its production is still questionable in developing countries like Nigeria. For a better growth condition and yield, a desirable soil structure or suitable tilt is required (Srivastava *et al.,* 2006). A good soil management programme protects the soil from water and wind erosion, provides a good weed-free till for planting, destroys hardpan or compacted layers that may limit root development and allow maintenance of an increase organic matter (Wright *et al.,* 2008).

Tillage treatments affect crop growth and yield by altering bulk density, compaction and hydraulic properties of the soil. Desired plant growth depends on rooting ability, nutrient status and accessibility of roots to nutrients, soil aeration and water availability or infiltration, runoff and storage, soil temperature and chemical transport, which can be restricted by severe compaction (Ahuja *et al.,* 1998). Additional field operations and energy may be required to remove soil compaction (Johnson and Bailey, 2002). Tillage is carried out mainly to loosen the upper layer of the soil, to mix the soil with fertilizer and organic residues, to control weeds and to create a suitable tillage for germination and plant growth (Rasmussen, 1999).

More than primary tillage practice, secondary tillage leading to alteration of soil conditions has complex effects on soil characteristics. According to the degree of disturbance by tillage systems, changes have been observed in soil water content, aeration and soil temperature which influence the decomposition rate of residue left in the soil (Ma *et al.,* 1999; Rochette *et al.,* 1999; Espana *et al.,* 2002). Also, such environmental changes can affect microorganisms in different forms; either in number, diversity or activity. However, reduced and particularly no-till practice can minimize soil disturbance, increase soil organic matter and improve soil structure compared with conventionally plowed soil (Carter, 1992 Frabzlubbers *et al.,* 1999).

The objective of the study is to determine the performance of two early maize varieties as influenced by different methods of tillage operation for better growth and yield performance in Kabba, Kogi State Nigeria.

Materials and methods

***Experimental site*:**
The study was carried out at the Agronomy Section in Kabba College of Agriculture on latitude 7˚85′47″N and longitude 6˚08′02″E. The site falls within the Southern Guinea Savanna agro-ecological zone of Nigeria. It experiences rainy season from the month of April to November with average annual rainfall as 1,329mm, mean annual temperature of the area as 30°C and mean annual relative humidity as 67%. The dry season extends from December to March (Weather-base, 2019).

Experimental Design and Treatments:
The field experiment was arranged in a Randomized Complete Block Design (RCBD) using factorial arrangement and replicated three (3) times. The experiment consisted of eighteen (18) experimental plots with two treatments factors namely; Factors A and B. Factor A Treatment consist of Maize varieties TZE Y POP DT STR 41 cultivar and Sammaz 15 cultivar, while factor B comprises of the Tillage methods employed viz Mechanical tillage, Manual tillage and No-till.

***Cultural Practices*:**
The land was prepared using the different tillage preparation methods viz: mechanical tillage, manual and no- till. Chemical properties of the soil of the experimental site, was obtained for analysis before planting and at harvest. The soil sample collected was analyzed at Federal University of Technology Akure (FUTA), Ondo State Nigeria. The experimental field size was 32.5m by 14m of which 5m by 4m per plot was laid out into three replicates and the guard blocked of 0.5m between treatments and 1m between the replicates. The arrangement culminated in 3 replicates/blocks, 6 treatment combinations, 5m length of plot, 4m breadth, and 20m^2 area of plot prepared. The maize seeds and varieties obtained from the International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria, was sown at 2 seeds per hole at a spacing 75cm by 50cm. Weeding was done manually, with the use of hoe and cutlass. It was done continuously until harvest when weeds are noticed to prevent competitions for nutrients and space.

***Sampling Techniques and Data Collection*:**
Five (5) plants were randomly selected and tagged from the centre of each plot for the collection of growth and yield data. Collection of data was on the growth and grain yield parameters of the maize plant. Five (5) plants tagged were to collect and observe growth parameters such as number of leaves measured by counting, plant height (cm) by using measuring tape, stem girth (cm) measured with the aid of Vernier-caliper and leaf area (cm^2) measured using Leaf area meter all at two-week interval. Other yield parameters such as cob length (cm) was measured using measuring tape, cob diameter (cm) measured with Vernier-caliper, cob weight (g) taken with weighing scale, yield per plant, yield per plot and yield per hectare were also collected by weighing scale.

***Data Analysis*:**
Data obtained from the yield and growth in this study, were subjected to analysis of variance (ANOVA) while the means of treatments that shows significant difference was separated using Duncan Multiple Range Test (DMRT). All tests were carried out at 5% probability level with Statistics software version 10.

Results and Discussion

Table 1: Pre-Planting and Post-Harvest Analysis

Soil Properties	**Pre-Planting Soil Analysis**	**Post-Harvest Soil Analysis**		
		Mechanical	**Manual**	**No-till**
Sand %	60.70	59.70	59.35	58.60
Clay %	21.60	22.10	21.90	20.90
Silt %	17.70	17.50	17.40	17.00
Soil texture	Sandy clay loam	Sandy clay loam	Sandy clay loam	Sandy clay loam
Soil pH	6.20	6.10	5.97	5.85
Bulk density	1.36	1.41	1.38	1.35
Total porosity	38.40	36.23	38.20	38.80
Organic matter	1.58	1.62	1.60	1.57
Total Nitrogen	0.18	0.24	0.22	0.19
Available phosphorus	2.03	2.13	2.09	2.06
Exchangeable Cation				
Potassium	0.28	0.34	0.30	0.28
Calcium	2.56	2.62	2.59	2.57
Magnesium	2.98	3.04	3.01	2.99
Sodium	1.61	1.69	1.64	1.63

***Soil Pre-Planting and Post-Harvest Analysis**:*
The properties of the soil in the experimental site are shown in Table 1. The sandy clay loam is slightly acidic (6.70 and high in bulk density (1.36). the pre-planting analysis indicated that the soil was low in nutrients status which may be due to leaching of basic cations caused by intensive rainfall or perhaps the parent materials of quarts and sesquioxides that is poor in plant nutrients. This result agreed with the findings of Nnaji *et al.,* (2005) and Aberger (2006) who reported large losses of basic cations due to leaching and highly intensive duration of rainfall. Application of fertilizer will be of great benefit to the crop on such site.

