IJAFS

JABU INTERNATIONAL JOURNAL OF AGRICULTURE AND FOOD SCIENCE

ISSN: 2141-7156

DECEMBER 2018

VOLUME 8

JABU INTERNATIONAL JOURNAL OF AGRICULTURE AND FOOD SCIENCE

VOLUME 8

JABU INTERNATIONAL JOURNAL OF AGRICULTURE AND FOOD SCIENCE (IJAFS)

PUBLISHED BY COLLEGE OF AGRICULTURAL SCIENCES, JOSEPH AYO BABALOLA UNIVERSITY, IKEJI-ARAKEJI

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CONTENTS

LAND USE PATTERNS AND EFFICIENCY OF CROP PRODUCTION AMONG SETTLERS AND NON-SETTLERS CROP FARMERS IN SOUTH-WEST NIGERIA

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Abstract

This study examined land use patterns and efficiency of crop production among settlers and non-settlers crop farmers in South-West Nigeria. A sample size of 300 small-scale farmers was randomly selected of which 262 were used to conduct the analysis. A well-structured questionnaire was used to obtain data from the farmers. The data was analyzed using descriptive statistics, stochastic frontier analysis, ANOVA and t-test. Efficiency analysis identified seed, fertilizer, herbicides, insecticides and farm size as the major factors contributing significantly to output. The inefficiency model identified farming experience, settlement and age as having a negative but significant relationship with inefficiency. The crop farmers had a mean efficiency of 0.8037. *The t-test revealed that there was significant difference exists between the costs incurred in the cropping systems. ANOVA result revealed that there was no significant difference between the revenue of the farming system, while there was significant difference between the cost of bush fallowing and crop rotation as well as continuous cropping and crop rotation. But there was no significant difference between the costs of bush fallowing and continuous cropping. Attempts should be made by the government of these states (Ogun and Oyo) to reclaim lands that have been degraded and also to ensure proper distribution of lands for farming purposes.*

Keywords: Land-Use-Patterns, Efficiency, Settlers, Non-Settlers, Farmers

IJAFS 2018 (1). 8: 1125-1140
Accepted for publication
April 2018

INTRODUCTION

Land is perhaps the single most important natural resource in the sense that it affects every aspect of people's life such as their food, clothing and shelter (Zahid *et al.*, 2015). It is the base for producing raw materials for the manufacturing industry (Oparinde *et.al* 2018). Land being a renewable natural resource is a key factor in the production process (Ogundari, 2006). Furthermore, all socio- economic activities whether industrial or agricultural take place on land. No nation, city or community can survive without it. Therefore, every person in a community has vital roles to play in the proper distribution and utilization of land, as well as an understanding of its associated problems. Land is becoming increasingly scarce for agricultural production in Nigeria (Oyekale, 2004). In years past, the Federal Government of Nigeria introduced several policy measures and programmes to solve the problem of declining agricultural land amongst which are the 1976 land use act and the farm settlement scheme. Due to poor implementation and inadequate policy back-ups, virtually all the

measures are either abandoned or scrapped. As a result of defective enforcement, the land use act is largely defective. Furthermore, as a result of lack of infrastructure, settlers abandoned many of the settlements since the settlements are not better than the rural areas.

Land use patterns directly affect the productivity level of the land. Agricultural lands can be subjected to several forms of use in terms of the nature of agricultural practices carried out (Ambali 2012). These practices range from cropping systems such as; mono/sole cropping and mixed cropping, to farming systems such as; continuous farming, bush fallowing and crop rotation. In the practice of mono/sole cropping, the farmer is interested in growing a single kind of crop; for instance, a maize farmer, cocoa farmer, cassava farmer; while mixed cropping involves the cultivation of different types of crops on the same piece of land. It could be a two-crop combination (e.g., cassava/maize), three-crop combination (e.g. vegetable/maize/yam), four or more-crop combinations. Continuous farming, as the name implies, is a farming system that is characterized by "incessant" production season or "all-year-round" production (Omonona *et al*, 2010). Under the bush fallowing system, a piece of land is left "unfarmed" for a period of time in order for it to regain its lost nutrients. It is a period of "soil-rest", where all forms of farming activities cease. Crop rotation is a system of farming in which the farmer follows a planting plan or pattern; cultivating different classes of crops at intervals. A popular plan could be "deep-rooted/shallow-rooted/deep-rooted" or "tuber/legume/cereal/vegetables". It should however be noted that a proper understanding of the various farming and cropping systems is key to ensuring increased and efficient productivity.

Sustainable (agricultural) production is achievable only if equitable land distribution and availability is ensured (Ekenta *et al*, 2012). Hence, ensuring land availability for agricultural production is non-negotiable particularly in view of the role it performs in any economy. The role of (equitable) land distribution and availability in any economy include employment and income generation, poverty reduction as well as food security (Oyedipe, 1984; Choi and Feinerman, 1993; Rygnestad and Fraser, 1996; Shi *et al.*, 2005; Zahid *et al.*, 2015) which are all components of the millennium development goals (MDG). Many of these issues were put to thought when Nigerian policy makers adopted the successful Israeli model (of farm settlement).

Hence, the objective of this study is to assess the Influence of Land Use Patterns on Efficiency of Crop Production among Settlers and Non-Settlers Crop Farmers in South-West Nigeria. Specifically, the study is to examine the land use patterns in the study area, analyze the costs and returns across land use patterns; and determine the effect of land use patterns and socioeconomic characteristics of the farmers on efficiency of crop production.

Methodology

The study was conducted in South-west geo-political zone of Nigeria which comprises of Ondo, Osun, Ekiti, Ogun, Oyo and Lagos States. The climate of the South-west is tropical with relatively high temperatures characterized by very narrow variation in seasonal and diurnal ranges. Commonly cultivated crops in the area include cocoa, coffee, oil palm, rubber, maize, rice, guinea corn, millet, cowpea, groundnut, yam, cassava, potato, onion, chilly pepper, tomato, okra and garden egg.

A multi-stage sampling technique was adopted with the first stage involving a random selection of 2 States from the South-west geo-political zone. The second stage will involve the selection of 6 farm settlements in the study area. The selection will be based on sampling proportional to size (i.e. the State with the highest number of Settlements will have more sample size). The third stage will be a random selection of 5

communities in the selected settlement using the village-block classification of the States' Agricultural Development Programme (ADPs). In the fourth stage, 10 farmers were sampled from (each) selected village. This altogether give a total of 300 respondents.

The data sourced through focus group discussion (with farmers) and interview schedule using a pre-tested questionnaire. Data collected include:

(i) Farmer specific variables: household consumption expenditure (i.e. different types, quantity, and prices of food and non-food household items), age of the farmers, education, household size and composition off-farm income, membership of association and contact with extension agents.

(ii) Farm specific variables: number of farms, farm size; accessibility to agro-chemicals production, output. Processing and marketing costs as well as yield and produce (selling) price.

Data analysis involved the use of descriptive statistics such as frequencies percentages, measures of dispersion and measures of central tendency as well as the Stochastic Frontier Production Function (SPF)

Stochastic frontier function: A farm household producing a single output Y with n inputs ($x_{I, \ldots\ldots} x_n$) will have (inefficient) transformation of inputs into output characterized by a production function {f(x)} (Oparinde *et al*, 2018).

The stochastic frontier (production) function for the farm can be represented by:

$$Q_i = [f(x_i\, a)]^{(vi - ui)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (i)$$

where:-

Q_i = output of the ith farm;

x_i = inputs;

a = parameters to be estimated.

F(x) = a functional form e.g. Cobb – Douglas;

U_i = technical inefficiency in production;

V_i = stochastic error term.

This model is specified in such that the possible production Y_i is bounded above by the stochastic quantity {f(xi, b)} vi hence the term stochastic frontier.

Assumptions of the SPF:-

1) There is presence of technical inefficiency of production;
2) The error term (v_i) account for measurement error and other factors not under the control of the farmer;
3) The error terms (v_i) are independently and identically distributed as N(O, S^2 V) random variables independent of all U_{isi}.
4) The inefficiency of terms (U_i) are non-negative truncations of N(O, S^2 V) distribution (i.e.) half normal distribution) or have exponential distribution.

SPF approaches: - There are two approaches to the estimation of SPF i.e. the Data Envelopment Analysis (DEA) and the Stochastic Frontier Approach (SFA). The DEA method of frontier analysis is the linear programming approach to efficiency analysis while SFA is the parametric approach. However, the SFA will be adopted for this study primarily due to concern for the (possible) effects of outliers as a result of measurement errors or other factors determining the shape and positioning of DEA frontier, thereby affecting the measures of technical efficiency.

i = 1,2,…….n.

Model Specification.

The SPF for arable crop farmers will be specified as:

$$\text{In } Q_i = a_0 + b_1 \text{lnSZ} + b_2 \text{lnTVC} + b_3 \text{InTFC} + V_i - U_i \text{ ----------} \quad \text{(ii)}$$

With the technical inefficiency assumed to be explained by:

$$Mi = b_0 + b_1 AG + b_2 ES + b_3 FE + b_4 SE + b_5 MS + b_6 ST \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \text{(iii)}$$

where:

V_i, U_i, Q_i, M_i, a and b = as previously defined;
SZ = farm size (Ha);
TVC = total variable costs (₦);
TFC = total fixed costs (₦);
AG = age of farmer (years);
ES = Educational status of farmer (years spent in the school as a proxy);
FE = Experience in farming (years)
SE = Settlement
MS = Marital Status
ST = State

Results and Discussions

Socioeconomic Characteristics of the Farmers

The table 1 revealed that 34 percent of the farmers were within the age range of 41-50 years. The result also revealed that about 49.3 percent o the farmers were in their active years. This implies that majority of the farmers were in their active age. The mean age was 51 years and the standard deviation was 11.5. This corroborates the findings of Ambali (2012) that crop farmers has a mean age of 50 and 49 years. Most of the farmers were married (89.3%). This goes to show that the farmers recognize the usefulness of the spouse with respect to farming as certain farming activities are gender based. This finding agrees with the position of Ambali (2012), where he posited that most crop farmers are married. The results revealed that majority of the crop farmers were male folks (82.1%). This might be because males have more access to land than females.

The table reveals that a high percentage (68.3%) of the farmers has large (≥5) family size. The mean household size was six persons with a standard deviation of 2.4.This agrees with the findings of This The implication of this is that the farming households would have access to family labour which would in turn reduce the cost of hiring labour for basic farming practices. This also agrees with the findings of Oparinde *et.al* (2018) and Ogundari, (2006) that pegged the average household size of farming households at ten (10) and concluded that the large household size encouraged utilization of family labour. Majority (74.5%) of the farmers had one form of formal education or the other. This implies that there would be easy adoption of improved farming technology sand consequently, increased productivity. This result disagrees with the findings of Omonona *et.al* (2010) who opined that farmers are mostly exposed to informal education. The mean year of experience is 22 years and the standard deviation was 13.9. This implies that adoption of new and improved technology would be done with ease and this would in the long run increase productivity.

Table 1: Socioeconomic Characteristics Settlers and Non-Settlers

Age Range	Frequency	Percentage	Mean	Standard deviation
≤30	9	3.4		
31-40	40	15.3		
41-50	89	34.0		
51-60	73	27.9		
61-70	40	15.3		
71-80	10	3.8		
>80	1	0.4		
Total	**262**	**100.0**	51	11.5
Gender				
Male	215	82.1		
Female	47	17.9		
Total	**262**	**100**		
Marital Status				
Single	7	2.7		
Married	234	89.3		
Divorced	4	1.5		
Widow	17	6.5		
Total	**262**	**100**		
Household size				
1-4	83	31.7		
5-9	162	61.8		
>9	17	6.5		
Total	**262**	**100**	6	2.4
Education				
None	67	25.6		
Primary	68	26.0		
Secondary	77	29.4		
Tertiary	22	8.4		
Adult	28	10.7		
Total	**262**	**100.0**		
Farming Experience				
≤20	79	30.2		
21-30	69	26.3		
31-40	46	17.6		
41-50	40	15.3		
51-60	23	8.8		
Above 60	5	1.9		
Total	**262**	**100**	22	13.9

Source: Field survey, 2017

Distribution of Land Acquisition and Land Use-pattern

Distribution of Respondents on the Basis of Land Acquisition

The result from Table 2 reveals that most (45.4%) of the farmer acquired their farm land from the government while 25.2% rented their land from individual. Only 5.7% purchased the land used. The reason behind the huge percentage of respondents acquiring land from the government could be because the government in the study area understands the relevance of agriculture and its contribution to communal development; hence, stringent policies that could hinder acquisition of land are avoided and farmers are encouraged to go into production by promoting easy access to farm lands. This could also account for the low number of farmers

operating on a large scale as regulations are placed on the size of land leased out per time to ensure continuous availability to intending farmers. This results does not agree with the findings of Ekenta *et.al* (2012) who concluded that land acquisition by inheritance was predominant and one of the reasons for large scale production by farmers in Osun State. Another implication of land acquisition from government is that, as opposed to purchase, limitation is placed on the farming system adopted. Bush fallowing, for instance, would be difficult, if not impossible to practice as such lands are leased out by government for the purpose of cultivation not fallowing. Also, continuous system of farming will be prevalent and this can have negative impact on the soil condition and eventually, crop production.

Table 2: Distribution of Land Acquisition and Land Use-pattern

Land Acquisition	**Frequency**	**Percentage**
Rent/Lease from Individual	66	25.2
Rent/Lease from Government	119	45.4
Purchase	15	5.7
Inheritance	54	20.6
Gift	8	3.1
Total	262	100
Cropping System	**Frequency**	**Percentage**
Sole/mono cropping	52	19.8
Mixed cropping	210	80.2
Total	**262**	**100**
Farming System	**Frequency**	**Percentage**
Continuous Farming	122	46.5
Crop Rotation	110	42.0
Bush Fallow	30	11.5
Total	**262**	**100**

Source: Field survey

Distribution of Respondents on the Basis of Cropping System

The results from Table 2 also reveal that mixed cropping (80.2%) system was the predominant cropping system in the study area. This, most likely, arises from the fact that most of the crop farmers have food demands to meet at home and considering that the government only rents out a piece of land at a time, as well as the fact that the crop farmers have vested interest in cultivating other food crops both for subsistence and commercial purposes, mixed cropping appears to be the best cropping system. Also, as a result of land acquisition through lease from government, diversification of practice becomes pertinent; mixed cropping system therefore, satisfies that objective.

Distribution of Respondents on the Basis of Farming System

The most commonly practiced farming system is continuous farming (46.5%). This is because arable crops are mostly cultivated and their production period is mostly under a year. Also, considering the need to meet domestic demand for food; which is constantly on the increase, crop farmers have to continually grow crops to meet the pressing demand. There is no provision for bush fallowing because the farmer is "on the clock" as a result of lease.

Budgetary Analysis

Table 3 shows the result of the budgetary analysis of the farmers in the study area. The total variable cost (TVC) is ₦9,414.83, the total fixed cost is ₦401.53, the total cost is ₦9,816.37 and the total revenue is ₦897,773.15. The gross margin (GM) is ₦888,358.31. This show that crop farming in the study area is profitable.

Table 3: Monthly Cost and Return of both Farm Settlers and Non- Settlers

Items	Amount (₦)
Variable cost	
Seed (₦)	3247.27
Labour (₦)	1656.53
Fertilizer (₦)	3259.08
Herbicide (₦)	946.41
Insecticide (₦)	305.54
Total (₦)	9414.83
Fixed Cost	
Depreciation	401.53
Total Cost (TC)	9816.37
Total Revenue (TR)	897773.15
Gross Margin (GM)	888358.31

Source: Field survey, 2017

Table 4 presents the results of budgetary analysis across various farming systems in the study area. Sole cropping has a gross margin of ₦1,165,985.53, while mixed cropping has a gross margin of ₦1,684,003.42. It is evident from the results that mixed cropping is more profitable than sole cropping. Also, continuous farming has a gross margin of ₦553,328.45, crop rotation is ₦1,395,878.23 and bush fallow has a gross margin of ₦387,709.28. This shows that the farming system of crop rotation is the most profitable farming system. Crop rotation, when properly practiced, can improve fertility of the soil, which in turn increases productivity. Continuous farming on the other hand, puts pressure on the soil and exhausts the soil nutrient having a negative impact on productivity. Bush fallowing, a practice of "leaving the soil to rest" helps the soil regain its lost nutrients; however, the land is not being utilized during the fallow period as there is cessation of production. Mono/Sole cropping promotes focus and specialization; hence, the farmer is able to adopt specific technology that would cause an increase in productivity and efficiency.

Table 4: Cost and Return across the cropping and farming system

Variable Cost	Cropping System		Farming System		
	Sole/Mono	Mixed	Continuous	Crop Rotation	Bush Fallow
Seed	5460	38635	2212.73	4570.19	2603.72
Labour	22304.46	102411.6	1542.73	1764.10	1724.92
Fertilizers	21500	5500	2119.54	3635.11	1640.83
Herbicides	4250	1100	740.54	895.23	546.53
Insecticides	3200	1000	902.66	1839.09	750.00
Fixed Cost					
Depreciation	5950	2850	398.91	443.56	258.07
Total Cost	62664.46	151496.57	7917.11	13147.28	7524.07
Total Revenue	1222700	1832650	560846.65	1408581.95	394975.28
Gross Margin	1165985.53	1684003.42	553328.45	1395878.23	387709.28

Source: Field survey, 2017

Distribution of Efficiency Score across the Socioeconomic Characteristic of the Famers

The table 5 presents the efficiency scores of farms across their socioeconomic characteristic. The mean efficiency of the farms was 0.80, indicating that in order for them to operate on the frontier; they have to overcome an inefficiency level of 20%. The farmers with formal education had more efficiency score (0.8368)

than those with no formal education, although both groups of farmers were efficient. This agrees with the findings of Omonona *et.al* (2010).Farmers with no formal education are least efficient because they are not exposed to improved farming technology and even when exposed, the likelihood of adoption and diffusion of such technology is next to none as they lack the intellectual wherewithal.

Table 5: Efficiency Score of the farms across Socioeconomic Characteristic of the Famers

Educational Level	Efficiency Score
No Formal Education	0.7923
Formal Education	0.8368
Gender	
Male	0.8211
Female	0.7997
Household size	
1-4	0.7936
5-9	0.8305
>9	0.7982
Age Range	
≤30	0.7397
31-40	0.7931
41-50	0.8337
51-60	0.8568
61-70	0.8493
71-80	0.6605
>80	0.5096
Total	**0.8037**

Source: Field survey, 2017

Male had mean efficiency score of 0.8211 while that of female was 0.7997. It is evident from the result that male are more efficient than the female. This agrees with the findings of Omonona *et.al* (2010) and Okoruwa *et.al* (2006). Farming as an occupation is fraught with arduous tasks and given the energy requirement of some farming activities, females would find it difficult to cope with such tasks and this would in turn affect their efficiency. Males, on the other hand, have the energy required to cope with certain strenuous activities and hence, displays more efficiency than female folks. The findings of Nwaru and Ndukwu (2011) contradict this result. They were of the view that female potatoes farmers were more technically efficient that the male folks.