Table 2: Effects of Different Tillage Methods on Plant Height of Early Maize Varieties Cm)

	2wks	4wks	6wks	8wks	10wks
Variety (A)					
TZE 41	12.38[a]	50.78[a]	95.17[b]	142.80[b]	150.97[b]
Summaz 15	13.24[a]	50.83[a]	97.07[a]	147.58[a]	157.67[a]
Tillage (B)					
Mechanical	12.37[b]	57.50[a]	113.12[a]	168.67[a]	177.55[a]
Manual	12.13[c]	54.30[b]	105.48[a]	158.70[a]	164.63[a]
No-till	13.93[a]	46.43[c]	70.28[b]	118.70[b]	130.80[b]
Interaction A × B	NS	NS	NS	NS	NS

Table 3: Effects of Different Tillage Methods on Number of Leaves of Early Maize Varieties (Cm)

	2wks	4wks	6wks	8wks	10wks
Variety (A)					
TZE 41	6.04[b]	9.20[b]	10.34[b]	11.84[b]	12.51[b]
Summaz 15	6.44[a]	9.91[a]	10.92[a]	12.24[a]	12.97[a]
Tillage (B)					
Mechanical	6.43[a]	10.33[a]	11.90[a]	13.10[a]	13.25[a]
Manual	6.00[a]	10.07[a]	11.85[a]	12.80[a]	12.93[a]
No-till	6.30[a]	10.77[a]	11.07[a]	12.37[a]	12.45[a]
Interaction A × B	NS	NS	NS	NS	NS

Table 4: Effects of Different Tillage Methods on Leaf Area of Early Maize Varieties

	2wks	4wks	6wks	8wks	10wks
Variety (A)					
TZE 41	51.69[b]	271.23[b]	443.35[b]	604.54[b]	637.56[b]
Summaz 15	61.61[a]	282.15[a]	499.53[a]	683.72[a]	710.06[a]
Tillage (B)					
Mechanical	48.81[a]	289.73[a]	494.08[a]	672.08[a]	726.76[a]
Manual	51.99[a]	262.23[b]	487.23[b]	657.07[b]	663.95[b]
No-till	39.16[b]	211.45[c]	449.66[b]	603.24[c]	630.73[c]
Interaction A × B	NS	NS	NS	NS	NS

Table 5: Effects of Different Tillage Methods on Stem Girth of Early Maize Varieties

	2wks	4wks	6wks	8wks	10wks
Variety (A)					
TZE 41	0.23[a]	0.57 [a]	1.13[a]	2.31[a]	2.90[a]
Summaz 15	0.26[a]	0.63[a]	1.27[a]	2.64 [a]	3.20[a]
Tillage (B)					
Mechanical	0.23[a]	0.74[a]	1.46[a]	2.81[a]	3.60[a]
Manual	0.22[a]	0.66 [a]	1.31[a]	2.53[a]	3.00[a]
No-till	0.21[a]	0.41[b]	0.94[b]	1.89[b]	2.10[b]
Interaction A × B	NS	NS	NS	NS	NS

***Plant Height*:**
Table 2 presented the result of the effect of different tillage methods on plant height of the early maize varieties. Significant differences were observed in the plant height at 6, 8 and 10 weeks after planting due to the different varieties planted. However, there was no significant difference in plant height at 2 and 4 weeks after planting. At 10 weeks after planting, variety Sammaz 15 recorded the highest plant height (157.67cm) compared with TZE Y POP DT STR 42 (150.97cm). Results of the effects of different tillage methods imposed on the plant height showed significant differences observed in the height at 2, 4, 6, 8 and 10 weeks after planting. Plot mechanically tilled recorded the highest plant height (177.55cm), followed by plots with manually tilled (164.63cm) while plot with no-till recorded the least value (130.80cm)

***Number of Leaves*:**
In the Table 3 presented, was the effect of maize varieties and tillage method on number of leaves produced overtime. The number of leaves produced was significantly affected at 2, 4, 6, 8 and 10 weeks after planting due to differences in the variety planted. It was constantly higher in Sammaz 15 irrespective of the weeks after planting. At week 10, number of leaves produced in Sammaz 15 variety was 12.97cm while TZE Y POP DT STR 41 recorded 12.51cm. The Table also shown that there was no significant difference in the number of leaves produced as a result of tillage methods employed. However, the highest number of leaves was observed in plots with mechanical tillage operation (13.25), followed by plots with manually prepared tillage (12.93) and was least in plots with no-till (12.45).

***Leaf Area*:**
From Table 4, significant difference was observed in the leaf area of the varieties planted. Leaf area increased in weeks after planting. At 10 weeks, Sammaz 15 and TZE Y POP DT STR 41 recorded values of leaf area as 710.06cm^2 and 637.56cm^2 respectively. Tillage methods employed significantly influenced the leaf area of maize in the experiment. Plots with mechanical method of tillage recorded the most leaf area (726.76cm^2), followed by manually prepared tillage (663.95cm^2) and least in plots with no-till operation (630.73cm^2).

***Stem Girth*:**
On the effect of varieties and tillage methods used on stem girth as shown in Table 5, there was no significant difference in the stem girth at weeks 2, 4, 6, 8 and 10. There was also no significant difference in the methods of tillage used at week 2 after planting, although significant difference were observed in stem girth due to tillage methods at 4, 6, 8 and 10 weeks. It was highest on plot mechanically tilled (3.6cm) followed by manually tilled plot(3.0cm) and least on plots with no-till method (2.1cm).

Growth and yield parameters observed were better in Sammaz 15 compared with TZE 41. This could be due to differences in genetic make-up of the variety. Leaf area was more in Sammaz 15 compared to the TZE 41 variety. This result could be linked to better nutrient mining by the Sammaz 15. The work supported the findings of Ogundare *et al.*, (2015) who reported genetic influence in growth and yield of three maize varieties.

Table 6: Effects of Different Tillage Methods on Cob Parameters of Early Maize Varieties

	COB Length (cm)	COB Diameter (cm)	COB Weight (g)
Variety (A)			
TZE 41	15.20 [b]	3.70 [b]	0.13[b]
Summaz 15	17.40[a]	4.10[a]	0.18 [a]
Tillage (B)			
Mechanical	16.60[a]	4.60[a]	0.20[a]
Manual	15.30 [a]	3.90[a]	0.18[a]
No-till	9.60[b]	2.30[b]	0.10[b]

Table 7: Effects of Different Tillage Methods on Grain Yield of Early Maize Varieties

	Yield/Plant (g)	Yield/Plot (kg)	Yield/Hectare (tons)
Variety (A)			
TZE 41	0.51 [b]	28.50 [b]	2.82[b]
Summaz 15	0.62[a]	34.10[a]	3.46 [a]
Tillage (B)			
Mechanical	0.63[a]	34.70[a]	3.49[a]
Manual	0.51 [b]	28.10[b]	2.82[b]
No-till	0.24[c]	13.20[c]	1.33[c]

***Cob parameters*:**

The result in Table 6 shows the effects of the different maize varieties and tillage methods imposed on cob parameters such as cob length, cob diameter and cob weight of maize. There was significant difference in the cob length of the two varieties. The cob length of Sammaz 15 recorded the highest value of 17.4cm, while TZE Y POP DT STR 41 was 15.2cm. The Sammaz 15 recorded highest value of cob diameter of 4.1cm compared to the TZE Y POP DT STR 41 variety of 3.7cm the cob weight after shelling of grains from Sammaz 15 and TZE Y POP DT STR 41 were 0.18g and 0.13g respectively.

The result of the effect of tillage methods on these parameters was also shown in Table 6, indicating a significant difference in the cob length, cob diameter and cob weight of the maize in the study. The mechanically prepared plot produced the highest value of 16.6cm for cob length compared to the manual tillage and no-till methods with 15.3cm and 9.6cm respectively. The mechanically tillage method also recorded highest cob diameter of 4.6cm, followed by manual tillage (3.9cm) and least in no-till method (2.3cm). The result of cob weight value as affected by different tillage method also followed the same trend, with mechanically tilled, manually tilled and no-till method having 0.20g, 0.18g and 0.10g respectively.

***Grain yield parameters*:** Table 7 illustrates the effects of the early maturing maize varieties on crop yield parameters. There was significant difference recorded in the yield of the two maize varieties. Sammaz 15 recorded higher value of yield per plant of 0.62g compared with TZE Y POP DT STR 41 with 0.51g. The yield per plot was higher with 34.1kg in Sammaz 15 compared with TZE Y POP DT STR 41 with 28. 5kg.yield per hectare followed the same trend with 3.46tons and 2.82tons respectively.

Tillage methods significantly influenced the grain yield parameters. Mechanically tilled plot recorded the most yield per plant, per plot and per hectare, followed by manually tilled and no-till methods in that order as shown in Table 7. Among the tillage methods employed, mechanical tillage method best improved growth and yield of the maize varieties. This could be due to better soil physical conditions, better soil mixing when the method was carried out. This research supported the findings by Odegbe (2002), who reported that mechanical tillage system improved growth and yield of cassava better than other methods.

Conclusion

The performance of maize varieties was influenced by different tillage methods in the study. Curtivar Summaz 15 performed better than TZE Y POP DT STR 41 cultivar in both growth and yield. In the other way, mechanically tilled plots recorded better growth and yield of the maize varieties than either manual or no-till plots. Farmers should grow cultivar Sammaz 15 for optimum yield as well as adopting the mechanical tillage method for optimum growth and yield of maize in the region. Further is however recommended to be carried out on different locations.

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EVALUATION OF GROWTH AND YIELD OF OKRO (*Abelmoscus esculentus*) AND HOT PEPPER (*Capsicum frutenscence*) UNDER INTERCROPPING IN KABBA

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Abstract
The experiment was conducted at the teaching and research farm of Kabba College of Agric. five spatial arrangements were used on okro and pepper to study effects of the intercrop on vegetative growth and yield components of okro and pepper. Treatments considered are; Sole okro, Alternate stand of okro and Pepper, Alternate single row, Alternate double row of Okro and Pepper and Sole Pepper. The treatments were laid out in a Randomize Complete Block Design (RCBD) and replicated four times. Parameters assessed include; plant height, leaf number, branch number, okro pod and pepper fruit per plant, okro pod and pepper fruit yield per plot. Result obtained indicates that alternate stand arrangement gave the best crop performance (P<0.05) than the other arrangements hence it was concluded that alternate arrangement is the appropriate farming system approach for the okra and pepper in the study location.

Keywords: *Intercrop, Growth, Yield, Cropping, System*

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Introduction

Intercropping is the growing of two or more crops simultaneously on the same field during a growing season and it is a traditional practice in the tropics (Bybee-Finley and Ryan, 2018). The most common goal of intercropping is to produce a greater yield on a given piece of land by making use of resources that would otherwise not be utilized by a single crop (Launay *et al*., 2009). Careful planning is required, taking into account the soil, climate, crops, and varieties. It is particularly important not to have crops competing with each other for physical space, nutrients, water, or sunlight. Examples of intercropping strategies are planting a deep-rooted crop with a shallow-rooted crop, or planting a tall crop with a shorter crop that requires partial shade.

Intercropping is a common practice in many areas of Africa as a part of traditional farming systems commonly implemented in the area due to declining land sizes and food security needs (Dakora, 1996). It also aids in the more efficient utilization of the available resources and the increased productivity compared with each sole crop of the mixture (Muoneke *et al*., 2007; Carrubba *et al*., 2008; Launay *et al*., 2009; Mucheru- Muna *et al*., 2010).

Many researchers have reported the advantages of intercropping over monocropping (Quainoo *et al*., 2000; Makinde *et al.*, 2011; Sani *et al*., 2011). Intercropping ensures better interception of sunlight energy, more effective utilization of water and nutrient and a higher exploration of the growing factors related to the environment (Ghanbari *et al*., 2010; Fustec *et al*., 2010.)

In Nigeria, farmers grow a variety of crops, often intermingled in the same field, to sustain themselves and their families. Although modern agriculture has shifted the emphasis to a more market-driven economy and this tends to favour intensive mono-cropping. Large-scale farmers in particular have found it easier to plant and harvest one crop on the same field using machinery and inorganic fertilizers. However, small-scale farmers who do not have ready access to machinery and markets and who can normally only grow enough food to sustain themselves, recognize that inter-cropping is a way of ensuring their livelihood. Most crops grown in intercrops are crops of dissimilar growth patterns, such that the peak period of growth does not coincide.
The objective of this study is to determine the effects of intercrop on the growth and yield of Okro and Hot pepper.