The farm efficiency score by household as presented in the table 3 revealed that the households with 5-9 members are most efficient. This is contrary to the findings of Okoruwa *et.al* (2006), who opined that those with household size of range 10-20 were more efficient. This goes against the prior expectation that a larger household size would be more efficient since family labour would be used to replace the cost of hiring labour. The reason for this shift could either be that those with very large household size have members that are among the dependent category (either too young or too old to farm) or the household members lack interest in farming and do not possess the technical know-how. The table also shows that farmers between the age of 51 and 60 years are most efficient with a score of 0.8568. This implies that majority of the farmers are in their active years and have overtime, gathered a lot of experience which has helped increased their level of efficiency. Okoruwa *et.al* (2006) support the finding that the upland rice famers within the age range of 50-59 were more technically efficient. Omonona *et.al* (2010) presented a contrary view, they were of the opinion that those with the age of ≤50 were more efficient.

Table 6: Efficiency Score of the farms across zones and settlement

Zone/Settlement	Efficiency Score
Ilora Settlement	0.8085
Non-Settlement	0.7839
Ogomosho Settlement	0.8231
Non-Settlement	0.6262
Akufo Settlement	0.8815
Non-Settlement	0.7963
Sawonjo Settlement	0.8342
Non-Settlement	0.8004
Ikenne Settlement	0.8808
Non-Settlement	0.7992
Ajegunle Settlement	0.8266
Non-Settlement	0.8012
Total	**0.8037**

Source: Field survey, 2017

Table 6 shows the efficiency scores across the various zones and farm settlement. In all the farm settlements, settlers are more efficient than non-settlers. However, the settlers at Akufo have the highest level of efficiency at 0.8815. Several factors could have contributed to their attainment of this high efficiency level; some of which could be; ease of land acquisition, good cropping system and good farming system.

The table 7 shows the efficiency scores across the two states. In Ogun state, settlers are more efficient than non-settlers. The experience is the same with that of Oyo state. From the result, settlers in Ogun have the highest efficiency score (0.8139) when both states are compared. Some of the reasons could also be; ease of land acquisition, good cropping system and good farming system.

Table 7: Efficiency Score of the farms across States and settlement

State/Settlement	Efficiency Score
Ogun Settlement	0.8139
Non-Settlement	0.8006
Oyo Settlement	0.8047
Non-Settlement	0.7788
Total	**0.8037**

Source: Field survey, 2017

Table 8 presents the result of the efficiency score of the farmers by state. The results shows that the farmers in Ogun state with efficiency score of 0.8264 are more efficient than farmers in Oyo state with efficiency score of 0.7809; a factor which also contributed to the high efficiency score of Ogun settlement.

Table 8: Efficiency Score of the farmers across State

State	Efficiency Score
Ogun	0.8264
Oyo	0.7809
Total	**0.8037**

Source: Field survey, 2017

The table 9 presents the result of the efficiency score of the farmers by settlement. The results shows that settlers with efficiency score of 0.8217 are more efficient than non-settlers with efficiency score of 0.7878.

Table 9: Efficiency Score of the farms across Settlement

Settlement	Efficiency Score
Settlement	0.8217
Non-Settlement	0.7878
Total	**0.8037**

Source: **Field survey, 2017**

The table 10 presents the result of the efficiency score of the farmers by cropping system. The results showed that the farmers that practice sole cropping had efficiency score of 07949 compared to farmers that practiced mixed cropping with efficiency score of 0.8395. It is therefore recommended that farmers should involve in mixed farming since it draws them more closely to the production frontier.

Table 10: Efficiency Score of the farms across Cropping System

Cropping System	Efficiency Score
Sole/Mono Cropping	0.7949
Mixed cropping	0.8395
Total	**0.8037**

Source: **Field survey, 2017**

The table 11 presents the result of the efficiency score of the farmers by Farming system. The results showed that the farmers that practiced continuous farming had the least efficiency score of 0.8267 has the least efficiency score while those that practiced crop rotation had the highest efficiency score of 0.8278. This stems from the fact that continuous farming exerts more pressure on soil resources, thereby affecting its productivity; while crop rotation, when properly done conserves soil resources and promotes crop growth and productivity.

Table 11: Efficiency Score of the farms across Farming System

Farming System	Efficiency Score
Continuous	0.8267
Crop Rotation	0.8278
Bush Fallow	0.8270
Total	**0.8037**

Source: Field survey, 2017

The estimated results of the Maximum Likelihood Estimates (MLE) of the parameters of the Cobb Douglas Stochastic Frontier Production Function (SFPF) and the inefficiency model are presented in Table 12. From the Table, the sigma squared was statistically significant ($p<0.01$), which indicates the correctness of the specified assumption of the distribution of the composite error term. Also, the major factors that influenced the output of crop farmers in the study areas were; seeds, herbicides, insecticide and farm size. These also contributed significantly to the technical efficiency of the respondents. The co-efficient of seed was significant ($p< 0.01$) and positive, which implies that increase in output of crop farmers, can be achieved by increasing the quantity of seeds planted. However, the importance of quality should not be neglected. Similarly, the co-efficient of insecticide cost was positive and significant ($p< 0.01$), which indicates the relevance of insect pest eradication to output as it is important for the farmer to ensure that crop damaging pests are eradicated to ensure efficient production of crops. The coefficient of the cost spent on herbicide use was positive and significant ($p< 0.1$), indicating the relevance of weed control in crop production. Weeds are known to compete with crops for a lot of growth resources like, water and nutrients; hence eradication of weeds would in the long run ensure efficient production. Also, Farm Size was statistically significant and positive ($p< 0.05$) indicating that the larger the farm size, the more efficient the farmers. Therefore, as quantity of seeds required for

cultivation increases, the need to treat seeds against pests (both insects and weeds) also increases, which also increases the size of farm needed and ultimately the output obtained. Labour use, depreciation, fertilizer and herbicide cost did not contribute significantly to technical efficiency.

Table 12: Determinant of Inefficiency among Settlers and Non-Settlers

Variables	Coefficient	t-value
Constant	2.6038***	3.3402
Seed cost	0.1314***	3.3789
Labour	0.4624	-0.0891
Depreciation	-0.0161	-0.6470
Fertilizer cost	-0.0961*	1.4444
Herbicide cost	0.1804**	2.0916
Insecticide cost	0.2129***	2.3223
Farm size (Ha)	0.2325**	2.4726
Inefficiency		
Constant	-0.0042	-0.0044
Age	-0.0016	-0.2934
Sex	-0.0697	0.4923
Farming Experience	-0.0128**	-2.5329
Occupation	0.0837	0.7669
Settlement	-0.4289***	-3.2970
Marital Status	-0.0655	-0.3670
Household size	0.0159	0.6586
Education	-0.2268*	-1.8108
Land Acquisition	-0.0988	-0.8811
Continuous Farming	-0.0171	-0.0445
Crop rotation	-0.0012	-0.0033
Bush fallowing	-0.0028	-0.0072
Mixed Cropping	-0.0857	-0.1449
Mono/Sole Cropping	0.0730	0.1244
State	-0.2756**	-2.3585
Sigma-Squared	**0.5432*** **	**9.7456**
Gamma	**0.00000012**	**0.00000174**

Source: Field survey, 2017

Log likelihood Function = -282.912

From the result of the inefficiency model, the major factors which influenced the inefficiency of the respondents were; farming experience, education, settlement and state. Farming experience was found to have a negative and significant co-efficient ($p< 0.05$). The implication of this is that as the respondents' farming experience increases, their inefficiency declines. This agrees the with Omonona *et.al* (2010). This result is consistent with a priori expectation that, the more time a person spends doing a particular thing, the better he gets at it; this does not exclude the practice of farming. Education was also found to be significant with a negative coefficient ($p< 0.1$). The more educated an individual is, the more the ease of adoption of improved technology. Education sharpens the mind of individuals and makes them easily able to think outside the box as far as his practice is concerned. Farmers who are well educated are usually teachable, especially when it comes to adopting technology that would help them increase their efficiency. State was also found to have a negative but statistically significant coefficient ($p<0.05$). Also, Settlement had a negative co-efficient which was significant ($p<0.01$); indicating that the more settled a farmer is, the less inefficient he becomes. Settlers are more efficient than non-settlers.

The table 13 shows the distribution of technical efficiencies among farmers. Most of the farmers (46.46%) had technical efficiencies that ranged from 0.64000 to 0.82999 while few farmers (11.02%) had technical efficiencies that ranged from 0.45000 to 0.63999. The mean technical efficiency was 0.8037, indicating that they had an inefficiency level of 19.63%.

Table 13: Distribution of Technical Efficiency among Farmers

Range	Frequency	Percentage (%)
0.45000-0.63999	28	11.02
0.64000-0.82999	108	42.52
Above 0.829999	118	46.46
Minimum	**0.4689**	
Maximum	**0.9994**	
Mean	**0.8037**	

Source: Field survey, 2017

LSD for Fallowing (M_1) and Continuous (M_2) Revenue

LSD = $t_{\alpha/2}(\sqrt{MSE}(1/N1 + 1/N2))$

Where

$t_{\alpha/2}$= 1.96

LSD =1.96($\sqrt{3}.15 \times 10\text{^}13(1/30 + 1/122)$)

LSD = 2241778.22

Difference between mean of Fallowing and Continuous cropping

$|M_1 - M_2|$ = |394975.3 – 560846.7|

= |-165871.4|

LSD for Fallowing (M_1) and Rotation (M_3) Revenue

LSD =1.96($\sqrt{3}.15 \times 10\text{^}13(1/30 + 1/110)$)

LSD = 2265783.74

Difference between mean of Fallowing and Crop Rotation

$|M_1 - M_3|$ = |394975.3 – 1408582|

= |-1013606.7|

LSD For Continuous Cropping (M_2) and Rotation (M_3)

LSD =1.96($\sqrt{3}.15 \times 10\text{^}13(1/122 + 1/110)$)

LSD =1146368.85

Difference between mean of Continuous Cropping and Crop Rotation

$|M_2 - M_3|$ = |560846.7– 1408582|

= |-847735.3|

Table 14: Difference between Means of Cost for Cropping Systems

t-Test: Paired Two Sample for Means		
	MIXED	MONO
Mean	8222.520217	1593.844511
Variance	53398124.57	16104641.19
Observations	262	262
Pearson Correlation	-0.448614345	
Hypothesized Mean Difference	0	
Df	261	
t Stat	10.96132033	
P(T<=t) one-tail	1.50602E-23	
t Critical one-tail	1.650712727	
P(T<=t) two-tail	3.01204E-23	
t Critical two-tail	1.969094666	

Source: **Field survey, 2017**

Table 15: Difference between Means of Revenue for Cropping Systems

t-Test: Paired Two Sample for Means		
	MIXED	*MONO*
Mean	483397.298	414375.848
Variance	5.58113E+12	2.6318E+13
Observations	262	262
Pearson Correlation	-0.016590995	
Hypothesized Mean Difference	0	
Df	261	
t Stat	0.196573596	
P(T<=t) one-tail	0.422157106	
t Critical one-tail	1.650712727	
P(T<=t) two-tail	0.844314211	
t Critical two-tail	1.969094666	

Source: Field survey, 2017

LSD FOR FALLOWING (M_1) AND CONTINUOUS (M_2) COST

LSD =1.96($\sqrt{}$38424740.7(1/30 + 1/122))

LSD = 2475.96

Difference between mean of Fallowing and Continuous cropping

$|M_1 - M_2| = |6772.74 - 8200.5|$

$= |1427.76|$

LSD FOR FALLOWING (M_1) AND ROTATION (M_3) COST

LSD =1.96($\sqrt{}$38424740.7(1/30 + 1/110))

LSD = 2502.47

Difference between mean of Fallowing and Crop Rotation

$|M_1 - M_2| = |6772.74 - 12387.51|$

$= |5614.77|$

LSD FOR CONTINUOUS CROPPING (M_2) AND ROTATION (M_3)

LSD $=1.96(\sqrt{38424740.7(1/122 + 1/110)})$

LSD $=1597.46$

Difference between mean of Continuous Cropping and Crop Rotation

$|M_1 - M_2| = |8200.5 - 12387.51|$

$= |4187.1|$

Table 16: Analysis of Variance and Least Significant Difference (LSD) For Revenue among Different Farming Systems

ANOVA *Source of Variation*	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	5.01354E+13	2	2.50677E+13	0.794625	0.452849025	3.030651254
Within Groups	8.17056E+15	259	3.15466E+13			
Total	**8.2207E+15**	**261**				

Source: Field survey, 2017

The results from table 14 revealed that there was significant difference between the means of cost of the cropping system. This implies that with respect to cost consideration, the farmer has to consider the cropping system to adopt and should opt for the system that minimizes cost. Table 15 showed no significant difference between revenue generated from the different cropping system. It was also revealed from the result that among the various farming systems, there was no significant difference between the means of revenue generated from each farming system. There was a significant difference between the mean of cost of bush fallowing and crop rotation ($p < 0.05$). This implied that the farming system adopted by the farmers played a major role in determining the level of profit. Farmers should therefore be encouraged to carry out farming practices that helped minimize cost so that profit can be maximized. In this case, more cost was incurred by farmers practicing crop rotation compared to those practicing bush fallowing and such cost difference cannot be ignored. The results also revealed that there was a significant difference between the mean of cost of continuous cropping and crop rotation ($p < 0.05$). Farmers who practiced crop rotation incurred more cost than those who practiced continuous farming and such cost implication cannot be ignored as it goes a long way to affect the profit of the farmers. There was no significant difference between the mean of cost of bush fallowing and continuous farming.

Table 17: Analysis of Variance and Least Significant Difference (LSD) for Cost among Different Farming Systems

ANOVA Source of Variation	SS	Df	MS	F	P-value	F crit
Between Groups	1320974616	2	660487308.1	17.18911556	9.78156E-08	3.030651254
Within Groups	9952007841	259	38424740.7			
Total	11272982458	261				

Source: **Field survey, 2017**

SUMMARY STATISTICS

Table 18: LSD FOR REVENUE AMONG DIFFERENT FARMING: Farming System

FARMING SYSTEM	MEAN	FALLOWING (M1) (394975.3)	CONTINUOUS CROPPING (M2) (560846.7)	CROP ROTATION (M3) (1408582)
FALLOWING (M1)	(394975)	0	165871.4^{NS}	1013606.7 ^{NS}
CONTINUOUS CROPPING (M2)	(560847)		0	847735.3 ^{NS}
CROP ROTATION (M3)	(1408582)			0

Source: Field survey, 2017
NS- Not Significant

Table 19: LSD FOR COST AMONG DIFFERENT FARMING: Farming System

FARMING SYSTEM	MEAN	FALLOWING (M1) (6772.74)	CONTINUOUS CROPPING (M2) (8200.5)	CROP ROTATION (M3) (12387.51)
FALLOWING (M1)	(6772.74)	0	1427.76^{NS}	5614.77**
CONTINUOUS CROPPING (M2)	(8200.5)		0	4187.1**
CROP ROTATION (M3)	(12387.51)			0

Source: Field survey, 2017
NS- Not Significant
****Significant at 5%**

Summary

This study examined the relationship between land use patterns and efficiency of crop production among settlers and non-settlers crop farmers in South-West Nigeria. Results showed that majority of the food crop farmers were in their active age, male, married, educated and were strictly crop farmers. The predominant farming system is continuous farming and mixed cropping is the most adopted cropping system. Maximum likelihood estimation (MLE) shows that seed cost had the highest production coefficient and was statistically significant at 1 percent level of significance. Results of the inefficiency analysis showed farming experience, settlement, education and state to have negative coefficients that were statistically significant at 5%, 1%, 10% and 5% level of significance respectively. Marital status was positively significant at 1% level of significance. Farmers in Ogun state were more efficient than their counterparts in Oyo State. The farmers had a mean efficiency of 0.80, indicating that in order for them to operate on the frontier, they have to overcome an inefficiency level of 20%.

This study reveals the impact of several cropping and farming systems on both the income of the farmers and their level of efficiency. The results also revealed that while there was significant difference between the means of cost of the cropping system, no significant difference existed between revenue generated from the different cropping system. It was also revealed from the result that among the various farming systems, there was no significant difference between the means of revenue generated from each farming system. There was a significant difference between the mean of cost of bush fallowing and crop rotation ($p < 0.05$). The results also revealed that there was a significant difference between the mean of cost of continuous cropping and crop

rotation ($p < 0.05$). There was no significant difference between the mean of cost of bush fallowing and continuous farming.

Conclusion

Attempts should be made by the government of these states (Ogun and Oyo) to reclaim lands that have been degraded and also to ensure proper distribution of lands for farming purposes. Laws binding land acquisition should be made flexible, so as to encourage farmers to expand their production and to reduce pressure on lands brought about by mixed farming and continuous cropping systems.

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INFLUENCE OF CATCHMENT SURFACE AND HARVESTING TIME ON QUALITY OF RAINWATER IN A PERI-URBAN SETTLEMENT

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Abstract

The study examines the effect that catchment surface and harvesting period had on quality of harvested rainwater. The study was carried out in Kotopo area of Abeokuta metropolis, Nigeria. There is the need to investigate the safety of harvested rainwater in that area because the inhabitants of the area depend on rainwater for drinking, cooking, washing and other domestic purposes. A 2 factor, 4 levels General factorial experimental design (GFD) was selected for the study using Design expert® 8.0 software. The first factor (Catchment surface) considered included Corrugated iron sheet, Aluminum sheet, Aluminum-zinc alloy sheet, and Control (open air) while the second factor (Period of collection) included the month of March, April, May and June. PH, electrical conductivity (EC), and total dissolved solids (TDS) was determined using (PH/EC/TDS) meter; while iron, zinc and Aluminum were determined using Atomic Absorption Spectrophotometer (AAS); chloride was also determined using argentometric method. Total coliform count (TCC) and total bacteria count (TBC) were also determined using multiple tube tests and plate count method respectively. The data obtained from the study was analyzed using design expert® 8.0 software for analysis of variance (ANOVA). The results from the study were compared with Standard Organization of Nigeria (SON), World Health Organization (WHO), European Union and Bureau of Indian stipulated standards of rainwater quality for domestic use. The average values of the analysis were: (6.87 pH, Chloride 29.00mg/l, Electrical conductivity 32.94µs/cm, total iron 0.016mg/l, total dissolve solids 3.33 mg/l, Zinc 0.19 mg/l, total coli form count 4593.75, and Aluminum 0.023mg/l). The total bacteria count was found to be Zero throughout the period of collection and on the entire catchment surface. This shows that the rainwater is free of bacterial throughout the period of collection and the rain is not acidic since the average pH of the sample is found to be close to neutral 6.87. With the exception of coli form count, which has no guideline from World Health Organization (WHO), Bureau of Indian Standard (BIS), the European Union (EU) standard, but only in Standard Organization of Nigeria (SON), the study showed that rainwater meant for domestic purposes is safe for harvesting throughout the period of collection using the stipulated catchment surfaces. Harvested rainwater is therefore, recommended for the domestic use of inhabitants of Kotopo area of Abeokuta metropolis to reduce indiscriminate drilling of boreholes in the metropolis which could cause earthquake and over abstraction of ground water with attendant negative consequences.

Key Words: Rainwater; Water quality; Catchment surface; Collection period

IJAFS 2018 (2). 8: 1141-1156
Accepted for publication
September 2018

Introduction

Water is an essential natural resources on the earth needed for life sustenance, and its demand is growing in most cities of Nigeria. It has long been suspected of being the source of much human illnesses (Clair *et al*., 2002). According to UNICEF estimates, globally no fewer than 1,400 under-five children die every day from diarrhea diseases linked to lack of safe water, adequate sanitation and hygiene (Godwin, H., 2014). Multi-indicator cluster survey published in 2013 by the National Bureau of Statistics of Nigeria showed that nearly 70 million Nigerians lacked access to safe water in 2011 thereby placing Nigeria as the third country globally with most people without access to safe water (Godwin, H., 2014). Water plays an important role in the world economy, it functions as a solvent of many chemical processes without which life will remain a mirage. Access to safe drinking water has improved steadily and substantially over the last decades in most part of the world (Fang and Ye., 2012; Lomborg and John, 2001).

However, it had been noted that some observers have estimated that by 2025 more than half of the world population will be facing water-based vulnerability (Fang and Ye., 2012) (Kulshreshtha, 1998; Balgovind, 2009). Report, according to Fang and Ye, (2012), suggests that by 2030 in some developing regions of the world, water demand will exceed supply by 50% (Fang and Ye., 2012). Lack of access to safe water is a threat to developing economies such as Nigeria, which loses around ₦455 billion – 1.3 per cent of its Gross Domestic Product (GDP) each year due to poor water, sanitation and hygiene and its effect (Alex, 2014).

In many countries, rainwater continues to be an important source of water in isolated home stead; farm collection and storage for agricultural uses, which had been widely practiced for thousands of years. In the last two decades, interest in rainwater has grown; its utilization is now an option along with more traditional water supply technologies particularly in rural areas (Gould and Nissen, 1999). It is of particular importance and relevance for arid and semi-arid remote and scattered human settlement. In Nigeria, there are no concerted efforts to adopt the use of rainwater harvesting technologies in order to augment supply. Being a tropical country, the nation is blessed with at least five months of rainfall in the south and four months in the northern part of the country.

The public taps are most of the time dry, making access to clean, and portable water very low. Rainwater harvesting is one of the important sources of water for domestic uses identified in the Nigerian National Water Policy (2004), but its implementation by government is non-existent. Nigeria government had the target of increasing water coverage by 75 per cent by 2015, records show that coverage of water have been on a steady decline from 37 per cent in 1990 to 31 percent in 2011(Alex, 2014). Millions of cubic meters of water that could be used to augment supply are allowed to runoff into streams, rivers etc., during the rainy season thereby causing floods and creating erosion hazards along its path. A percentage of this water can be harvested for domestic uses especially in areas with basement complex geological formations which has groundwater yield of < 2 l/min. Literatures reports that these crystalline igneous/metamorphic rock formation underlays over 60 % of the country's landscape (Eroarome, 2009). Communities in these areas are always perplexed by acute water scarcity for domestic purposes.

Rainwater harvesting has been practiced for centuries in Nigeria, but in many homes observed by the study its application is at a very low scale and hardly could one see a cistern for collection of rainwater that has a capacity beyond 1000 liters. It is common to see women and children collecting rainwater with buckets. In proposing a rainwater harvesting technology, to reduce indiscriminate drilling of boreholes in the metropolis, which could cause earthquake, and over abstraction of ground water with attendant negative consequences,

the quality of the harvested water is of grave importance, this is largely determined by the type of materials used as a catchment surface (Roof material). Several materials are used for roofing in South-west Nigeria which includes: Asbestos, Galvanized iron, Aluminum, concrete, Aluminum-Zinc alloy. These materials no doubt have some health implications as it must have certain impact on the quality of rainwater harvested from them as catchment surface (Carolina, *et al*., 2010). Asbestos for example has been confirmed to be carcinogenic hence the discontinuation of its use as a material for water pipes (Barrett *et al*., 1989; O'Reilly *et al*., 2007; Shinya, 2009; Kirt, 2011; ATSDR, 2014; WHO, 2014). Hence, the paper is to examine the effect that catchment surface and harvesting time (period of collection) has on the quality parameters of harvested rainwater using Kotopo area of Abeokuta as a case study.

Materials and Methods

The study was carried out in Abeokuta, Ogun State, Nigeria; a number of roofing materials available in the south-western part of Nigeria was purposefully selected, this is because the catchment surface is the most critical component of a rain water harvesting system. A 2 factor, 4 levels General factorial experimental design (GFD) was selected for the study using Design expert® 8.0 software. The first factor (Catchment surface) considered included corrugated iron sheet, Aluminum sheet, Aluminum-zinc alloy sheet, and Control (open air) while the second factor (Period of collection) included the month of March, April, May and June of year 2011; these months were selected because they are the most critical months of serious water scarcity and the onset of the wet season.

Water samples were collected using standard sample bottles (100ml) for laboratory analysis while sterile containers were used for microbiological examination, sample collection was done after the roof had been flushed by the rain for about 10 minutes; a total of 16 experiments and 144 chemical analyses were carried out to determine pH, electrical conductivity (EC), total dissolved solids (TDS) using (pH/EC/TDS) meter; while iron, zinc and Aluminum were determined using Atomic Absorption Spectrophotometer (AAS); chloride was also determined using argentometric method. Total coliform count (TCC) and Total Bacteria count (TBC) were also determined using multiple tube tests and plate count method respectively. The data obtained from the study was analyzed using design expert® 8.0 software for analysis of variance (ANOVA).

RESULTS AND DISCUSSION

The results of the Laboratory analysis are presented in Table 1.

Table 1: Result of laboratory analysis

FACTOR 1	FACTOR 2	1	2	3	4	5	6	7	8	9
Catchment surface	**Period of collection**	**pH**	**Chloride (mg/l)**	**E. C. (μs/cm)**	**T. D. S. (mg/l)**	**T. Iron (mg/l)**	**Aluminum (mg/l)**	**Zinc (mg/l)**	**B.C.**	**Coliform Count**
AL SHEET	MAR	6.63	6.00	31	16	0.0198	0.03	0.0101	NIL	4.5
G I SHEET	MAR	6.60	13.00	45	22	0.0133	0.01	1.2444	NIL	4
ALU-ZINC	MAR	6.45	10.00	33	16	0.016	0.04	0.1137	NIL	NIL
CONTROL	MAR	7.50	29.00	227	115	0.0175	0	0.0047	NIL	1.1
AL SHEET	APRIL	6.51	90.08	9	4	0.027	0.01	0.0119	NIL	8.8
G I SHEET	APRIL	6.68	90.53	12	6	0.019	0.02	0.8879	NIL	2.9
ALU-ZINC	APRIL	6.51	108.28	9	4	0.0127	0.02	0.1785	NIL	1.24
CONTROL	APRIL	6.86	42.6	39	19	0.0268	0.02	0.0275	NIL	2.96
AL SHEET	MAY	7.1	7	2	1	0.085	0.02	0.0104	NIL	1.1
G I SHEET	MAY	7.25	5	7	3	0.0151	0.02	0.2508	NIL	2.8
ALU-ZINC	MAY	7.03	6	3	1	0.0154	0.01	0.016	NIL	3.3
CONTROL	MAY	7.78	8	36	18	0.0147	0.03	-0.0158	NIL	600
AL SHEET	JUNE	6.7	7	11	5	0.0195	0.01	0.011	NIL	2800
G I SHEET	JUNE	6.66	6	10	5	0.0118	0.03	0.2044	NIL	1700
ALU-ZINC	JUNE	6.3	4	8	4	0.0122	0.04	0.177	NIL	1100
CONTROL	JUNE	7.3	3	45	22	0.012	0.04	0.0015	NIL	400

Source

The analyses of variance (ANOVA) for the parameters determined are presented in Tables 3- 10. The response of each parameter to catchment surfaces and period of collection are presented in figures 1-8 and the trend of each parameter in water samples from catchment surfaces are presented in figures 9-16.

The pH values of the sample on the entire catchment surface shows that there are no significance over the period of collection and the values ranges from 6.45-7.78 and a mean of 6.9 which is within the range of Standard Organization of Nigeria(SON), World Health Organization(WHO) and Bureau of Indian Standard (BIS) guidelines as shown in Table 2.

The electrical conductivity of the sample on the entire catchment surface shows that there are no significance over the period of collection and the values ranges from 2-227μs/cm and has a mean of 37.75μs/cm which is within the range of Standard Organization of Nigeria (SON), World Health Organization (WHO) and the European Union standard as shown in Table 2. The Zinc values of the sample on the entire catchment surface, and found to be very minimal in control, which shows that there is significance over the period of collection and the values ranges from -0.0067 to 1.2444 mg/l and a mean of 0.61 mg/l which is within the range of Standard Organization of Nigeria (SON), World Health Organization (WHO) and Bureau of Indian Standard (BIS) guide lines as shown in Table 2.

The Total Iron (T.I.) values of the sample on the entire catchment surface, and found to be very minimal in control, which shows that there is no significance over the period of collection and the values ranges from 0.0085-0.027 mg/l and a mean of 0.31 mg/l which is within the range of Standard Organization of Nigeria(SON), World Health Organization (WHO) and Bureau of Indian Standard (BIS) and the European Union (EU) guide lines as shown in Table 2. The Total Dissolve Solids (T.D.S.) values of the sample on the entire catchment surface, which shows that there is no significance over the period of collection and the values ranges from 1-115 mg/l and a mean of 2.07 mg/l which is within the range of Standard Organization of Nigeria (SON), Bureau of Indian Standard (BIS) and the European Union (EU) guide lines as shown in Table 2.

The Total Coli (T.C.) form count values of the sample on the entire catchment surface, which shows that there is no significance over the period of collection and the values ranges from 281.56-10968.44 and a mean of 5625. There are no guidelines concerning coli form by World Health Organization (WHO), Bureau of Indian Standard (BIS) and the European Union (EU) guidelines as shown in Table 2. It is however still within the range as stipulated by Standard Organization of Nigeria (SON).

The Chloride values of the sample on the entire catchment surface shows that there are no significance over the period of collection and the values ranges from 5-90mg/l and a mean of 37.5mg/l which is within the range of Standard Organization of Nigeria (SON), World Health Organization (WHO) and Bureau of Indian Standard (BIS) and the European Union guide lines as shown in Table 2. The Total Bacterial count was found to be nil in all the samples with respect to the period of collection and the catchment surfaces which also conform to the guide line given in Table 2, by the European Union, that 0 bacteria should be found in 100ml.This also shows that the rainwater samples are free of bacterial.

Table 2: Water Quality standard of Rain water for domestic use.

Parameters	Standard Organization of Nigeria	World Health Organization	European Union	Bureau of Indian Standard
PH	6.5-8.5	6.5-8.5	Not Mentioned	6.5-8.5
EC	1000μs/cm	250μs/cm	250μs/cm	Not mentioned
TDS	500mg/l	No guideline	500mg/l	200mg/l
Al	0.2 mg/l	0.2mg/l	o.2mg/l	No guideline
Fe	0.3 mg/l	0.3mg/l	0.2mg/l	1.0mg/l
Zn	3 mg/l	3mg/l	Not mentioned	15mg/l
Cl	250 mg/l	250mg/l	250mg/l	100mg/l
TBC	0 cfu/100ml	Not mentioned	0 cfu/100ml	No guideline
TCC	10 cfu/ml	No guideline	No guideline	No guideline

Source: SON (Nigerian Standard for Drinking -Water Quality (NSDQW), 2007); WHO (Guidelines for Drinking-water Quality, 3rd Edition, 2008); EU (European Union (Drinking Water) Regulations 2014, BIS (Indian Standard for Drinking water- Specification IS 10500:1991).

Table 3: Analysis Of Variance (ANOVA) for pH

Source	Sum Of Square	Degree Of Freedom	Mean Square	F- Value	P-Value
Model	0.000	0			Prob>f
Residual	2.63	15	11	0.18	
Total	2.63	15	11		

Source

Table 4: Analysis Of Variance (ANOVA) for Electrical conductivity

Source	Sum Of Square	Degree Of Freedom	Mean Square	F- Value	P-Value
Model	0.000	0			Prob>f
Residual	43740.94	15	2916.06	11	
Total	43740.94	15		11	

Source

Table 5: Analysis Of Variance (ANOVA) for Coli form count

Source	Sum Of Square	Degree Of Freedom	Mean Square	F- Value	P-Value
Model	0.000	0			Prob>f
Residual	8.321E+008	15			
Total	8.321E+008	15		5.548E+007	

Source

Table 6: Analysis Of Variance (ANOVA) for Total Dissolve Solids

Source	Sum Of Square	Degree Of Freedom	Mean Square	F- Value	P-Value
Model	0.000	0			Prob>f
Residual	11277.44	15	751.83		
Total	11277.44	15			

Source

Table 7: Analysis Of Variance (ANOVA) for Total Iron

Source	Sum Of Square	Degree Of Freedom	Mean Square	F- Value	P-Value
Model	0.000	0			Prob>f
Residual	3.978E-004	15	2.652E-005		
Total	3.978E-004	15			

Source

Table 8: Analysis Of Variance (ANOVA) for Zinc ANOVA

Source	Sum Of Square	Degree Of Freedom	Mean Square	F- Value	P-Value
Model	1.13	3	0.38	5.76	Prob>f
A-catchment	1.13	3	0.38	5.76	0.0112
Residual	0.79	12	0.066		0.0112
Total	1.92	15			

Source

Table 9: Analysis Of Variance (ANOVA) for Chloride

Source	Sum Of Square	Degree Of Freedom	Mean square	F-Value	P-Value
Model	16728.18	3	5576.06	24.80	< 0.0001
B-period of collection	16728.18	3	5576.06	24.80	< 0.01(significant)
Residual	2698.00	12	224.83		
Total	19426.18	15			

Source

Table 10: Analysis Of Variance (ANOVA) for Aluminum

Source	Sum Of Square	Degree Of Freedom	Mean Square	F- Value	P-Value
Model	0.000	0			Prob>f
Residual	2.244E-003	15	1.496E-004		
Total	2.244E-003	15			

Source

Table 11: Summary of Statistics for Rainwater Quality Parameters

Parameters	**Range**	**Mean**	**Standard deviation**	**Predicted r^2**
PH	6.64-7.09	6.87	0.42	-0.1378
Electrical Conductivity	4.16-61.71	32.94	54.00	-0.1378
Coli form count	624.85-8562.65	4593.75	7448.26	-0.1378
Total Iron	0.014-0.019	0.016	5.150E-003	-0.1378
Zinc	-0.0067-1.2444	0.19	0.28	0.2715(Significant)
Chloride	19.05-35.39	27.22	14.99	0.7531(Significant)
Total Dissolve Solids	1.70-30.92	16.31	27.42	-0.1378
Aluminum	0.015-0.028	0.022	0.012	-0.1378

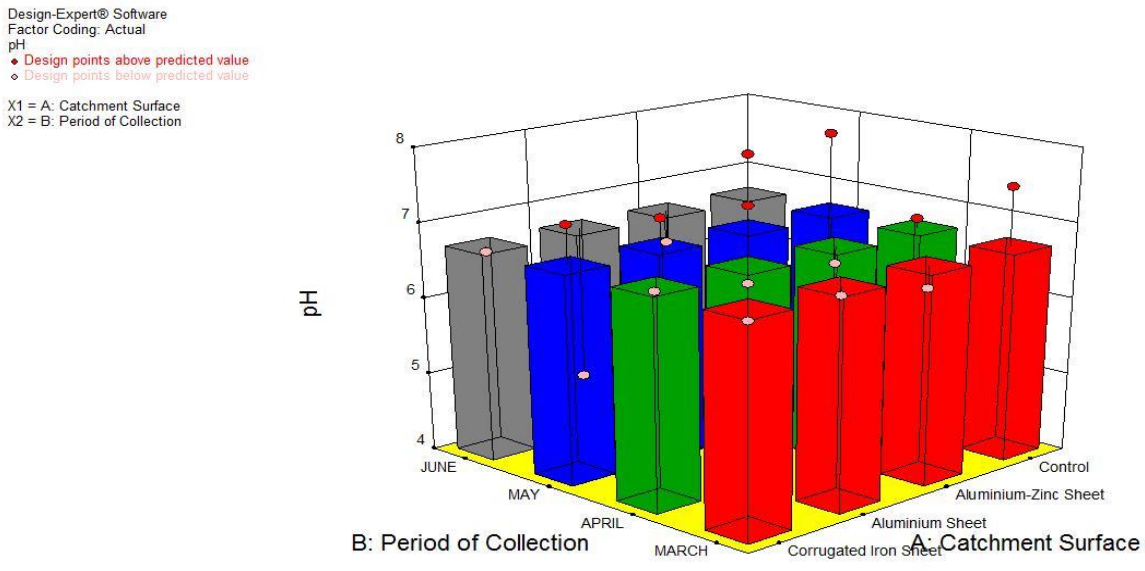

Figure 1: pH response to Catchment surface and period of collection

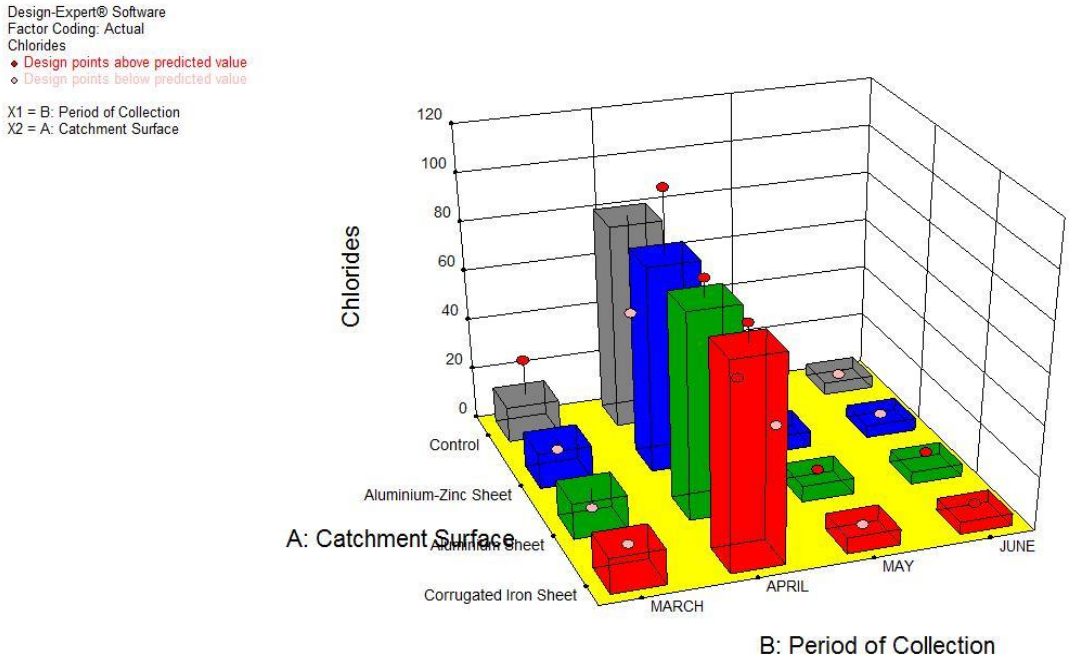

Figure 2: Chloride response to Catchment surface and period of collection

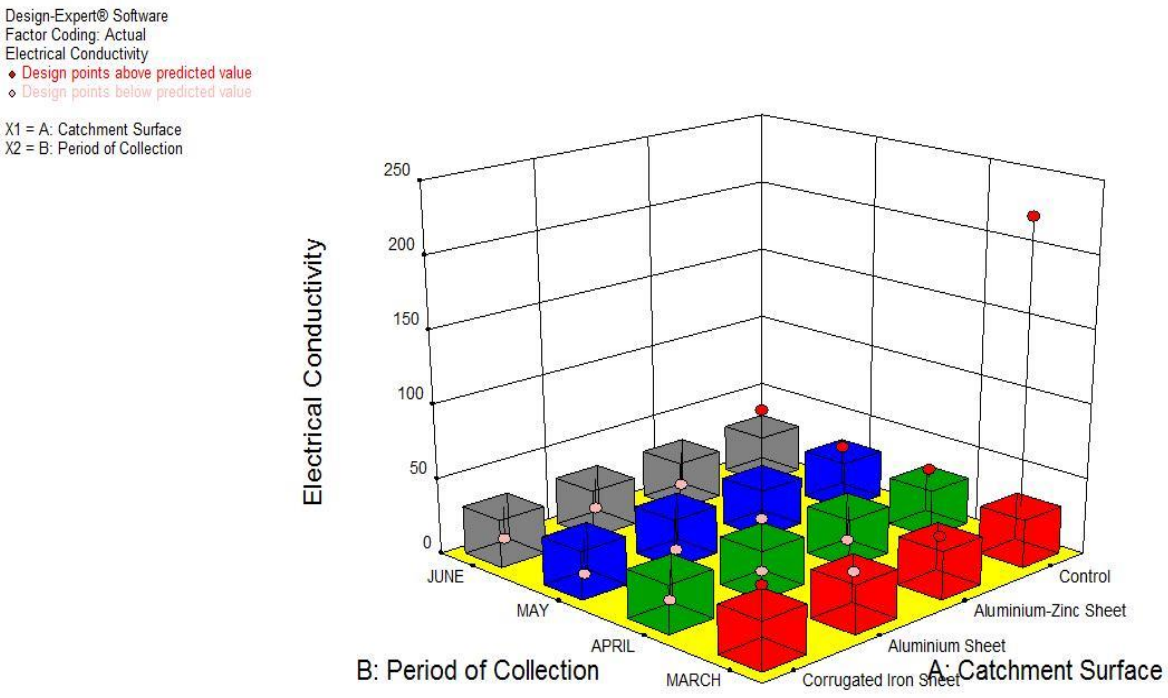

Figure 3: Electrical conductivity response to catchment surface and period of collection