Materials and Methods

Description of study area

The study was conducted in the teaching and research farm of Kabba College of Agriculture situated on latitude $7^0$50N and Longitude $6^0$45 and at elevation of 427m above sea level in the southern guinea savanna ecological zone of Nigeria.

Experimental Design

The experiment was laid out in a randomized complete block design (RCBD). The treatments were spatial arrangements namely: Sole Okro, Alternate stands of Okro and Pepper in row, Alternate single row of Okro and Pepper, Alternate double rows of Okro and Pepper and Sole Pepper. The treatments were replicated four times.

Field Work

Okro seeds were first planted at 50cm spacing. Two weeks after germination of Okro, Pepper was transplanted at 30cm and 16.6cm in alternate stand. Fertilizer application was done two weeks after planting and Okro germination; 300kg/ha of NPK 15:15:15 was applied, while 100kg 15:15:15 was applied as top dressing at flowering stage of the crops. Beetles were observed on the Okro foliage and Karate 2.5cc was sprayed on the crop at rate of one liter/ha fortnightly to reduce the effect of beetle on the foliage.

Data Collection

Growth parameters (Average Plant height, Average leaf number/plant and Average stem girth/plant), Yield parameters (Pod Number/plant, Okro pod weight, Fruit number/plant, Pepper fruit weight) were collected following standard procedure.

Data analysis

Data collected were subjected to analysis of variance (ANOVA) using Statistics version 12 and means were separated by Duncan Multiple Range Test (DMRT) at 5% probability level.

Results and Discussion

Pre- planting soil analysis

The soil properties of the site are showed in table 1. The soil is sandy soil, moderately acidic with moderate bulk density. The pre-planting soil analysis indicated that soil of the experimental site was low in soil nutrients status especially Nitrogen (N) and phosphorous (P). The low nutrient status may be due to leaching of basic cation due to intensive rainfall or perhaps due to the parent materials of quartz and sesquioxides which are poor in plant nutrient. This agreed with findings of Babalola and Kadiri (2017) that losses of basic cations can be due to leaching and high intensity and duration of rainfall. Application of manure will be of great benefit to the crop.

Table 1 Pre-planting soil analysis

SOIL PROERTIES	
Sand (%)	13.6
Clay (%)	77.0
Silt (%)	9.44
Soil texture	Sandy Loam
pH H_2O	4.9
pH $calcl_2$	5.75
Bulk density (g/cm^3)	1.33
Organic carbon (%)	1.2
Total nitrogen (%)	0.06
Available P (mg/kg)	0.53
Exchangeable cation	
Potassium(cmol/kg)	4.2
Calcium (cmol/kg)	0.05
Magnesium(cmol/kg)	1.13
Sodium (cmol/kg)	0.53

Source: Field Survey, 2021

Effect of Spatial Arrangement of Crops on Growth

Results on effects of spatial arrangement of okro and pepper (table 2) revealed that there were significant effects of the treatments on Okro growth; this might be due to intra-specific competition between the crops at early stage for growth factors such as light and space. Alternate row (54.82cm) was highly significant ($P<0.05$) when compared with other treatments, this is followed by sole okro (50.19cm) while the lowest was recorded at the alternate single row. For average leaf number of okro, there were no significant effects of the treatments this could be due to the crops maximizing available condition that treatment imposed on it for vegetative growth.

For pepper, average plant height was also significant alternate row (52.83cm) and alternate double row (52.75cm) are significantly higher ($P<0.05$) than other treatments, the lowest value was recorded in Sole Pepper (35.44cm). Result of average number of leaves for pepper shows that there

were significant differences (P<0.05) with alternate single row (53.75cm) being highly significant than other treatments, the lowest value was recorded at alternate double row (45.50cm).

Table 2: Growth Parameters

Treatments	Average Height of Okro (cm)	Average Height of Pepper (cm)	Average Number of leaves of Okro	Average Number of leaves of Pepper
Sole Okro	50.19^{b}	-	6.75	-
Alternate Stands	54.82^{a}	52.83^{a}	6.50	36.75^{d}
Alternate Single Row	36.71^{d}	44.61^{b}	6.25	53.75^{a}
Alternate Double Row	42.47^{c}	52.75^{a}	6.75	45.50^{c}
Sole Pepper	-	35.44^{e}	-	52.50^{b}
Significance	*	*	ns	*
SEM	0.12	0.15	0.27	0.30

Source: Field Survey, 2021

*Means within a column followed by different letters are significantly different at 5% level of significance using Duncan's Multiple Range Test (DMRT) * = p<0.05 ns = not significant*

Effects of Spatial Arrangement of crops on Yield

Results on yield parameter (table 3) revealed that sole Okro (9.15kg) and alternate stands (8.82kg) were significantly higher (P<0.05) than other treatments. The highest average fruit yield recorded for sole crop for both crops may be due to the fact that competition for growth and yield conditions (Sani *et al.*, 2011). Values for sole crop for pepper was high when compared with other treatments, this might be due to the growth habit of pepper and the fact that growth was not as vigorous as okro hence okro plant overshadow and cast canopies over them. For the alternate arrangements the average best yield was recorded at alternate stand (8.82kg for okro and 0.34kg for pepper).

Table 3: Yield Parameters

Treatments	Average Okro Pod Yield/Plot (kg)	Average Pepper fruit yield/plot (kg)
Sole Okro	9.15[a]	-
Alternate Stands	8.82[a]	0.34[b]
Alternate Single Row	5.95[c]	0.28[c]
Alternate Double Row	6.59[b]	0.25[d]
Sole Pepper	-	0.51[a]
Significance	*	*
SEM	0.06	2.72

Source: Field Survey, 2021

*Means within a column followed by different letters are significantly different at 5% level of significance using Duncan's Multiple Range Test (DMRT) * = p<0.05*

Conclusion

The alternate stand performed better for plant height for both test crops while sole crop performed better for yield. Resource poor okro and pepper farmers that want to maximize resources can adopt the alternate crop arrangement pending further research on economic evaluation of the cropping systems.

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DETERMINANTS OF VULNERABILITY TO POVERTY AND COPING MECHANISM OF RURAL HOUSEHOLDS IN NIGERIA.