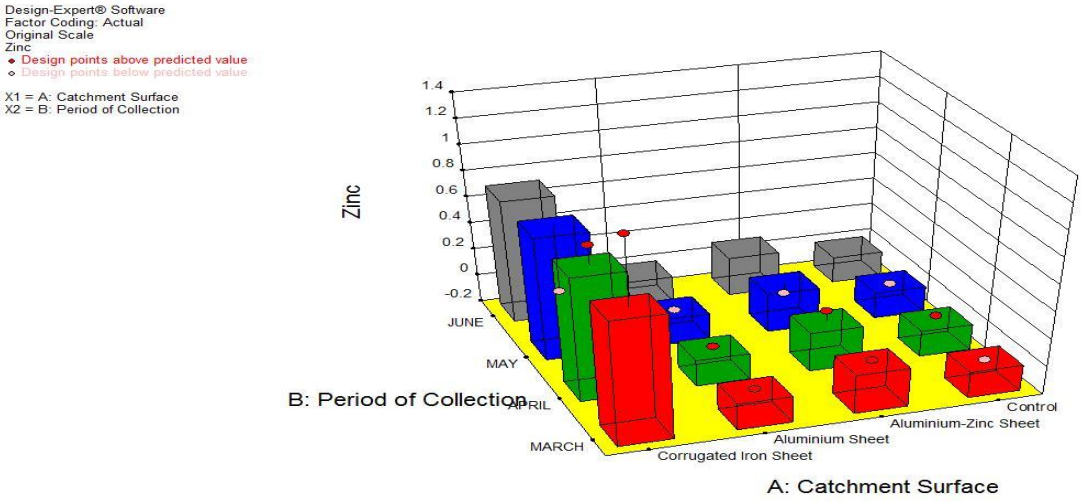

Figure 4: Zinc response to catchment surface and period of collection

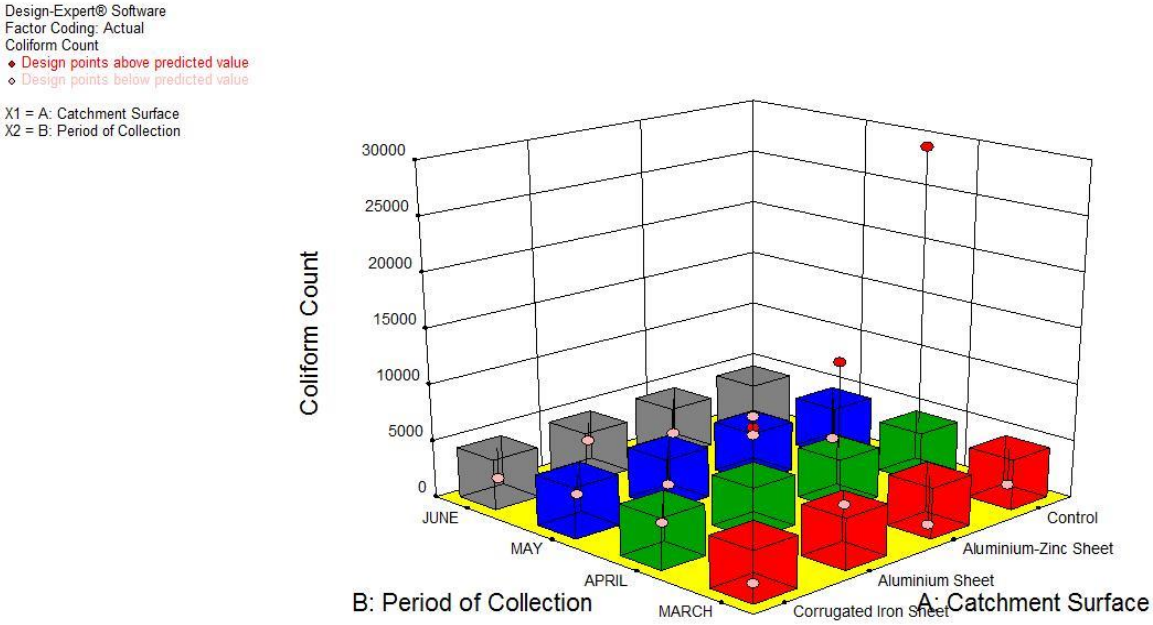

Figure 5: Coli form count response to catchment surface and period of collection

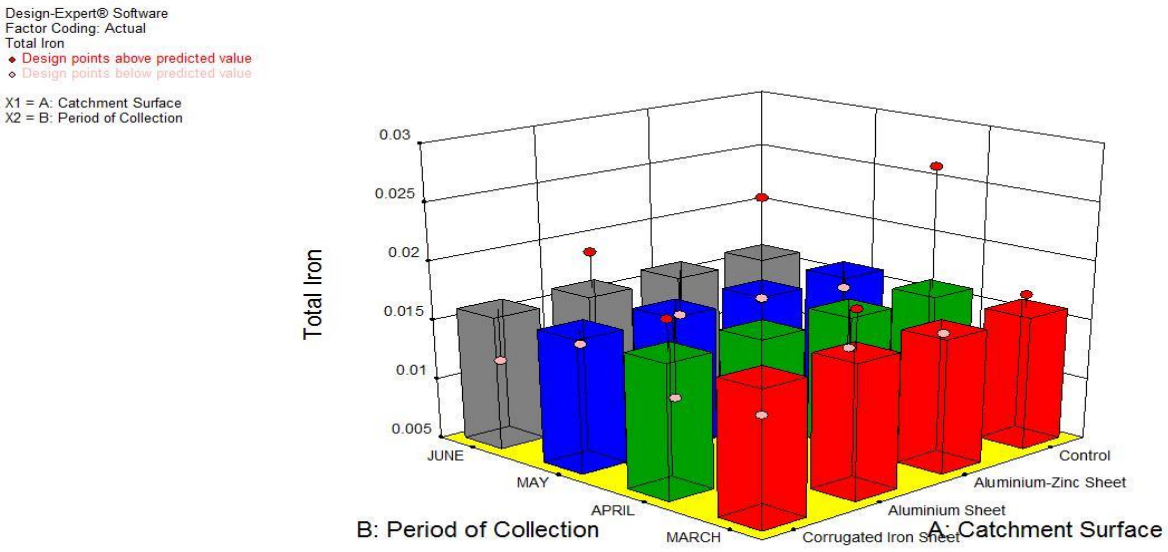

Figure 6: Total Iron response to catchment surface and period of collection.

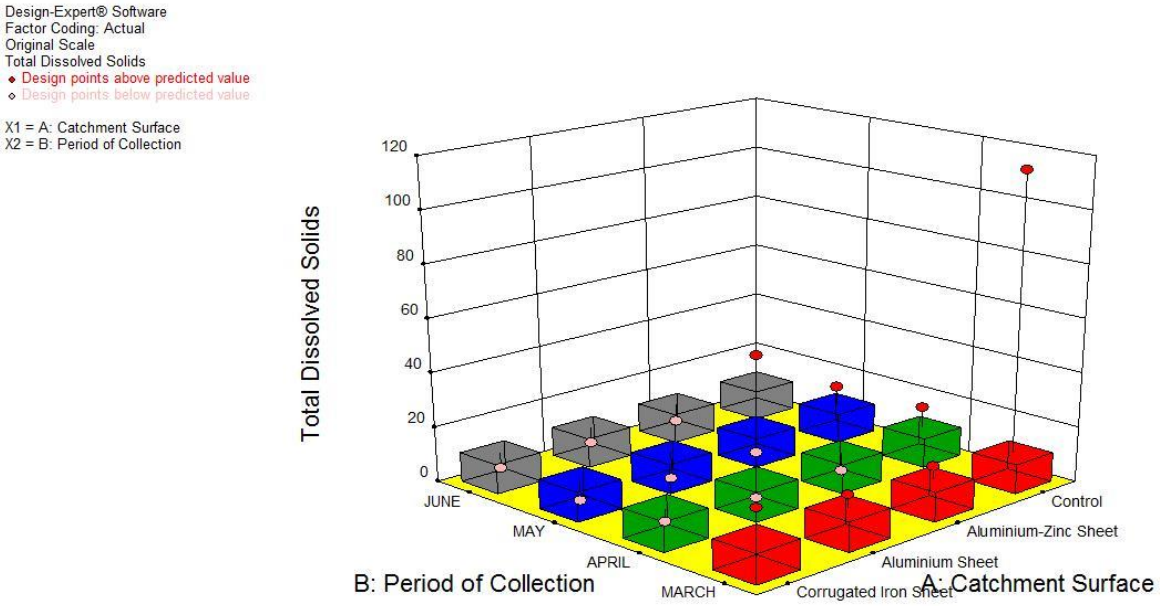

Figure 7: Total Dissolve Solids response to catchment surface and period of collection

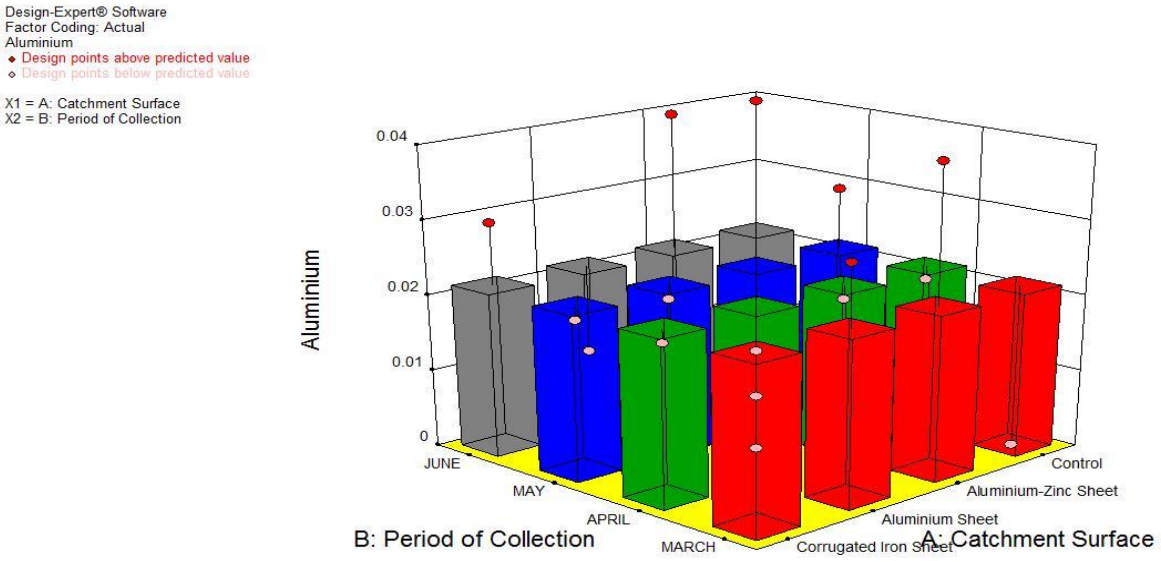

Figure 8: Aluminum response to catchment surface and period of collection

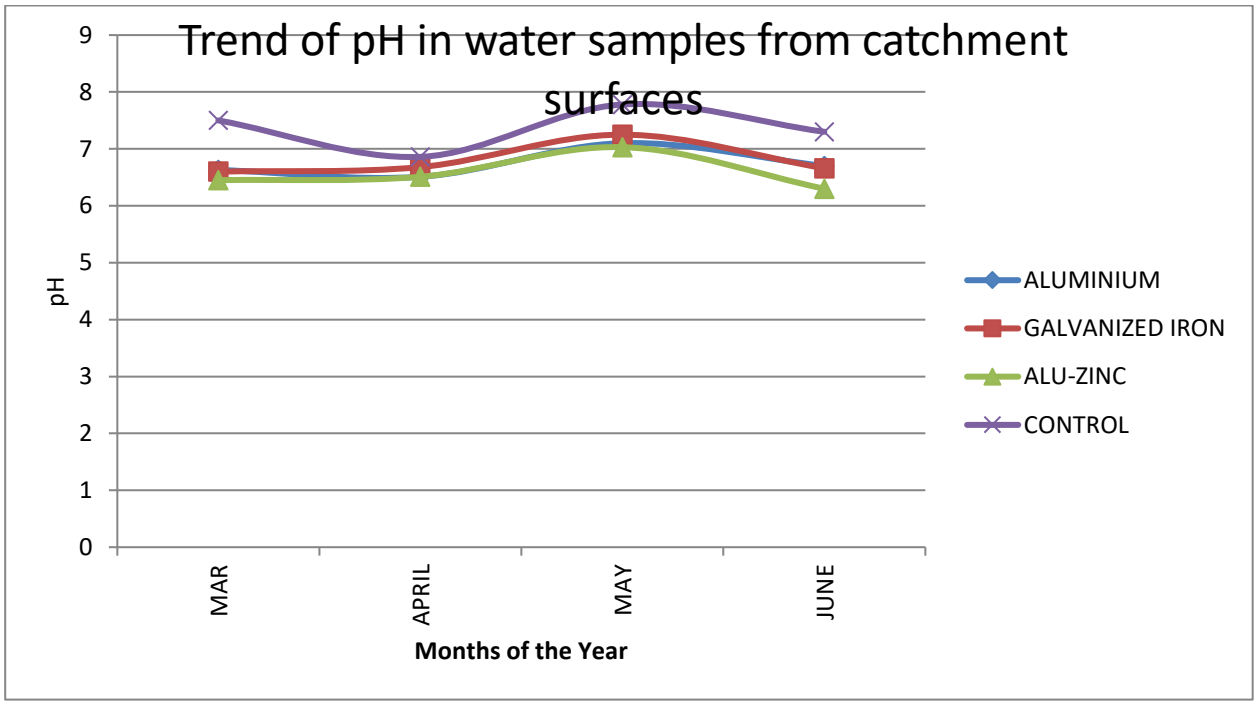

Figure 9: Trend of PH in water samples from catchment surfaces

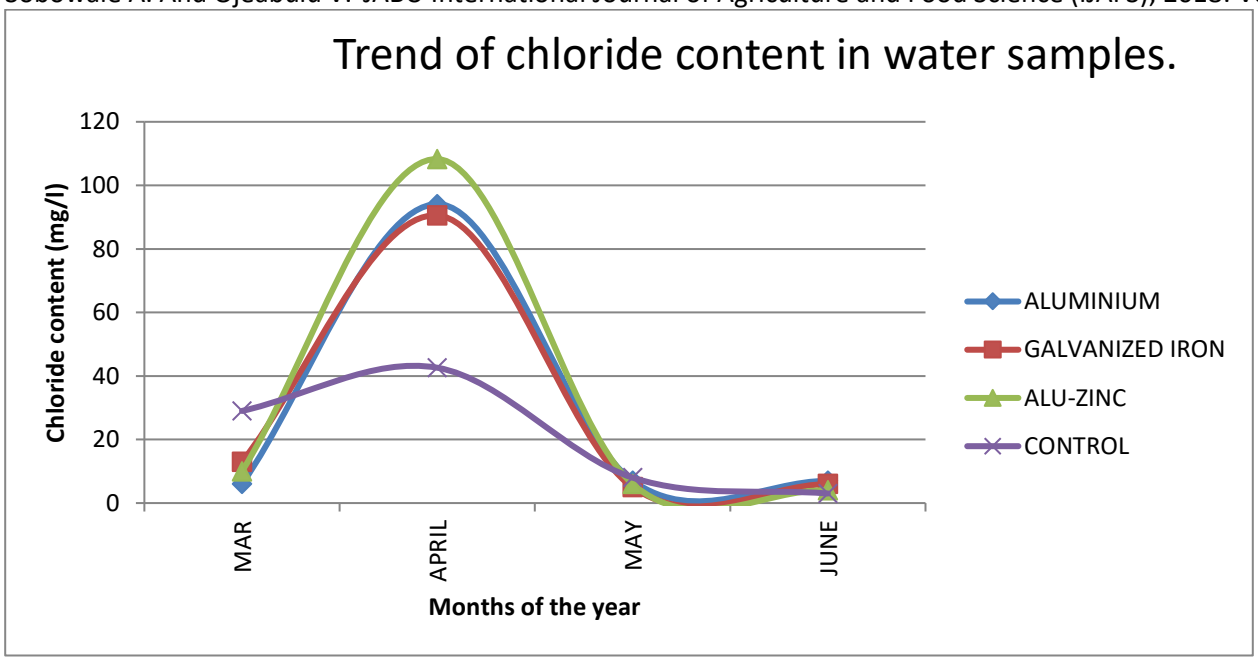

Figure 10: Trend of Chloride content in water samples from catchment surfaces

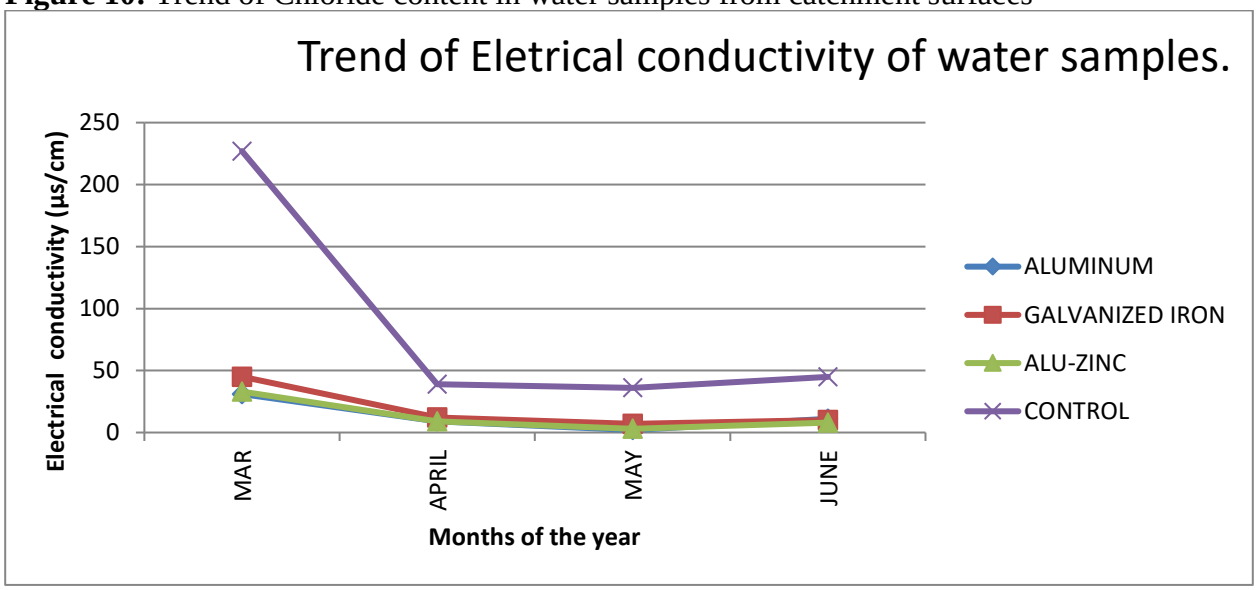

Figure 11: Trend of Electrical conductivity of water samples from catchment surfaces

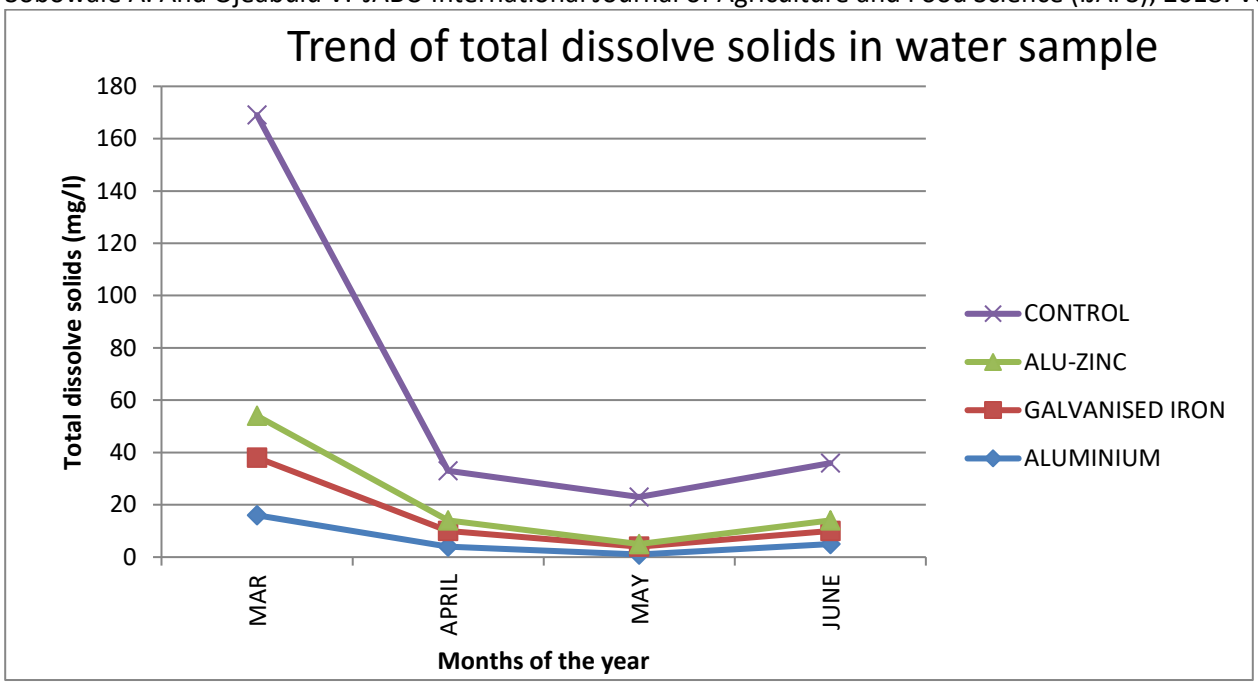

Figure 12: Trend of Total Dissolved Solids in water samples from catchment surfaces

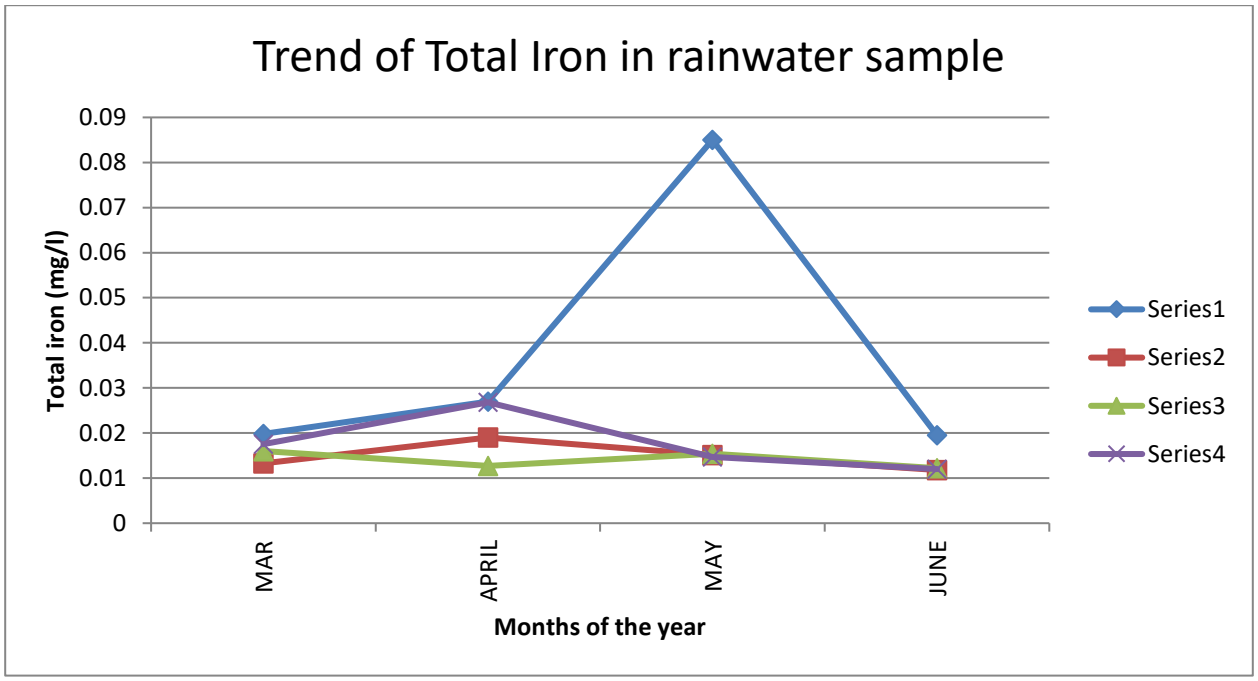

Figure 13: Trend of Total Iron in water samples from catchment surfaces

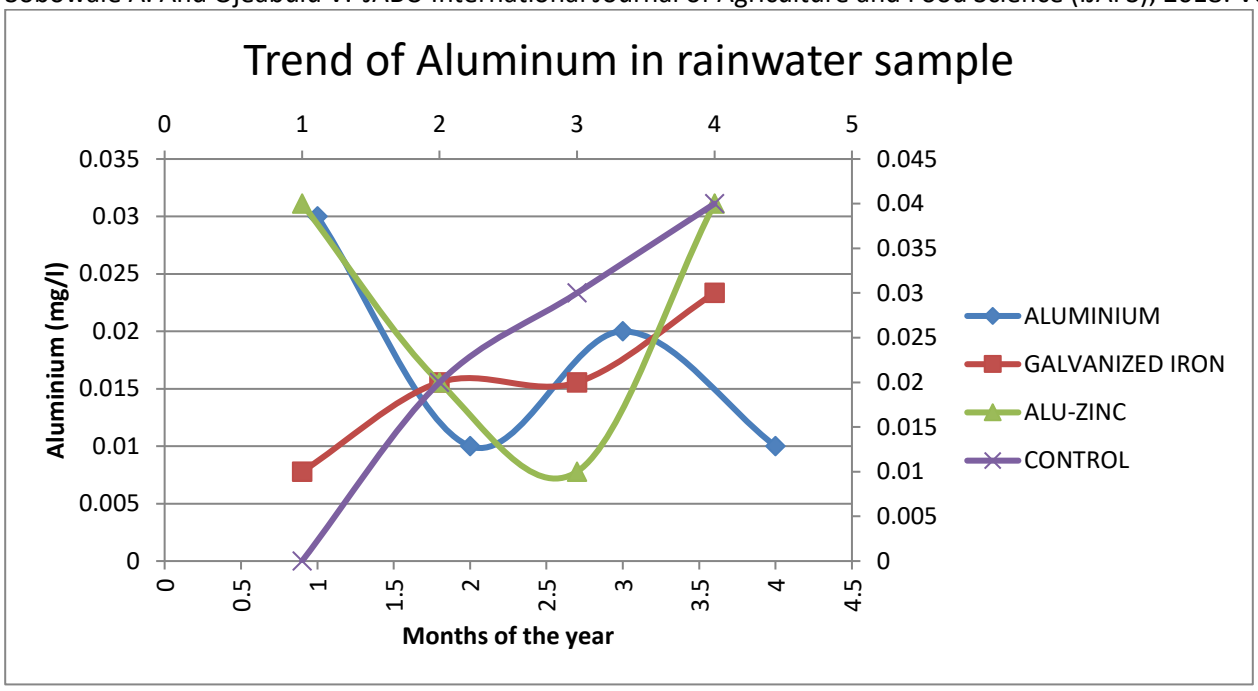

Figure 14: Trend of Aluminum in water samples from catchment surfaces

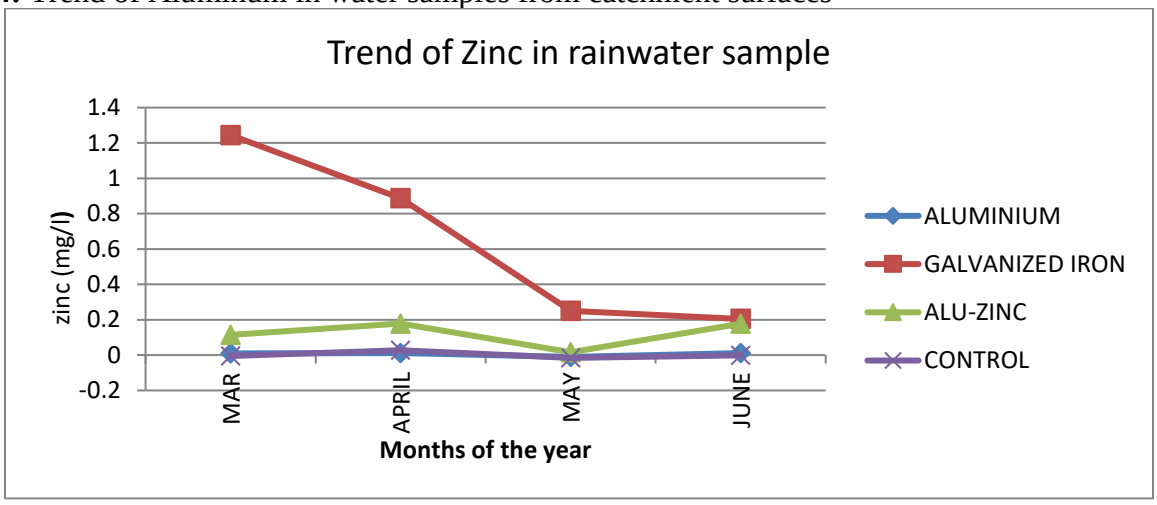

Figure 15: Trend of Zinc in water samples from catchment surfaces

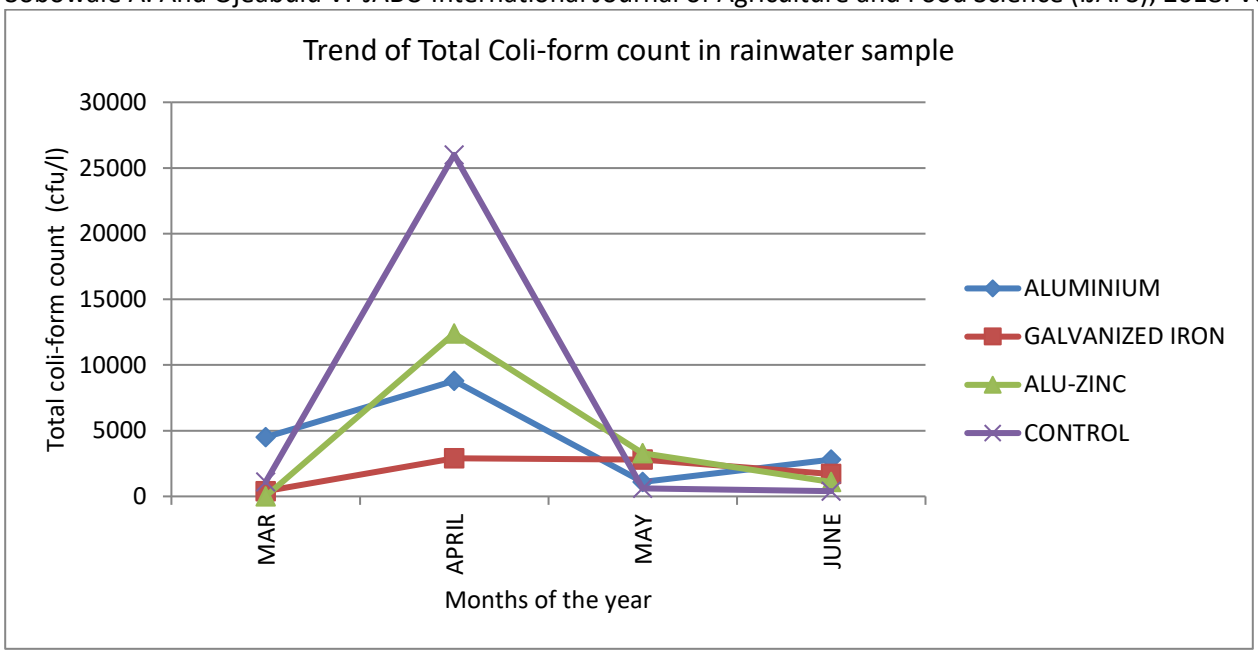

Figure 16: Trend of Total Coli-form count in water samples from catchment surfaces

Conclusion

Result obtained from the study indicates that, with the guideline from Standard Organization of Nigeria (SON), World Health Organization (WHO), Bureau of Indian Standard (BIS) and the European Union (EU), rainwater is safe for harvesting throughout the period of collection and the catchment surface in the area for domestic purpose. However, there is need for proper treatment for the Coli form count.

To meet up with the Government of Nigeria target of achieving 75% safe water coverage by 2020, capacities on appropriate choice of technology for rainwater harvesting should be strengthened especially technologies that do not rely on electricity. Harvested rainwater is therefore, recommended for the domestic use of inhabitants of Kotopo area of Abeokuta metropolis to reduce indiscriminate drilling of boreholes in the metropolis which could cause earthquake and over abstraction of ground water with attendant negative consequences.

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PRELIMINARY PHYTOCHEMICAL AND *IN VITRO* ANTIOXIDANT STUDIES ON METHANOL EXTRACT OF *VERNONIA CALVOANA* LEAVES AND ITS POLAR FRACTIONS

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Abstract

This study examines the possible in vitro antioxidant activities of the methanol extract of Vernonia calvoana leaves and its phytochemical constituents. Fresh leaves were collected, dried at room temperature and ground into powder with a laboratory mill. The powdered material was then de-fatted with petroleum ether and the dry marc, extracted in 80 % methanol for 72 h. The filtrate was dried in a rotary evaporator at 40°C. Fractionation of the crude methanol extract using gradedconcentrations (30, 40 and 50 %) of aqueous MeOH yielded F_1, F_2, F_3 and F_4 fractions. 1, 1-diphenyl-2-picrylhydrazyl radical (DPPH) and Ferric reducing/antioxidant power (FRAP) spectrophotometric methods were used to evaluate the in vitro antioxidant potentials of the crude and the polar fractions. In the DPPH assay, Fraction F_1 (F1) did not only exhibit the highest antioxidant potential compared to the crude and the rest of the fractions, its antioxidant activities were also consistently concentration dependent. FRAP assay was also revealed the high antioxidant capacity of F_1 with the highest value of 2.234 µM at 500 µg/ml relative to the crude and other fractions at this same concentration (crude=1.957; F_2 1.731; F_3 =1.245 and F_4 =1.025 µM). Flavonoids and saponins were detected in the crude extract; their derivatives may also be present as part of the readily soluble constituents of Vernonia leaf extract. Some of the components especially flavonoids, are known to possess high antioxidant potentials. This may be the reason behind the observed use of the plant leaves in different traditional therapies in Southern Nigeria.

Keywords:*Vernonia calvoana* leaves,antioxidant, phytochemical, 2,2-diphenyl-1-picrylhydrazyl (DPPH), ferric reducing antioxidant power (FRAP), IC_{50}

IJAFS 2018 (3). 8:1157-1166
Accepted for publication
September, 2018

Introduction

So many physiological defects, imbalances and pathologies are attributable to oxidative stress in living systems. Oxidative stress has been shown to be caused by free radicals, including the superoxide radical, hydroxyl radical (OH^-), hydrogen peroxide (H_2O_2), and lipid peroxides (Demidchik, 2015). These reactive oxygen species (ROS) are produced as a consequence of normal biochemical processes in the body but may be exacerbated under conditions of increased exposure to xenobiotics. There is a compelling need for novel antioxidants with high potencies to counter the hazards of ROS and to complement specific medical therapies. Fortunately, the plant kingdom offer valuable prospect in 'lead-finding' as a source of natural products and

new chemotherapeutic agents. The search for plant-derived medication has accelerated in recent years as ethnopharmacologists, botanists, microbiologists, and natural products chemists are greatly involved in exploring the universe for phytochemicals and ‘‘leads’’ which could be developed for treatment of numerous diseases (Nwaehujor *et al.*, 2013).

The genus, Vernonia has about one thousand species of forbs and shrubs in the family Asteraceae which include *V. calvoana, V. amygdalina* and *V. colorata.* These species are the most widely consumed leaf vegetables in West Africa. In Nigeria, *V. calvoana* is popular in Southern riverine (Niger delta) areas where the leaves, adorned for the sweet taste, are used as fresh vegetables in delicacies. The leaf is also component of traditional concoction used as an anthelmintic, antidiabetic and antidote to food poisoning. It was also employed as remedy for navel aches and constipation (Sobrinho *et al 2015*).
The present study evaluated the antioxidant properties of the methanol extract and the polar fractions of *V. calvoana* leaves.

Materials and methods

Source of Plant Material and identification

The leaves of *V. calvoana* were freshly harvested from a farm in Calabar municipal, Cross River State, Nigeria and were air-dried at room temperature. They were identified by Department of Botany, University of Calabar, Nigeria. A voucher specimen (UNICAL/BT/0125) was deposited in the herbarium of the department of Biochemistry, University of Calabar.