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Abstract.
The study examines the factors that influence the vulnerability of farming households to poverty in the rural area. It specifically profiled the respondents based on their vulnerability status; identify the coping strategies adopted by the respondents to cushion the effect of poverty on the household and analyze the determinants of vulnerability to poverty. Data was sourced from the National Living Standard survey (NLSS) of year 2010 and 2012 where multistage technique was used to select a total of 1014 respondents used for the study. Descriptive statistics such as frequency count, %ages, were used. FGT poverty measure estimated the poverty incidence, depth and severity, FGLS estimation was used to estimate the vulnerability to poverty status of the respondents. Tobit model adopted was used to captured the factors influencing household vulnerability to poverty. Result showed that 42.4% of the respondents were non-vulnerable to poverty while 57.6% were vulnerable to become poor in future. Majority of the respondents were male, while a largest %age had no formal education. The %age of households with more than ten members were identified to be in a vulnerable group (15.87%) triples those of the non-vulnerable households (4.21%). Consumption of less quality meals was one of the strategies adopted by households as means of coping with shackles of poverty. Access to credit, shocks among others were the factors that determined household vulnerability to poverty in the area. It was recommended that farmers should be enlightened on how to manage shocks as they emerge.

Key words: Vulnerability, poverty, Coping strategies, NLSS, Rural Nigeria

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INTRODUCTION

In recent times, researchers have carried out studies on vulnerability. Such studies emphasized more on poverty and vulnerability classification, sources of vulnerability, coping mechanisms, vulnerability and poverty, identifying household-specific vulnerability characteristics, analyzing the differences in household vulnerability by observable characteristics and determinants of vulnerability to poverty. Isabel and Johannes (2013), argued that the recent evidence on individuals' decision making is of high relevance for the measurement of poverty when switching from a static and certain to a dynamic and uncertain

framework. The numerous proposed measures of multi-period poverty and vulnerability have until now not taken into accounts the insights from behavioral economics.

Raghbendra *et al* (2012) used a unique panel data for rural India for the periods 1999 and 2006 their paper models vulnerability to poverty. They quantified household vulnerability in rural India in 1999 and 2006, investigated the determinants of ex post poverty as well as ex ante vulnerability, assess the role of ex ante vulnerability on poverty shift during the sample periods (i.e. movement into/out of poverty). Amao *et al* (2017) examined the concept of coping mechanisms, vulnerability and poverty among rural households of Bangladesh. The responsiveness of private and public coping mechanisms was examined, while the study also attempted to link household - level vulnerability to probability of being poor. Adepoju and Obayelu (2013) investigated poverty and vulnerability to poverty in rural South-West Nigeria (SWN). Primary data were collected from 582 rural households in a two-wave panel survey (harvesting and lean periods) employing a multi-stage sampling technique. Data were analyzed using; Foster, Greer and Thorbecke (FGT) poverty measure; 3-Stage Feasible Generalized Least Squares (3FGLS); Tobit and Probit regression methods.

Pritchett *et al* (2000) and Chaudhuri *et al* (2002) developed quantitative measures of vulnerability, as the ex-ante risk of facing poverty in the future. Chaudhuri, *et al*. (2002) using cross sectional data from the mini-SUSENAS in Indonesia in December 1988 and a three-stage feasible generalized least squares procedure to estimate the inter temporal variance of the log of consumption on household characteristics, found out that at the national level, while 23 per cent of the Indonesian population was poor, 45 per cent of the population was vulnerable to falling into poverty in the future. Alayande and Alayande (2004) attempted a quantitative and qualitative assessment of vulnerability to poverty in Nigeria. In qualitative terms, they noted that weak governance structure in the form of absence of rule of law, lack of political effectiveness and efficiency and high level of insecurity were major sources of vulnerability to poverty in Nigeria

Oni and Yusuf (2008) on the determinants of expected poverty in rural Nigeria also extended the vulnerability to expected poverty approach with the incorporation of covariate risks in the regression analysis allowing for inclusion of time varying covariates (such as regional specific variables) namely: rainfall, radiation, notable diseases, and price level and unemployment rates among others. Kasirye (2007) employed panel data set of 1309 households in Uganda to measure vulnerability to poverty between 1992/93 and 1999/2000 and to estimate the impact of household characteristics on vulnerability. The likelihood of future poverty was estimated based on the expected mean and variance of household consumption. Gaiha *et al*. (2007) drew upon the Vietnam Household Living Standards Survey (VHLSS) data that covered the whole of Vietnam in 2002 and 2004, construct ex ante measures of vulnerability. Jamal (2009) assessed the extent of household vulnerability to poverty in Pakistan. The estimates showed that about 52 *%* of the population was vulnerable to poverty during 2004-05.

Indranil *et al* (2010) used the framework of decision making under uncertainty to arrive at a new measure of vulnerability to poverty. Nonignon (2010) assessed ex-ante welfare through vulnerability to poverty estimates among households in Ghana and to examine the effect of various socioeconomic characteristics on vulnerability to poverty. Adepoju *et al* (2011) examined vulnerability to poverty of households among rural households in South West Nigeria using primary data from a two-wave panel survey (lean versus harvesting periods). Edoumiekumo *et al* (2013) analyzed household poverty and vulnerability to poverty in Bayelsa state of Nigeria using National Bureau of Statistic 2009-10 NLSS data. A poverty line of

N22393.62 was constructed. Agbaje *et al* (2013) investigated the vulnerability to poverty across in rural Nigeria, using the 2004 NLSS data. The result of the 3-Stage Feasible Generalized Least Squares showed that at the standard vulnerability threshold of 0.5, 62.2% of rural households were vulnerable to poverty.

Dawit (2015) assessed ex-ante welfare of each household from vulnerability to poverty estimates among households in rural Ethiopia and examine the effect of various socioeconomic characteristics on vulnerability to poverty using three step Feasible Generalized Least Squares (FGLS) estimation procedure to estimate vulnerability to poverty and to predict the effect of household socioeconomic status on expected future consumption and analyze the variations in future consumption. Nancy *et al* 2016 measures vulnerability to poverty in rural Malawi, the results show that in 2010 two-fifths of all households had a chance of at least 40 *%* of falling below the poverty line in the future. The results show that many households in rural Malawi are vulnerable to poverty. Adepoju *et al*, (2011) also used the methodology of the fixed effects instrumental variable (FEIV) model and the Multinomial Logit model to control for heterogeneity and for analyzing the factors affecting the probability that a household is in chronic poverty as opposed to transient poverty. Birhan and Testahun (2017) by using a nationally representative cross-sectional data set, identified the determinants and levels of rural households' vulnerability to poverty. Household size, head's sex, age, literacy status, marital status, dependency ratio, and agro-ecology are the major determinants. The study found 54% vulnerability and 31% poverty rates.