Extraction and fractionation of crude extract

The dried leaves were finely ground using a laboratory mill. A 300 g of the ground material was first de-fatted with petroleum ether and then macerated in 80 % aqueous methanol for 72 h. The filtrate was evaporated with a rotary evaporator at 40°C. The extract was loaded in a 3 cm x 50 cm column pre-loaded with silica gel Silica Gel 70-30 mesh, 60A (Sigma Aldrich, Germany)and pre-conditioned with methanol. The column was then successively eluted with 450 ml of 100 % MeOH (F_1), 300 ml of 70 % MeOH (F_2), 250 ml of 50% MeOH (F_3) and 250 ml 0f 20 % MeOH (F_4). The eluted fractions (F_1, F_2, F_3 and F_4) with different Rf values of 0.51, 0.43, 0.36 and 0.28 respectively in actone, chloroform, methanol (1:4:2) showing one spot on thin layer chromatography (TLC) were dried at 40 ^oC, weighed and used for further studies.

Acute toxicity test

Thirty (30) mature albino mice of both sexes (21-28 g) were randomly separated into 6 groups (1–6) of 5 mice per group. Groups 1–5 were dosed orally with varying doses (250, 500, 1000, and 2000 mg/kg) of the crude methanol leaf extract of *V. calvoana* respectively while group 6 was given an equivalent volume of distilled water (0.03 ml/10 g). The mice were allowed access to feed and water *ad libitum* for 72 h and observed for signs of toxicity and death.

Preliminary qualitative phytochemical analysis

The crude extract was subjected to phytochemical analysis as described by Bargah (2015). A 2 g of the crude extract was dissolved in distilled water to form 20 ml solution; this was screened for the presence of alkaloids, flavonoids, tannins, polyuronoids, saponins, terpenes, anthraquinones, carbohydrates and glycosides using standard methods.

Test for alkaloids

Mayer's test: 2 ml of the filtrate and control solution were pipetted into two separate test tubes. To the test tubes were added 3 drops of Mayer's reagent. The solutions were mixed and allowed to stand for 5 min and then observed for presence of precipitate and color change. Wagner's test: 2 ml of the filtrate and control solutions were pipetted into two separate test tubes. To the test tubes were added 3 drops of Wagner's reagent. The solutions were mixed and allowed to stand for 5 min and then observed for presence of precipitate and color change. Dragendorrf's test: 2 ml of the filtrate and control solutions were pipetted into two separate test tubes. To the test tubes were added 3 drops of Dragendorff's reagent. The solutions were mixed and allowed to stand for 5 min and then observed for presence of precipitate and color change.

Test for flavonoids

I. 2 ml of the filtrate and control solutions were pipetted into two separate test tubes. To the test tubes were added 3 drops of NaOH. The mixtures were allowed to stand for 2 min and then observed for presence of precipitate and color change.

II. 2 ml of the filtrate and control solutions were pipetted into two separate test tubes. To the test tubes were added 3 drops of NaOH and 3 drops of 0.5 N HCl. The mixtures were observed for presence of precipitate and color change.

Test for tannins

i. 2 ml of the filtrate and control solution were pipetted into two separate test tubes. To the test tubes were added 3 drops of 10 % ferric chloride. The mixtures were observed for presence of precipitate and color change.

ii. 2 ml of the filtrate and control solution were pipetted into two separate test tubes. To the test tubes were added 3 drops of 10 % lead acetate. The mixtures were observed for presence of precipitate and color change.

Test for polyuronoids

5 ml of ethanol and control solutions were pipetted into separate test tubes. 1 ml of filtrate was added drop-wise into the test tubes. The mixtures were observed for presence of precipitate and color change

Test for saponins

Emulsifying test: 2 ml of the filtrate and control solution were pipetted into two separate test tubes. To the test tubes were added 3 drops olive oil and the mixture shaken vigorously. The mixtures were observed for presence of brown emulsion. Frothing test: 1 ml of the filtrate and control solution were pipetted into two separate test tubes. To the test tubes were added 4 ml distilled water. The mixture was shaken vigorously and then observed for presence of frothing.

Test for terpenes

A given mass (0.1 g) of the crude extract was dissolved in 10 ml concentrated chloroform. The solution was filtered and used for this test.

i. To 1 ml of filtrate and control solutions in separate test tubes were added 1 ml acetic anhydride. The solutions were mixed thoroughly with a glass rod. The test tubes were then placed in a slanting positions and 1 ml H_2SO_4 was added by the side of each test tube into the mixture. The junction of the two liquid layers was observed for presence of color change.

Test for anthraquinone

A given mass (0.1 g) of the crude extract was dissolved in 10 ml concentrated chloroform. The solution was filtered and used for this test.

i. To 5 ml of filtrate and control solution in separate test tubes was added 5 ml ammonia solution. The mixtures were shaken vigorously. The mixtures were observed for presence of precipitate and color change.

Test for carbohydrates

0.1 g of the crude extract was mixed with 4 ml distilled water. The mixture was boiled for 3 min in a water bath and filtered. The filtrate was used for the following tests

i. Test for reducing sugar: To 2 ml of filtrate and control solutions in separate test tubes were added 3 drops of Molisch reagent. The mixtures were observed for presence of precipitate and color change.

ii. Test for starch: To 2 ml of filtrate and control solutions in separate test tubes were added 3 drops of 2 % iodine solution. The solutions were mixed thoroughly and boiled in a water bath for 2 min. The mixtures were observed for presence of precipitate and color change.

Test for glycoside

To 2 ml of filtrate and control solutions in separate test tubes were added 2 ml of Fehlings I and Fehlings II solutions. The solutions were mixed thoroughly and boiled in a water bath for 2 min. The mixture was observed for presence of precipitate and color change.

In vitro antioxidant analysis

The crude methanol extract of *V. calvoana*, the fractions (F_1, F_2, F_3 and F_4) fractions and reference antioxidants (ascorbic acid, butylated hydroxytoluene, catechin and gallic acid) were evaluated with different *in vitro* anti-oxidant assays. Test Samples (800 µg) were individually dissolved in 1 ml methanol and further reduced by serial dilution to 400 µg/ml, 200 µg/ml, 100 µg/ml and 50 µg/ml. Each test was performed in triplicates.

Evaluation of antioxidant capacity using the 1, 1-diphenyl-2-picrylhydrazyl radical (DPPH) spectrophotometric assay

The free radical scavenging activity of extracts was analyzed by the DPPH assay following a standard method (Boligon *et al., 2014*). A given volume (2 ml) of the extract at varying concentrations (10-500 µg/ml) was mixed with 1 ml of 0.5 mM DPPH (in methanol) in a cuvette. The absorbance at 517 nm was taken after 30 min of incubation in the dark at room temperature. The percentage antioxidant activity was calculated as follows:

% Antioxidant Activity [AA] = 100 – [{(Abs sample – Abs blank) X 100}/Abs control].

Methanol (1.0 ml) plus 2.0 ml of the extract was used as the blank while 1.0 ml of the 0.5 mM DPPH solution plus 2.0 ml of methanol was used as the negative control. Ascorbic acid was employed as reference standard.

Ferric reducing/antioxidant power (FRAP) assay

The total antioxidant potential of sample was determined using a ferric reducing ability of plasma (FRAP) assay (Kaushik *et al 2012*) as a measure of "antioxidant power". FRAP assay measures the change in absorbance at 593 nm owing to the formation of a blue colored Fe^{II}-tripyridyltriazine compound from colorless oxidized Fe^{III} form by the action of electron donating antioxidants. Standard curve was prepared using different concentrations (100-1000 µmol/L) of $FeSO_4 \times 7H_2O$. All solutions were used on the day of preparation. In the FRAP assay, the antioxidant efficiency of the extracts under the test was calculated with reference to the reaction signal given by an Fe^{2+} solution of known concentration, this representing a one-electron exchange reaction. Ascorbic acid was measured within 1 h after preparation. The sample to be analyzed was first adequately diluted to fit within the linearity range. All determinations were performed in triplicates.

Calculations were made by a calibration curve. FRAP value of sample (µM) =
changes in absorbance from 0-4 min x FRAP value of std (1000 µM)
changes in absorbance of std 0 min-4 min

Hydrogen peroxide scavenging assay

The method described by Bokhari *et al. 2013* was followed to investigate hydrogen peroxide scavenging capacity of the test samples. Hydrogen peroxide (2 mM) solution was prepared in phosphate buffer (50 mM, pH 7.4). Samples (100 µl) were pipetted into flasks and their volumes made up to 400 µl with 50 mM phosphate buffer (pH 7.4). H_2O_2 solution (600 µl) was added and absorbance at 230 nm was taken 10 min after vortexing the flasks. Percent scavenging activity was determined by following formula:

H_2O_2 % scavenging activity = (1- absorbance of sample) x 100
absorbance of control

Ascorbic acid was used as the standard antioxidant.

Hydroxyl radical scavenging assay

This was performed on test samples according to the method adopted by Saumya and Mahaboob (2010). The reaction mixture comprised of 2-deoxyribose (2.8 mM, 500 µl) in 50 mM of phosphate buffer, 100 µl of 0.2 M hydrogen peroxide solution, 200 µl of 0.1M ferric chloride, 0.1M EDTA and 100 µl of test sample. The reaction was initiated by the addition of 100 µl of ascorbate (0.3M). The mixture was incubated at 37 °C for 60 min. TCA (2.8% w/v, 1 ml) and 1 ml of thiobarbituric acid (TBA) solution in 50 mM of sodium hydroxide (1%; w/v) was added. This reaction mixture was heated for 15 min in boiling water bath and then allowed to cool. Absorbance was recorded at 532 nm.

Hydroxyl scavenging activity (%) =1-(Absorbance of sample ×100)
Absorbance of control

ABTS radical cation scavenging activity

The method (Zampini *et al 2010*) was carried out with slight modification for ABTS: 2, 2 azobis, 3 ethylbenzothiozoline-6-sulphonic acid radical cation scavenging activity. ABTS (7 mM) solution was reacted with 2.45 mM potassium persulfate and kept overnight in dark for generation of dark colored ABTS radicals. For the assay, the solution was diluted with 50 % ethanol for an initial absorbance of 0.7 at 745 nm. Activity was determined by adding 100 µl sample of different dilution with 1 ml of ABTS solution in glass cuvette. Decrease in absorbance was measured after one min and 6 min of mixing. The difference was calculated and compared with control. Percent inhibition was calculated by formula:
% ABTS scavenging effect = (control absorbance - sample absorbance) X 100
control absorbance

β-Carotene bleaching assay

Mueller and Boehm (2011) modified method was used for β-carotene bleaching assay. β- carotene (2 mg) was dissolved in 10 ml of chloroform and blended with 20 mg of linoleic acid and 200 mg of Tween 20 followed by removal of chloroform under nitrogen with subsequent addition of 50 ml of distilled water with vigorous shacking to prepare β-carotene linoleate emulsion. An aliquot of each sample (50 µl) was mixed with 1ml of the emulsion, vortexed and absorbance was determined at 470 nm immediately against the blank solution. Capped tube was then kept in a water bath at 45 °C for 2 h and the difference between the initial readings is

calculated by measuring the reading after 2 h. β-Carotene bleaching inhibition was estimated by the following equation:

$$\% \text{ bleaching inhibition} = \frac{(A_{ot} - A_{120t})}{A_{oc} - A_{120}} \times 100$$

Superoxide anion radical scavenging assay

Riboflavin light NBT system assay was followed for superoxide radical scavenging activity as described by Masuoka *et al* (*2016*). The reaction mixture containing 0.5 ml of phosphate buffer (50 mM, pH 7.6), 0.3 ml riboflavin (50 mM), 0.25 ml PMS (20 mM), and 0.1 ml NBT (0.5 mM), prior to the addition of 1 ml sample in methanol. Florescent lamp was used for starting the reaction. Absorbance was recorded at 560 nm after incubation for 20 min under light. The percent inhibition of superoxide anion generation was calculated using the following formula:

% Percent scavenging activity = (1- Absorbance of sample /Absorbance of control) ×100

Phosphomolybdate (Anti-lipid) assay for Total antioxidant capacity

The total antioxidant potency of test compounds was investigated by phosphomolybdate method (Shabbir *et al 2013*). An aliquot of 0.1 ml of different concentrations (800, 400, 200, 100 and 50 µg/ml) of each sample was added to 1 ml of reagent (0.6 M H_2SO_4, 0.028 M sodium phosphate, 0.004 M ammonium molybdate) and incubated for 90 min at 95°C in a water bath. Absorbance was recorded at 765 nm after the samples cooled to room temperature. Ascorbic acid served as standard.

Statistical analysis

All data were expressed as mean±SEM and subjected to one-way analysis of variance followed by post-hoc multiple-comparison Dunnett's test using the SPSS software to determine the level of significance between "test" and "control" group data means. Values of $p<0.05$ was considered significant.

Results

Acute toxicity studies

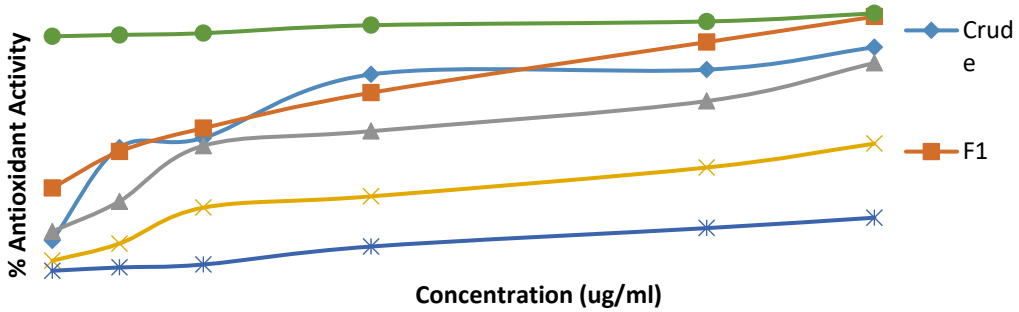
No mortality or overt clinical manifestation detected in mice within 72 h observation period following oral administration of the crude extract up to a dose of 2000 mg/kg.

Phytochemical analysis

Phytochemical analysis of the crude methanol extract showed the presence of alkaloids ++, flavonoids ++++, tannins +, phenols +++, steroids +, saponins +++, terpenes +, anthraquinones ++, carbohydrates++ and glycosides ++.

Antioxidant capacity using the 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical spectrophotometric analysis

Fraction F_1 and the crude displayed an almost equipotency with ascorbic acid at the maximal test concentration of 500 µg/ml. F_1 had 81.40 % relative to 72.37% for the crude while ascorbic acid produced 82.37 % antioxidant activity. The rest of the fractions however had comparatively reduced antioxidant values with 67.73 % for F_2, 44% for F_3 and 22.17% for F_4 at the same concentration (500 µg/ml) (Fig. 1).

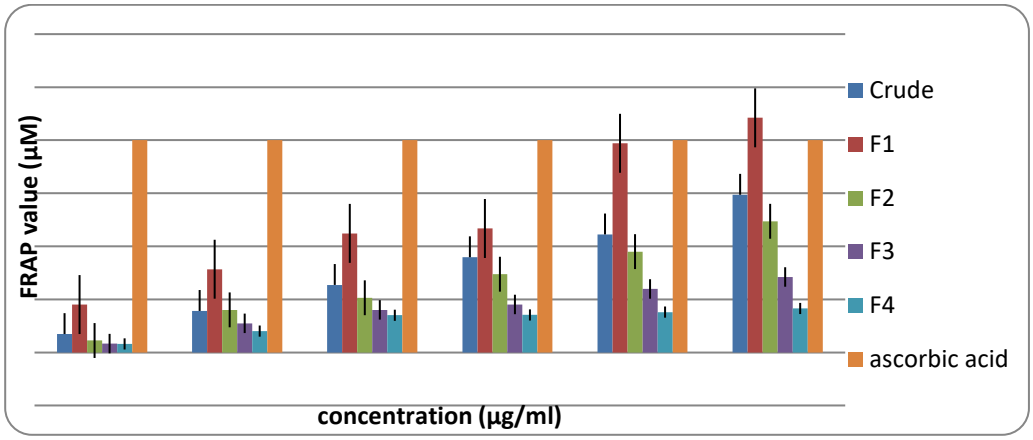


* F < 0.05 significantly different from reference compound (Ascorbic acid)

Figure 1: Antioxidant activities of the crude methanol extract of *Vernonia calvaona* leaves and polar fractions with DPPH assay

Ferric Reducing/Antioxidant Power Assay (FRAP)

In the FRAP assay, F_1 was consistent in producing the highest antioxidant value of 2.234 µM at 500 µg/ml. The crude and the rest of the fractions exhibited appreciable but reduced antioxidant power compared to ascorbic acid at the maximal test concentration of 500 µg/ml. The crude extract had 1.957 µM but F_2, F_3 and F_4 gave 1.731, 1.245 and 1.025 µM values in antioxidant power respectively. Ascorbic acid is known to have a FRAP value of 2 at varying concentrations (Fig. 2).



* P < 0.05 significantly different from reference compound (Ascorbic acid). FRAP value of ascorbic acid between 10 – 1000 µg/ml = 2.000

Figure 2: Antioxidant activities of methanol leaf extract of *V. calvoana* and its fractions using the FRAP method

Hydrogen peroxide scavenging assay

F_1 was most effective among the crude and other polar fractions from *V. calvoana* leaves in scavenging hydrogen peroxide radicals but its potency to do this was halved that of ascorbic acid. F_1 had a value of 119.00IC_{50} µg/ml compared to 53.00 IC_{50} (µg/ml) for ascorbic acid. F_2 displayed a minimal H_2O_2 scavenging activity, less than double the effect of ascorbic acid with IC_{50} µg/ml of 146.67±1.45. The crude extract, F3 and F4 had no significant ($p<0.05$) scavenging effect on hydrogen peroxide (Table 1).

Hydroxyl radical scavenging assay

F_1 and F_2 were also the most effective at neutralizing hydroxyl radicals among the crude and the rest of the fractions but their efficacies were comparatively lower than that of ascorbic acid. The IC_{50} (µg/ml) for F_1, F_2 and ascorbic acid was 133.67±0.67, 173.00±1.00 and 105.00 respectively (Table 1).

ABTS radical cation scavenging activity

In ABTS assay, it was only F_1, that exhibited significant ($p<0.05$) radical cations scavenging capacity among the test samples but it demonstrated with a twice reduced potency compared to ascorbic acid as revealed in the inhibitory concentrations (IC_{50} F_1 =111.00±2.31 while IC_{50} ascorbic acid=51.00) (Table 1).

Anti-lipid assay

F_1 was the only test sample that inhibited lipid peroxidation but with a value less than twice that of ascorbic acid. The crude extract and the rest of the polar fractions had no significant ($p>0.05$) effect (Table 1).

β-Carotene bleaching assay

The crude extract and all the isolated fractions did not induce inhibition of β-carotene bleaching activity.

Superoxide anion radical scavenging assay

Ascorbic acid had more than double effect compared to F_1, but more than triple effect relative to F_2 in superoxide radical scavenging activity IC_{50} F_1 =96.67±3.76; IC_{50} F_2 = 123.67±1.33 while IC_{50} ascorbic acid=37.00) (Table 1).

Table 1: IC_{50} values of the crude extract and polar fractions of *V. calvoana* leaves different antioxidant assays

Activity	IC_{50} (µg/ml) Crude	F_1	F_2	F_3	F_4	Ascorbic acid
H_2O_2	320.33±2.33*	119.00±0.00	146.67±1.45	178.00±0.00*	489.00±1.53*	53.00±0.00
Hydroxyl	254.33±2.96*	133.67±0.67	173.00±1.00	211.67±2.03*	479.00±1.00*	105.00±0.00
ABTS	240.67±1.33*	111.00±2.31	181.33±1.20*	223.00±1.73*	258.67±2.03*	51.00±0.00
Anti-lipid	212.00±1.53*	98.33±1.76	142.00±1.15*	201.67±2.40*	278.33±8.19*	34.00±0.00
B-carotene	239.00±1.00*	118.33±1.33*	156.00±1.53*	182.33±1.45*	281.67±2.91*	30.00±0.00
Superoxide	152.33±1.33*	96.67±3.76	123.67±1.33	178.33±1.33*	207.00±3.21*	37.00±0.00

Source: Laboratory Analysis

Values are expressed as mean±SD (N=3); Mean denoted*in a row vary significantly ($p<0.05$) from that of ascorbic acid.

Discussion

Oxidative damage at cellular level denatures proteins affecting their functions as biological catalysts and signaling components, carbohydrates by changing their structural conformation and lipids via lipid peroxidation. Cell membranes are made up of a high proportion of phospholipids which are initial targets for invading micro-organisms, chemical toxicants, and radiation which are harmful to tissues under lethal exposure. Potentially harmful reactive oxygen species (ROS) are also produced as a consequence of normal aerobic respiration (Aristidis *et al 2012*). These free radicals are usually removed or inactivated *in vivo* by a team of antioxidants (Gabriele *et al 2017*). Individual members of the antioxidant defense team are mobilized to prevent generation of ROS, to destroy potential oxidants, and to scavenge ROS. Thus oxidative stress-induced tissue damage is minimized. However, an absolute or relative deficiency of antioxidant defense may lead to a situation of oxidative stress, and this may give rise to or complicate a variety of pathologies including heart ailments and cancer (Gutteridge, 1994). Thus, there is increasing interest in antioxidants, particularly in

those intended to prevent the deleterious effects of free radicals in the body, and to prevent the deterioration of fats and other constituents of foodstuffs.

Antioxidants are known to be intermediates between chemical reactions and biological activities. They do not completely get rid of free radicals in the body but retard or minimize the damage caused and also block processes of oxidation by neutralizing free radicals thereby becoming oxidized themselves (Nwaehujor *et al.*, 2013). Endogenous antioxidants prevent oxidation by reducing the rate of chain initiation. Antioxidants are considered useful in preservation of foods, beverages, raw materials and parts of formulations for different drugs. Antioxidants consist of vitamins, polyphenols, flavonoids, minerals and endogenous enzymes such as superoxide dismutase, catalase and glutathione peroxidase that have the capability to neutralize unstable molecules (Trouillas *et al.*, 2003).

The results of DPPH assay showed that the crude extract of *V. calvoana* leaves had a high antioxidant activity of 72.37% at 500 µg/ml but fraction (F_1) exerted an almost comparable antioxidant activity to that of the standard, ascorbic acid at 500 µg/ml; F_1 had 81.40 % while ascorbic acid produced 82.37 % (Fig.1). The high percentage inhibition of free radicals by the crude extract and the component polar fractions was indicated in the significant reduction of colour of DPPH reagent from purple to yellow in the assay. A high antioxidant activity is significant in free radical scavenging activity of extracts. FRAP assay also collaborated the high antioxidant potential of F_1 in having the highest value of 2.34 µM at 500 µg/mlrelative to other fractions and ascorbic acid (Fig. 2). Ascorbic has a known FRAP value of 2.0 at different concentrations (Henkler *et al.*, *2010*). F_1,among other fractions was most effective in scavenging hydrogenperoxide radicals and radical cations but at a reduced (half) potency compared to ascorbic acid. The fraction (F_1) also inhibited lipid peroxidation with half efficacy of ascorbic acid. Fraction F_2 (F2) on the other hand, was only able to show appreciable antioxidant activity in scavenging free hydroxyl radicals, hydrogen peroxides and superoxide radicals but at reduced potencies compared to either F_1 or ascorbic acid. It was ineffective against lipid peroxidation and radical cations scavenging. The rest of the fractions (F_3 and F_4) exhibited negligible antioxidant activities as seen in Figures 1 and 2 as well as in Table 1. The test extract and its polar fractions did not confer inhibition of β-carotene bleaching activity.

Phytochemical analysis revealed the presence of alkaloids, flavonoids, tannins, phenols, saponins, terpenes, anthraquinones and carbohydrates in the crude methanol extract of *V. calvoana* leaves. Flavonoids are valuable dietary supplements duehigh antioxidant properties (Igile *et al.*, 2013). Luteolin, a flavonoid is reported to possess high antioxidant activity, measured in Trolox test, is twice stronger than vitamin E (*Lakovleva et al.*, *2015*). Further studies are presently on-going to purify F_1 and to elucidate its molecular properties.

Conclusion

The results of the different *in vitro* antioxidant assays demonstrated that the crude extract of *V. calvoana* leaves contained potent antioxidant principles. The polar bioactive fraction responsible for the observed antioxidant effects was identified as F_1 with Rf value of 0.51 in acetone, chloroform, methanol (1:4:2) showing one spot on TLC. This finding supports the use of the plant leaves in various traditional medicine therapies in Niger delta areas of Nigeria.

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EFFECTIVENESS OF COOPERATIVES ON ENHANCED KNOWLEDGE TOWARDS COCOA PRODUCTION PRACTICES IN EKITI STATE, NIGERIA

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Abstract

The study assessed the effectiveness of cooperatives on enhancement of knowledge towards improve cocoa production in Ekiti State, Nigeria. It identified the extension services provided by the cooperatives, determined the contribution of the cooperatives to farmers' knowledge. Data were collected from a random selection of 177 cocoa cooperative members in nine Local Government Areas across the agricultural development zones in the study area. Descriptive statistics and multiple regression, were employed for data analysis. Cochran tests was used to analyses the reliability of the data collected. The results revealed that the major agricultural extension activities of cooperatives in the study area were providing members with information about modern farming practices (87.27%), providing members with market information on farm product prices (74.54%), training members on storage methods (74.54%), training members on nursery management practices (73.47%). The major areas in which the cooperatives contributed to farmers' technology awareness were provision of shade at the nursery (30.24%), fencing nurseries with wire mesh (31.30%) and transplanting seedlings after 5 to 6 months (29.18%). Overall, the percentage contribution of the cooperatives to the aggregate technology awareness among respondents was low (27.3%) compared to the total technologies. Multiple regression results revealed that extension activities of cooperatives (β = 0.492), age of co-operators ($\beta = 0.159$) and frequency at cooperatives meetings ($\beta = 0.104$) were the only significant factors that enhanced cocoa production technologies. The study concluded that cocoa producers' co-operatives were little effective in their extension activities in the study area. Hence, there is the need to link cocoa producer cooperatives to institutional credit sources (to enhance their access to capital), Cocoa Research Institutes of Nigeria (CRIN) and ADP to enhanced knowledge towards cocoa production.

Keywords: Knowledge enhancement, productive cooperatives, cocoa production, Ekiti State, Nigeria.

IJAFS 2018 (4). 8:1167-1181
Accepted for publication
August 2018

INTRODUCTION

Agriculture had been the main stay of the Nigeria economy before and during the colonial period, and recorded tremendous success in supporting the national economy, accounting for about 60% of foreign exchange which

rose to 74.3% in 1968. This was before the national independence (Chinweizu, 2006). But the discovery, exploration and mining of crude oil in the southern part of Nigeria which raised the profile of the country in the world oil business to the 6th largest producer and indeed eighth largest deposit of natural gas in the world (Babatunde, 2010; Soludo, 2006). The advent of crude-oil production led to the desert of agricultural industry. The world development report (World Bank, 2007) emphasises agricultural extension as an important development intervention for increasing the growth potential of the agricultural sector, in the light of rising demand and supply side pressures, and for promoting sustainable, inclusive and pro-poor agricultural and hence economic development (Adereti 2011 and Adedoyin 2002).

A major instrument available to the agricultural extension service in the attainment of its objectives is cooperative society. Cooperative societies are independent association of people who voluntarily unite to form a jointly owned and democratically controlled enterprise called cooperatives, to meet members' economic, social and cultural needs (Oluyombo, 2010, Henry and Schimmel, 2011). Farmers cooperatives are seen as a medium through which services like provision of farm input, farm implements, farm mechanization, agricultural loans, agricultural extension, members education, marketing of members farm produce and other economic activities and services are rendered to members (Akinwumi, 2006; Bhuyam, 2007). Poulton, (2006) and Clegg (2006) highlighted some of the information to include the use of appropriate technology, innovative ideas, and sound technical advice not only to increase their agricultural productivity and incomes but also to make rural life meaningful and sustainable.

Cocoa is the second major non-oil foreign exchange earner in Nigeria after leather. It is produced in fourteen (14) states of the federation namely, Ondo, Cross River, Oyo, Osun, Ekiti, Ogun, Edo, Kogi, Akwa Ibom, Delta, Abia, Kwara, Ebonyi and Rivers with an annual production rate of 225,000 metric tons (CRIN 2011). Over 98% of the product is exported and it provides means of livelihood and employment to over five million (5,000,000) people (Foramfera.com 2014). Africa is the largest producer of cocoa, with the major market being in Europe and America. Ivory Coast, Ghana and Nigeria share the largest contribution to the world cocoa market with Ivory Coast being the leading producer. Nigeria is currently the world's fourth largest producer of cocoa after Ivory Coast, Indonesia and Ghana and the third largest exporter, after Ivory Coast and Ghana (Verter, 2014; and FAO, 2015).

Past studies have argued that cooperatives are one of such private sector instruments that can support the agricultural extension service. According to Clegg (2006) and Omotesho (2008) cooperatives remain the most effective vehicles for efficient mobilization of production resources and accelerated rural development. This is because cooperatives increase awareness and adoption of agricultural technologies among farmers. Hence, this study seeks to ascertain if the cocoa producer's cooperatives have undertaken these extension advisory services to its members in the study area. Consequently, the study examine to what extent cooperatives have contributed to the farmers knowledge on improved cocoa production practices. Also, the study will ascertain the cooperatives contributions to farmers' knowledge of improved cocoa management practices. In developing the conceptual construst for this study, few studies have examined cooperative involvement in extension activities particularly in cocoa industry (see Agbarevo 2013 and Ehiwarro 2016). Therefore this study will add to the knowledge on the influence of cooperative on cocoa production.

Methodology

Study Area

The study was conducted in Ekiti State, Nigeria. Ekiti State was created on 1st October, 1996 from the old Ondo State. The state is located between longitudes $4^{0}45^{1}$ - $5^{0}45^{1}$ East of Greenwich Meridian and Latitude $7^{0}15^{1}$ - $8^{0}5^{1}$ North of Equator. Ekiti State has a land mass of 700 square kilometres, bounded in the East and South by Ondo State and bounded in the North by Kwara and Kogi States (Ekiti - Land of Honour, 2014). It has an estimated population of about 3,190,093 people (NPC 2015). The state has sixteen (16) Local Government Areas divided into three agricultural development districts namely, Ekiti North, Ekiti Central and Ekiti South. The state enjoys tropical climate with two distinct seasons. These are the rainy season (April to October) and dry season (November to March). Temperature ranges between 21^{0}C and 28^{0}C with high humidity. The major occupation of the people is farming with major cash crops grown being cocoa, kolanut, oil palm, coffee and cotton, and food crops grown are yams, cassava, rice, plantains, bananas, maize and beans.

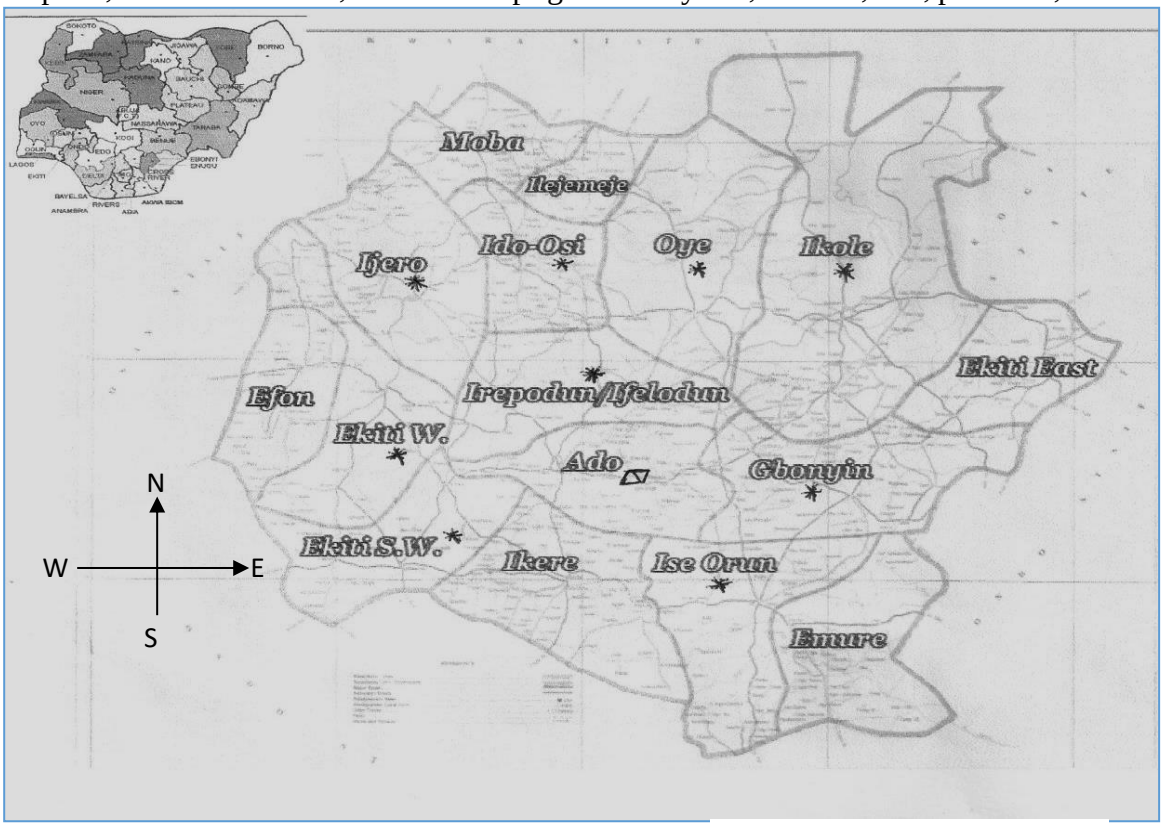

Figure 1: Map of Ekiti State showing study area
Source: Nigeria Muse, 2010

Sampling Techniques

A multi-stage sampling procedure was employed in the selection of respondents for the study, as described below and summarized in Table 1: The first stage was the purposive selection of the three (3) agricultural development zones (ADP) The second stage was the random selection of three (3) Local Governments areas

per ADP giving a total of Nine (9) Local Governments areas. Stage 3 involved proportionally sampled of 5% across the selected Local Government Areas to give a total of 87 that was used for the study.

Table 1: Sampling Procedure

SEN. DISTRICT	LGA	No. of cocoa producer cooperatives	Total no. Of co-operators	Average membership	No. Of cooperative 5%	Average membership of selected coop.	Sample 21.84%
Ekiti North	Ikole	200	4,000	20	10	200	44
	Idoosi	150	3,000	20	8	150	35
	Oye	100	2,000	20	5	100	22
	Sub-total	**450**	**9,000**	**60**	**23**	**450**	101
Ekiti Central	Ijero	200	4,000	20	10	200	44
	Ekiti west	230	4,600	20	12	230	52
	Irepodun/ifelodun	175	3,500	20	9	175	39
	Sub-total	**605**	**12,100**	**60**	**31**	**605**	135
Ekiti South	Ise	300	6,000	20	15	300	66
	Gbonyin	150	3,000	20	8	150	35
	Ekiti south west	200	5,000	20	10	200	44
	Total	**650**	**14,000**	**60**	**33**	**650**	145
	Grand total	**1,705**	**35,100**	**180**	**87**	**1,705**	**381**

Source: Ekiti State Ministry of Commerce and Industry

Sources of data

Data were collected from primary sources, namely from members of cocoa producer cooperatives societies drawn from the study area. Data were collected with the help of a questionnaire and interview schedule to obtain information needed to achieve the study stated objectives. Information obtained from the respondents include among others: cooperative characteristics, extension services offered by cooperatives to members. Data reliability test was performed using the Cronbach's Alpha method.

Data analysis techniques

Data were analyzed using descriptive statistics, comprising frequency tables, percentage, mean and standard deviation. Inferential statistics comprising multiple regressions, Cochran test and Friedman test were used to analyse the hypotheses of the study.Multiple regressions model was used to measure causal relationship between one or more independent variables and a continuous dependent variable (Garson, 2014). The explicit form of the multiple regression equation is shown below:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 ....., + b_nX_n + e \quad (1)$$

Where

Y = dependent variable

a = the coefficient of the constant term

b_1 = the coefficient of the independent variables
X_{1-n} = the independent variables
e = error term

This statistics were used to analyse co-operators socio-economic characteristics and extension services exposed to as determinants of their adoption of improved technologies as well as adoption behaviour. The variables in the equation are defined below as:

Y = Adoption of improved farm management/agronomic practices.
X_1 = Sex (male = 1, female = 0)
X_2 = Age (years)
X_3 = Educational status (years)
X_4 = Household size (number of people living and feeding together)
X_5 = Farming status (dummy: Full time = 1; part time = 0)
X_6 = Farm, size (ha)
X_7 = Farming experience (years)
X_8 = Income (₦)
X_9 = Length of cooperative membership (years)
X_{10} = Knowledge if improved farm technologies (proportion of total Technologies aware of from cooperative extension activities)

Ordinary least square (OLS) method was employed as estimation technique used for the study.

Measurement of variables in the study

The socio-economic characteristics of the respondents were measured are as follows:

(i) Age: The respondents (cooperators) were required to indicate their actual age in years.
(ii) Sex: The respondents (co-operators) were required to indicate whether they are male or female.
(iii) Marital status: Respondents were categorised as
    i. (a) Married (b) Single (c) Divorced (d) Widowed (e) Separated
(iv) Number of children were indicated by the respondents.
(v) Level of education: The level of education was operationalized into categories based on number of years spent in school e.g. Primary 6, Secondary School, OND, NCE, HND, and University Degree.
(vi) Primary occupation: The respondents were requested to indicate their primary occupation based on(a) Farming (b) Trading (c) Civil Servant; (d) Livestock rearing; (e) Food vendor/processor; (f) others (specify)
(vii) Farm size: in hectares
(viii) Cooperative membership: Respondents were asked to indicate how long they have been a member of the cooperative society. This were measured in years.
(ix) Frequency of meetings: Respondents were asked how often the cooperatives hold their meetings and how frequently they attend the meetings.

Results and Discussion

This section examined the socio-economic characteristics of respondents.

Age of respondents

The age distribution of respondents as presented in Table 2, shows that the majority of the cocoa cooperative farmers interviewed (33.42%) were 50-59years, followed by age range of 40-49years (25.20%), while 18.04% were 30-39years and 14.32% were 60years and above. The average age range of the respondents was 46-69years which shows that most of the co-operators are still within the active age category. Similar results regarding the younger age of members of co-operatives was reported by Ibitoye (2012) and Ehiwario (2016). They noted that even though there is no age limit in the membership of agricultural co-operatives, agricultural activities are strenuous which implied that old people may not be fit enough to be involved in tilling operations on the land hence the need for younger and active individual. Being young indicates that they possess enough energy to engage in extension activities. The aggregate result shows that only 9.02% of the respondents were less than 30 years. This signifies that young people were not so much interested in the production of cocoa in the State.