In the micro econometric literature approaches to assessing vulnerability can be divided in three broad categories. The first one construes vulnerability as expected poverty (VEP). Along this line are authors like, Pritchett, Suryahadi, and Sumarto (2000), Chaudhuri, Jalan, and Suryahadi (2002), Christiansen and Subbarao (2005). Pritchett *et al*, (2000) understand vulnerability to poverty as having experienced poverty during a certain period of time t, over a relevant span $t = -\infty,....,-2,-1,0$, or the probability of experiencing poverty in the near future. For Chaudhuri *et al*, (2002), vulnerability to poverty is the probability to become or remain poor at time t + 1, given certain socio-economic characteristics at time t. In turn, Oni and Yusuf (2008) perception of vulnerability to poverty is the absence of households' resilience to shocks that can bring welfare below a threshold deemed acceptable by society. The latter two definitions are admittedly more forward looking. In any case, the most commonly adopted definition in the academia is the probability of an individual or household to fall into poverty. While knowing the probability to fall into poverty may be preferable to a mere static assessment of poverty, it is arguably desirable that a vulnerability measure provide a complete picture to discern between those facing the risk of falling into poverty, those with the ability to move out of poverty, and the ones with so weak fundamental circumstances that they are trapped into poverty.

Methodology

The study was conducted in Nigeria. According to FRN, (2007) the population of Nigeria rose from about 88.5 million in 1991 to 140million in 2006 and to 168.8 million in year 2012 (World Bank 2012). The precise study area of this study is rural Nigeria whose population estimate as reported by World Bank 2012 is 77,803,783 in 2010. Nigeria is dived into 6 geo polical zones namely, North central, North East, North West, South West, South South and South East.

Data used for this study was sourced from the National Living Standard Survey (NLSS) of year 2012/2013. A multi-stage sampling technique was used to select respondents from data used. A random selection of two states from each of the six geo-political zones in Nigeria forms the first stage. The selected states include Plateau and Kwara, from north central zone, Bauchi and Gombe from north east zone,

Katsina and Zamfara from north west zone, Ebonyi and Cross-river from south south zone, Delta from, south east and Osun and Ondo from south west. The selection of 102 Enumeration Areas (EAs) and random selection of ten (10) households in each Enumeration Area forms the second and third stage respectively. This totaled 1020 households for the study.

Data analysis

***Poverty measure*:**

The class of decomposable poverty measures by Foster, Greer and Thorbecke (FGT) was adopted to measure poverty in the study. They are widely used because they are consistent and additively decomposable (Foster *et al.,* 1984). The FGT index is given by:

$$P_\alpha = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z-yi}{z}\right)^{\alpha} \quad \ldots 1$$

Where; Z is the poverty line defined as 2/3 of the mean per capita household expenditure (MPCHHE), y_i is the value of poverty indicator/welfare index per capita in this case per capita expenditure in increasing order for all households; q is the number of poor people in the population of size n, and α is the poverty aversion parameter that takes values of zero, one or two. By setting the value of α to zero, one, two respectively, the FGT poverty measure formula delivers a set of poverty indices.

***Vulnerability as expected poverty (VEP)*:**

Three steps generalized least square (FGLS) estimation procedure was used to analyze the vulnerability to poverty and to model the effect of household socio-economic status on expected future consumption and variation in future consumption. Vulnerability as expected poverty (VEP) approach was used to measured vulnerability. Taking into account the dynamic dimensions of poverty, the measure of 'Vulnerability as Expected Poverty' (VEP), an ex-ante measure proposed by Chaudhuri *et al.,*(2002) was adopted and used by Birhan and Testahun, (2017) and Sisay *et al*, (2016) because of the advantage of the VEP approach especially in terms of its ability to identify households that are exposed to risks but who are not poor. In this approach vulnerability is defined as the probability of being poor in the future and basically can take on two forms. It is either the ex-ante risk that a household that is currently not poor will fall below the poverty line or the risk that a household that is currently poor will remain poor. This can be formally expressed as:

$$Vt = Prob\ (C_{(t+1)} < Z) \quad \ldots 2$$

Where the vulnerability of a household during the current period Vt is dependent on the probability that future household consumption C (t+1) will be less than poverty line (Z). Empirically, building upon the works of Chaudhuri *et al*. (2002), VEP was obtained by the following procedure: First, the FGT measure of headcount poverty (Foster, *et al*., 1984) was estimated from household data. Second, household's expected consumption and its variance of the error term was estimated using the 3 stage Feasible Generalized Least Square (FGLS) estimation procedure. Household's vulnerability to poverty was then derived as the conditional probability of the household falling into poverty in the next period or the probability that a household's consumption will lie below the predetermined poverty line in the near future

$$\widehat{VEP}_i = \widehat{v_i} = \widehat{P_i}(In\ c_i < In\ z|X_i) = \emptyset\left(\frac{In\ z - X_i\widehat{\beta}}{\sqrt{X_i\widehat{\theta}}}\right) \quad \ldots 3$$

The standard vulnerability threshold of 0.5 will be adopted following (Imai *et al*., 2011; Oni and Yusuf, 2006) where households were classified into their vulnerability status. Hence, those with a 50 per cent or more chance of falling into poverty in the future will be identified as vulnerable**.**

Tobit model:

This was used to examine the determinants of vulnerability to poverty in Nigeria using the value of VEP estimated for each household as the dependent variable. The dependent variable has zero values for households below the vulnerability threshold which is indicative of censoring of an underlying variable and therefore requires Tobit estimators (Wen *et al.*, 2002). The Tobit Model developed by Tobin (1958) and as adopted by Omonona (2001) is expressed as:

$Y_{ij} = \beta X_i + e_i$

$Y_{ij} = \widehat{Vht} = \hat{P}_r(In_{ct+1} < InZ/X_i) = \frac{\emptyset[Z - Xh\widehat{\beta}]}{\sqrt{Xh\sigma}} = VEP$

Where $Y_{ij} = 0$ for $\tilde{V}h_t < v$

$Y_{ij} > 0$ for $\tilde{V}h_t \geq v$

Where:

X_i = Vector of explanatory variables
B = Vector of respective parameters
E_i = Independently distributed error term
Y_{ij} = Estimated vulnerability as expected poverty indices
V = Vulnerability threshold
Z = Poverty line
$Xh\hat{\beta}$ = Expected log of consumption
$Xh\hat{\sigma}$ = Expected variance of log consumption

Thus, the following explanatory variables were used in the regression analysis are and measured as;

X_1 = Sex (1=male, 0=female)
X_2 = Marital status (1 = married, 0 = Otherwise)
X_3 = Age of household head (years)
X_4 = Number of household member under 18 years of age
X_5 = Number of household member above 18 years of age
X_6 = Distance to water source
X_7 = Years spent in formal education
X_8 = Access to credit
X_9 = Health shocks
X_{10} = Agricultural shocks
X_{11} = Idiosyncratic shocks
X_{12} = Farm size
e = Error term

Results and Discussions

A. Categorizing respondents to vulnerable groups and their Socio-economic features profile

The household vulnerability to poverty and profiled socio-economic characteristics of the respondents are presented in Table 1 and 2. The selected households were profiled into vulnerability groups. Results

showed that 42.02 *%* of the households were non vulnerable to poverty while 57.79 of them were vulnerable to poverty in future which was higher than poverty point in time estimates. Distribution of household by poverty status was further decomposed into vulnerability and non-vulnerability groups. Results revealed that the entire poor household will remain in future. About 99 *%* of the non-poor were also non-vulnerable while only 0.5 *%* of the non-poor is vulnerable to become poor in the future.

Table 2 reveals that only 9.73 *%* of the vulnerable groups were female while 75.7 *%* of the non-vulnerable groups were male. The vulnerable group records 37. 03 *%* for members between 41 and 50 years and this accounted for the highest in this group. The least *%*age representation for both vulnerable groups are those respondents whose age were 30years or less than. A good number of the respondents had no formal education. While 66.36 *%* of the non- vulnerable had no formal education, 65.87 *%* of vulnerable group likewise are not educated. The *%*age distribution of the households decreases with increase in educational qualification. An exception to this is tertiary education where 17.52 and 13.48 *%* of the non-vulnerable and vulnerable groups respectively had post-secondary qualification.

Majority of the respondents were married. Specifically, 72.9 and 89.25 *%*s of the non-vulnerable and vulnerable group respectively was married. Among the non-vulnerable group, 21.96 *%*s of them were widowed while only 0.93 were widowed. None of the vulnerable group were divorced while just 1.19 *%* were separated from their spouses. About 55 *%* of the non-vulnerable group had about 5 household members or less when their vulnerable counterpart recorded 29 *%* for this category. The highest *%*age for the vulnerable group were those who had between 6 and 9 household members (54,27%). The least value for both groups is household with 10 or more members. However, the *%*age value of the vulnerable (15.87%) more than triples that of the non-vulnerable (4.21%).

Considering the farm size, about 42 *%* of the households in the non-vulnerable group cultivate a farmland that is above 6 hectares while 21.73 *%* of them have a farm size that is below 2 hectares. The vulnerable group like their counterpart also recorded 47.44 *%* for those household having more than 6 hectares of farmland. The least in these categories for the vulnerable group are farmers who cultivated between 4 and 6 hectares of farmland.

Table 1: Vulnerability and Poverty at Household Level

Vulnerability	**Poverty status**		
	Nonpoor	**Poor**	**Total**
Non-vulnerable	428 (99.5)	0 (0.0)	428 (42.2)
Vulnerable	2 (0.5)	584 (100.0)	586 (57.8)
Total	430 (42.4)	584 (57.6)	1,014 (100.0)

Figures in parenthesis are *%*age

Source: Author 's estimates based on the GHS data 2012/2013.

Table 2. Socio economic characteristics of the respondents

Socio economic features	Non-Vulnerable		Vulnerable		Pooled	
Sex	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
Female	104	24.3	57	9.73	161	15.88
Male	324	75.7	529	90.27	853	84.12
Total	428	100	586	100	1,014	100
Age						
<=30	12	2.8	9	1.54	21	2.07
31-40	70	16.36	91	15.53	161	15.88
41-50	128	29.91	217	37.03	345	34.02
51-60	138	32.24	199	33.96	337	33.23
Above 60	80	18.69	70	11.95	150	14.79
Total	428	100	586	100	1,014	100
Educational level						
No formal edu	284	66.36	386	65.87	670	66.07
Primary edu	37	8.64	69	11.77	106	10.45
Secondary edu	32	7.48	52	8.87	84	8.28
Tertiary edu	75	17.52	79	13.48	154	15.19
Total	428	100	586	100	1,014	100
Marital Status						
Divorced	4	0.93	0	0	4	0.39
Married	312	72.9	523	89.25	835	82.34
Separated	18	4.21	7	1.19	25	2.47
Widowed	94	21.96	56	9.56	150	14.79
Total	428	100	586	100	1,014	100
Household size						
<=5	236	55.14	175	29.86	411	40.53
06- 9	174	40.65	318	54.27	492	48.52
10 and above	18	4.21	93	15.87	111	10.95
	428	100	586	100	1,014	100
Farm size						
<2	93	21.73	124	21.16	217	21.4
02-4	98	22.9	110	18.77	208	20.51
04.1- 6	57	13.32	74	12.63	131	12.92
Above 6	180	42.06	278	47.44	458	45.17
Total	**428**	**100**	**586**	**100**	**1,014**	**100**

Source: Author's estimates based on the GHS data 2012/2013.

B. Poverty profile of the respondents in the study area

Table 3 presents the estimates of FGT poverty measure for the respondents in the study area. The three FGT estimates are given as headcount, intensity/gap of poverty and severity of poverty. The result revealed poverty headcount or incidence of 57.6 %, which indicated that about 58 % of the rural household

in the study area were poor. Also, the intensity of poverty, which is estimated by dividing the average poverty gap or the amount of income/expenditure necessary to bring households in poverty up to the poverty line, by total households was 30.1 *%*; this showed that intensity of poverty in the study area is high that is about 30 *%*. This indicated that an average rural household need to contribute this amount in other to move up poverty line threshold. Furthermore, severity of poverty was recorded as 18.4 *%*; this depicts the depth of poverty spread among the poor. Generally, high intensity and severity of poverty in the study area indicated that there is higher risk of future poverty. The findings corroborated the result of Awel, (2007) in his study on vulnerability and poverty dynamics in rural Ethiopia where headcount poverty was 64 *%*.

Table 3: FGT poverty measures

Poverty measures	Estimate
Headcount	0.576
Intensity of poverty	0.301
Severity of poverty	0.184

Source: Author 's estimates based on the GHS data 2012/2013

C. Coping Strategies adopted for mitigating problems of Food Insecurity and Poverty

Table 4 revealed that 17.39 *%* of the rural households consumed fewer quality meals as a means of coping with poverty, about 17.23 *%* settled for consumption of limited meal, 12.98 *%* engaged in the reduction of meal taken, 11.95 *%* skipped meals and 8.38 *%* needed to engage in labour work to raise food for their family. About 6.71 *%* permitted their children to eat first, 4.25 *%* borrowed food from their neighbours, and 3.73 *%* would have to remain without food the whole day while 3.10 *%* always choose to sleep hungry. This implied that most of the vulnerable households do not adopt economic coping mechanism that will help in mitigating poverty. The result contradicted the findings of Idrisa *et al.,* (2008) where they reported that 68.3% households allowed children to eat first.

Table 4: Coping strategies adopted by respondents in the study area

Mechanism	Frequency	%age	Mean	Std.Dev
Eat less quality food	438	17.39	0.431	0.495
Consuming limited food	434	17.23	0.428	0.495
Meal size reduction	327	12.98	0.322	0.467
Meal skipping	301	11.95	0.296	0.457
Engage in labour work	211	8.38	0.265	0.399
Children first	169	6.71	0.167	0.372
Borrowing food	107	4.25	0.106	0.307
Remain without food the whole day	94	3.73	0.092	0.290
Sleeping hungry	78	3.10	0.076	0.266
Total	2,519	100.00		

Source: Author's estimates based on the GHS data 2012/2013.

D. Determinants of vulnerability to poverty in the study area

The factors influencing household vulnerability to poverty is as presented in Table 5. The result showed that coefficient of sex, married respondents, less than 18 years old, above 18 years of age, distance to drinking water, health shocks, agricultural shocks, idiosyncratic shocks and farm size were positive. From

these variables, sex, less than 18 years old, above 18 years of age and agricultural shocks significantly influence vulnerability to poverty in the study area. On the other hand, the coefficient of age, years spent in school, and access to credit were negative. From which only access to credit was found to significantly influence vulnerability to poverty at 1% level of significance.

Sex was found to positively influence vulnerability to poverty in the study area, this implied that an increase in the number of male respondents will lead to a rise in the chance of household becoming vulnerable to poverty. The result negated the a-priori expectation; this might be as a result of the fact that average household head are tending towards unproductive age. Household members less than 18 years old and above 18 years of age were also positive and significant at 1% level. This indicated that a unit increase in the number of members that are 18 years or less will increase the chance of households becoming vulnerable to poverty in the study area by 5.9%, while increase in household members that are more than 18 years will increase the probability of households becoming vulnerable to poverty in the study area by 6.5%. The result was in consonance with the findings of Novignon, (2010) in his study on estimating household vulnerability to poverty from cross section data: empirical evidence from Ghana where age of the sampled respondents was significant determinants of vulnerability to poverty.

The coefficient of farm size was statistically significant at 10% level; the result implied that a unit increase in farm size of the respondents will increase the likelihood of household becoming vulnerable to poverty by 0.2%. this negated the a-priori expectation as rise in farm size supposed to reduce the chance of becoming vulnerable to poverty. Furthermore, the coefficient of access to credit was negatively significant at 1%; the result indicated that an increase in access to credit will reduce the likelihood of being vulnerable to poverty in the study area. All things being equal, a rise in credit access will boost the chance of becoming non-vulnerable to poverty. Lastly, the table revealed that agricultural shocks have positive influence on vulnerability to poverty in the study area at 5% significance level. The result showed that increase in agricultural shocks will lead to a rise in the likelihood of becoming vulnerable to poverty in the study area. The result further buttresses the findings of Jadotte (2010) in his study on vulnerability to poverty: A micro-econometric approach and application to the republic of Haiti where large livestock do not seem to provide protection against income drop under the presence of a shock.

Table 5: Determinants of vulnerability to poverty

Variables	Coefficient	Std.Err	t- value
Sex	0.666***	0.047	3.44
Married	0.002	0.092	0.01
Age	-0.010	0.002	-1.47
Age under 18	0.247***	0.008	7.88
Age above 18	0.271***	0.011	5.69
Distance to water	0.004	0.001	1.22
Years spent in school	-0.015	0.003	-1.42
Access to credit	-0.002***	0.003	-3.28
Health shocks	0.112	0.060	0.44
Agricultural shocks	0.491**	0.060	2.03
Idiosyncratic shocks	0.168	0.052	0.79
Farm size	0.613*	0.001	1.68
Constant	-1.916***	0.657	-2.91

LR chi2(12) = 153.25 Prob> chi2 = 0.0000
Log likelihood = -610.17902 Pseudo R^2 = 0.2116
y = Pr(Vulnerability) (predict) = 0.59571546

Source: Author 's estimates based on the GHS data 2012/2013.

Conclusion

The poverty measure showed that an average rural household in the study area is poor, poverty intensity and its severity was high. More than halve of the population were poor and adopted non-economic means of coping strategies to cushion effect of poverty on their household wellbeing, prominent among the strategies adopted include are consumption of less quality food, skipping meals, meal size reduction, consumption of limited meal, borrowing from neighbor among others. Access to credit, shocks and farm size among others factors influences household vulnerability to poverty. An enlightenment and awareness programme should be made available for the rural families on the effect of shocks (agricultural, health, covariate, idiosyncratic and social). This will help in long way to handcuff vulnerability to future poverty in the study area. Policies concerning poverty reduction need to take into account current non-poor but vulnerable households with the poor households.

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