Sex of respondents

The sex spread among the respondents indicated that male constituted the majority in cocoa production. Also, 77.19% were males while 22.81% were females. The implication of this is that most of the members of the cooperative in the study area were male. Mgbakor *et al.*, (2013) and Ehiwario (2016) reported similar results regarding low female participation in cooperative activities. They observed that females are not actively involved in farmers' cooperative societies despite the fact that women are actively involved in other forms of cooperative organization. This study also agrees with the findings of Ogunlela and Mukhlar (2009), that men are mainly involve in the cultivation of cash crops in most parts of Africa, Nigeria inclusive because women only have temporary rights to land ownership in most cases and are not usually allowed to grow cash crops like cocoa and oil palm.

Marital status of respondents

Most respondents were married (80.90% while about 9.55% were single). Being married thereby suggest a sense responsibility and which also shows the importance the society attached to the marriage institution and family labour which is still very much important among the cocoa farmers. Married individuals are considered to be more financially responsible and productive. The findings corroborates the result of Akinbile *et al* (2008) and Ehiwario (2016), which noted that peoples participation in community and cooperative organization are mostly offered by married people, who participate in order to improve their economic livelihood.

Educational level of respondents.

Most co-operators (52.78%) had primary and secondary education, 13.53% had not formal education while 33.68% had post-secondary education. This is an indication that respondents' literacy level was high. With this high level of education, it is expected that the level of adoption of cocoa technologies will be high. This corroborate the studies carried out by Inedia *et al* (2016) and Ogwuche, (2016) who found that education is positively correlated with adoption of technologies. Also, Ogunfiditimi (1981) found that the level of education of small scale farmers in Oyo and Ondo States of Nigeria have positive significant relationship with adoption of improved varieties of Cassava, Maize and Cocoa. He reiterated that the more the farmers advanced in their level of education, the more they tend to understand the impotance, intricacies and need for adopting new

improved farm practices. Onemolease *et al* (2001) discovered that educational level of farmers had a positive and significant effect on farm productivity and adoption.

Household size of respondents

Household size distribution of the respondents shows 41.38% to have 1-4 members, 40.58% (5-8), 15.38% (9-12) and 2.65% to have above 12 members. The average household size for the study area was approximately six. The findings indicated that most of the respondents had people living with them, suggesting a sense of responsibility and this, hopefully, will enhance their effective utilization of cocoa innovations. This finding is in line with Nosiru (2010) and Ogwuche (2016), who found that farmers with larger household size were more productive than those with smaller household size; since they use household members as labour input in the farm enterprise. Household size imposes the necessity to engage in co-operative activities as mire family size put pressure on the household head to devise means of sustenance by engaging in productive ventures. Having large family size, as indicated in this study, may suggest availability of farm labour among the farmers which could lead to increased farm productivity, especially in the area of application of insecticides, pruning of cocoa trees, harvesting and breaking of cocoa pods, fermentation and drying processes. Having people to cater for can be a motivating factor to compel individuals to engage in cooperative extension activities in order to improve upon their productivity and income levels. The result agrees with Kareem *et al*.(2012) who reported similar household range for member of cooperative societies in Ijebu-Ode, Ogun State.

Farming experience of respondents

The result of Table 2 shows that 31.83% of the respondents had 10-19 years farming experience, 23.34% had 20-29 years farming experience, 29.71% had 1-9years farming experience, and 3.45% had 40-49years, while 1.06% had 50 or more years of farming experience. The average experience, which was about 18 years, suggests that this long experience in farming among the co-operators gives them better experience and opportunity to have firsthand knowledge of the challenges and needs associated with cocoa farming in the study area. This assertion is in line with Okwuokenye and Onemolease (2011) who noted that having long farming experience help farmers to be better positioned to know the needs and problems associated with farming activities.

Table 2: Socio-economic characteristics of respondents

		Ekiti North (n=106)		Ekiti Central (n = 127)		Ekiti South (n = 144)		Total (n = 377)		
		Freq	%	Freq	%	Freq	%	Freq	%	Mean
Age range years	<30	1	.94	26	20.47	7	4.86	34	9.02	11.09
	30-39	20	18.87	21	16.54	27	18.75	68	18.04	5.54
	40-49	26	24.53	25	19.69	44	30.56	95	25.20	3.97
	50-59	48	45.28	33	25.98	45	31.25	126	33.42	2.99
	60 & above	11	10.38	22	17.32	21	14.58	54	14.32	6.98
Sex	Female	24	22.64	29	22.83	33	22.92	86	22.81	4.38
	Male	82	77.36	98	77.17	111	77.08	291	77.19	1.30
Marital status	Married	90	84.91	96	75.59	119	82.64	305	80.90	1.24
	Single	4	3.77	21	16.54	11	7.64	36	9.55	10.47
	Widow(er)	9	8.49	7	5.51	12	8.33	28	7.43	13.46
	Separated/Divorced	3	2.83	3	2.36	2	1.39	8	2.12	47.13
Educational level	No formal education	11	10.38	18	14.17	22	15.28	51	13.53	7.39
	Primary education	14	13.2	32	25.20	27	18.7	73	19.36	5.16
	Tertiary education	59	55.6	30	23.62	38	26.3	127	33.68	2.99
	Secondary education	22	20.7	47	37.01	57	39.5	126	33.42	2.99
Household size	≤ 5	61	57.5	42	33.07	53	36.8	156	41.38	2.42
	6-10	26	24.5	61	48.03	66	45.8	153	40.58	2.46
	>10	19	17.9	23	18.90	25	17.4	68	18.03	5.54
Farming experience range (years)	≤ 10	50	47.7	34	26.77	28	19.4	112	29.71	3.37
	11-20	45	42.5	65	51.18	98	68.1	208	55.17	1.81
	>20	19	17.9	24	18.90	25	16.4	68	18.03	5.54
Farm size (ha)	<2	33	31.1	48	37.80	36	25.0	117	31.03	3.22
	2.1 - 5.9	26	24.5	62	48.82	80	55.6	168	44.56	2.24
	>6	47	65.1	17	13.39	28	19.5	92	24.40	4.10
Income range	250,000 & below	14	13.2	48	37.80	44	30.6	106	28.12	3.56
	250,001-500,000	29	27.4	38	29.92	44	30.6	111	29.44	3.40
	500,001-750,000	47	44.3	31	24.41	37	25.7	115	30.50	3.28
	750,001 - 1,000,000	14	13.2	8	6.30	13	9.03	35	9.28	10.77
	1,000,001 - 1,250,000	0	.00	1	.79	4	2.78	5	1.33	75.4
	1,250,001 – 1,500,000	0	.00	1	.79	1	.69	2	.53	188.5
	1,500,001 - 1,750,000	2	1.89	0	.00	0	.00	2	.53	188.5
	1,750,001 - 2,000,000	0	.00	0	.00	1	.69	1	.27	377
Land ownership*	Inherited	74	69.81	68	53.54	91	63.19	233	61.8	1.62
	Purchased	4	3.77	13	10.24	16	11.11	33	8.75	11.42

Leased/rented	9	8.49	22	17.32	13	9.03	44	11.67	8.57
Family owned	18	16.98	25	19.69	60	41.67	103	27.32	3.66
Community land	1	0.94	2	1.57	5	3.47	8	2.12	47.125

**Multiple responses hence total exceeds sample size*
Source*: Field Survey 2017*

Farm size of respondents

The results for farm size show that 44.56% had 2.1-5.9ha, 21.75% had 6-9.99ha, and 31.03% had less than 2ha while 2.65% had 10ha and above. The average farm size was 4.04ha, and indicates that the farmers were small-scale farmers. This shows that most cocoa farmers in the study area were smallholders, and this may likely limit their output and discourage embracing new cocoa technologies. Such low scale may constitute a constraint to production expansion and serve as an incentive to seek out information on how to seek improve productivity. This result corroborates the works of Erie (1996), Omohan (1996) and Ogwuche (2016) that small farm holdings constitute more than 70% of all farming activities in Nigeria. Also, it is in line with Mgbeje (2005) and Ugwu (2009), who asserted that smallholders in African countries owned between 2-4 hectares.

Income of respondents

Annual income figures for the respondents revealed that 30.50% earned ₦500,001 - ₦750,000, 29.44% earned ₦250,001 – ₦500,000, 28.12% earned ₦250,000 and below, 9.28% earned ₦750,001 – ₦1,000,000 while only 1.33% earned ₦1,000,001 - ₦1,250,000.The average income of the co-operators was ₦453, 249.34. The income is low. These findings suggest that cocoa cooperatives farmers in the study area are still operating at the subsistence level. Income of farmers has been found to be a critical factor in agricultural production especially cocoa production. The more the farmers are well to do economically, the more their ability to purchase necessary inputs such as fertilizers, insecticides, herbicides and labour (Tesfaye *et al.*, 2001).

Respondent's attendance at cooperative meetings.

Table 3 reveals that 84.88% of the respondents attended cooperative meetings at least once in a month, in the last 6 months 12.48% attended cooperative meeting between 7-12 times in the last six months while 2.66% of the respondents attended cooperatives meetings more than 12 times within the last six months. According to cooperatives rules and regulation, it is compulsory for a member to attend meetings regularly. Meetings are held at least once every month for members to attend. Executive meeting are usually held before the general meetings where vital issues about members' credits and performances are discussed before the general meetings.

Table 3: Agricultural extension activities of cooperatives

Activities	Ekiti North		Ekiti Central		Ekiti South		Total	
	Freq	%	Freq	%	Freq	%	Freq	%
Providing members with information about modern farming practices	66	62.26	126	99.21	137	95.14	329	87.27
Providing members with market information on farm product prices	3	50	114	89.76	114	79.17	281	74.54
Training members on storage Methods	50	47.17	115	90.55	116	80.56	281	74.54
Training members on nursery management practices	54	50.94	105	82.68	118	81.94	277	73.47
Training members on disease/pest control measures	51	48.11	107	84.25	113	78.47	271	71.88
Training members on farm chemical (fertilizer) applications	51	48.11	101	79.53	117	81.25	269	71.35
Getting information from research institutes to solve members farming problem	49	46.23	95	74.8	117	81.25	261	69.23
Linking members to input Suppliers	48	45.28	103	81.1	110	76.39	261	69.23
Provision of improved planting materials to members	47	44.34	96	75.59	118	81.94	261	69.23
Organizing training for Members	49	46.23	96	75.59	115	79.86	260	68.97
Provision of subsidies on approved chemicals	44	41.51	104	81.89	103	71.53	251	66.58
Linking members to middlemen /marketers	45	42.45	100	78.74	104	72.22	249	66.05
Establishment of farm demonstration sites	38	35.85	73	57.48	113	78.47	224	59.42
Taking farmers (members) on Tour/excursion/agric shows.	36	33.96	83	65.35	65	45.14	184	48.81

Source: Field Survey 2017

Contribution of cooperatives to farmers' awareness of cocoa technologies.

The results of Table 4 reveal that under nursery practices, the major areas in which the respondents agreed that their cooperatives was instrumental to their knowing about the technologies were provision of shade at the nursery (30.24%), fencing the nursery with wire mesh (1m high) (31.30%), transplanting seedlings after five to six months (29.18%), locating nursery close to farm sites/water source (27.59%).For field establishment practices, the results of the table indicate that planting of improved cocoa seedlings technology (28.91%),providing shade cover for cocoa seedlings and site for new planting which should preferably be under forest cover (27.85%). Recommended spacing of 3m x 3m which can guarantee a plant population of 1,100/ha (27.06%), mulching of seedlings/young plants (28.12%) were the major practices the respondents claimed to know through the cooperatives.

Other areas in which the respondents said they have come to gain knowledge of cocoa technologies through the cooperatives include use of insecticides as control of major insects pests (23.08%), harvesting cocoa pods with sharp, clean and disinfected hooks or secateurs, fermentation of cocoa beans in heaps or forwarding boxes

(20.42%), drying of harvested cocoa beans immediately after fermentation (22.81%),storage of cocoa bean in clean jute bags (21.49%) and proper fumigation of stores where cocoa bean is stored (21.49%)

It was observed that cooperatives have contributed to the respondents' awareness of cocoa technologies in the study area. However, the general results suggested that cocoa producer cooperatives contribution to the farmers' awareness of cocoa technologies was low, since the maximum percentage was about 31%. CTA (2011), USAID (2011) and Ghiasy and Mirakzadeh (2012) maintained that cooperatives have been known to provide extension and advisory services to farmers on problems or opportunities, facilitate development of local skills and organizations, transfer new technology to farmers. Such activities help cooperative members to become aware and skilled in modern farming technologies.

Table 4: Contribution of cooperatives to farmers' awareness of cocoa technologies

	Ekiti North		Ekiti Central		Ekiti South		Total	
	Freq	%	Freq	%	Freq	%	Freq	%
Nursery practices								
Fencing the nursery with wire mesh (1M high)	16	15.09	33	25.98	69	47.92	118	31.30
Provision of shade at the nursery	11	10.38	32	25.20	71	49.31	114	30.24
Transplant seedlings after 5 to 6 months	20	18.87	33	25.98	57	39.58	110	29.18
Locating nursery close to farm sites/water source	9	8.49	35	27.56	60	41.67	104	27.59
Field establishment								
Planting of improved cocoa seedlings	19	17.92	37	29.13	53	36.81	109	28.91
Mulching of seedlings/young plants	17	16.04	38	29.92	51	35.42	106	28.12
Site selection: Site for new planting should preferably under forest cover	17	16.04	35	27.56	53	36.81	105	27.85
Provide shade cover for Cocoa seedlings	17	16.04	34	26.77	54	37.50	105	27.85
Regular weeding manually or with chemical	16	15.09	37	29.13	50	34.72	103	27.32
Recommended spacing for the new varieties is of 3M x 3M which can guarantee a plant population of 1100/ha	16	15.09	32	25.20	54	37.50	102	27.06
Fire Tracing	17	16.04	35	27.56	45	31.25	97	25.73
Regular pruning	13	12.26	35	27.56	47	32.64	95	25.20
Control of major insect pests								
Harvest ripe, healthy pods regularly to prevent pod loses to minor infection	15	14.15	37	29.13	25	17.36	77	20.42
Use of insecticides	15	14.15	35	27.56	37	25.69	87	23.08
Harvesting								
Harvesting with sharpened clean and disinfected hooks or secateurs	17	16.04	35	27.56	24	16.67	76	20.16
Fermentation								
Fermentation of Cocoa beans in heaps or forwarding boxes	17	16.04	39	30.71	21	14.58	77	20.42
Fermentation done within 5 to 7 days	16	15.09	40	31.50	20	13.89	76	20.16
Drying								
Use of solar driers	10	9.43	39	30.71	26	18.06	75	19.89
Drying of harvested Cocoa beans immediately after fermentation	12	11.32	38	29.92	36	25.00	86	22.81
Packaging and storage								

Storage of Cocoa bean in clean jute bags	16	15.09	43	33.86	22	15.28	81	21.49
Proper fumigation of stores where cocoa bean is stored	15	14.15	45	35.43	21	14.58	81	21.49
Keeping bagged cocoa beans away from smoke	16	15.09	43	33.86	19	13.19	78	20.69

Source: Field Survey, 2017

Test of difference in extension activities of cocoa producer cooperatives

Cochran test was used to analyze the hypothesis that states that, there is no significant differences in the agricultural extension activities/services provided members by the cocoa producers' cooperatives in the study area. The result is presented in Table 5. Cochran test result (χ^2= 295.82; df= 13; p ≤0.050) is significant at the 5% level which implies that there is a significant difference in the extension activities co-operators agreed that their cooperatives were involved in. Since the result is significant, the null hypothesis rejected while the alternative hypothesis is accepted. The post-hoc test reveals that the extension activities the cocoa producers cooperatives were significantly more involved in include training members on storage methods (0.745), providing members with market information of farm product prices (0.745), providing members with information about modern farming practices (0.873) and training members on nursery management practices (0.735). The least significant activities the cooperatives were involved in include taking farmers (members) on tour or excursion or agricultural shows (0.488), establishment of farm demonstration sites (0.594), linking members with middlemen/marketers (0.660), organizing training for members (0.690) and linking members to inputs suppliers (0.692).

Table 5: Differences in extension activities of cocoa cooperatives (Cochran test)

Activities	Proportion	
Taking farmers (members) on tour/excursion/Agric shows.	0.488	f
Establishment of farm demonstration sites	0.594	ef
Linking members to middlemen /marketers	0.660	e
Provision of subsidies on approved chemicals	0.666	e
Organizing training for members	0.690	de
Linking members to input suppliers	0.692	cde
Getting information from research institutes to solve members farming problem	0.692	bcd
Provision of improved planting materials to members	0.692	bcd
Training members on farm chemical (fertilizer) applications	0.714	bc
Training members on disease/pest control measures	0.719	b
Training members on nursery management practices	0.735	ab
Training members on storage methods	0.745	a
Providing members with market information on farm product prices	0.745	a
Providing members with information about modern farming practices	0.873	a

χ^2= 295.82; df = 13; p < 0.050
Source: Field Survey 2017

Table 6: Multiple regression outputs.

Independent variables	Unstandardized Coefficients (b)	Standardized Coefficient (Beta)	t	Prob. Level
(Constant)	-7.696		3.46	0.001
Extension activities of Cooperatives	1.111*	0.492	9.12	0.000
Age	1.093*	0.159	2.32	0.021
Number of meetings attended	0.484*	0.104	2.20	0.029
Income	0.230	0.089	1.35	0.178
Farm size	0.171	0.074	1.14	0.255
Household size	-0.230	-0.064	1.12	0.265
Farming experience	-0.105	-0.041	0.59	0.558
Educational level	-0.132	-0.039	0.70	0.485
Length of cooperative Membership	-0.122	-0.033	0.58	0.566
Sex	-0.081	-0.018	0.39	0.698

Adjusted R square = 0.233; F = 12.42; p ≤ 0.050
**Significant at 5% (critical t = 1.96)*
Source: Field Survey 2017

Conclusion

Cocoa producer cooperatives in the study area are actually involved in some form of agricultural extension service delivery to their members. Major activities include providing members with information about modern farming practices, market information (farm product prices), training members on storage method, nursery management practices, and disease or pest control measures. The percentage contribution of the cooperatives to the co-operators' awareness of cocoa production technologies was average. This findings suggest that the cooperatives played little role in the cooperators awareness of cocoa production technologies.

The study found that the contribution of cooperatives to the farmers' awareness of cocoa technologies was influenced by the extent of extension activities the cooperatives are engaged in, the age of the farmers as well as their attendance frequency in cooperative meetings

Based on the findings, the following recommendations are made: Cocoa producers' cooperatives should be linked to institutional credit sources especially microfinance banks. This will enhance their access to capital which will make it easier to engage in agricultural extension activities. Cocoa Research Institutes of Nigeria (CRIN) as well as the ADP should make concerted efforts to reach out to cocoa farmers with extension services using the cooperatives. This will boost the contribution of these cooperatives to the farmers' awareness and knowledge of cocoa technologies.

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DETERMINANTS OF FRUIT WASTAGE AMONG FRUIT MARKETERS IN BENIN METROPOLIS, EDO STATE

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Abstract

The study examined factors influencing fruit wastage among marketers in Benin Metropolis, Edo State. Data were obtained purposively from fifty fruit marketers from three major markets in Edo State using a structured questionnaire. Descriptive and inferential statistics were used to analyze data. Findings revealed that 60% of the respondents were between the ages of 26-45years, 64% were females, 48% were married, 48% had less than four persons as household size, 90% had formal education and 50% takes farming as their other occupation. It was also revealed that orange ranked 1st in fruit perishability and 48% recorded fruit wastage weekly. Regression result shows that the co-efficient of variability was 0.320 and sex (X_1=0.242) and year of starting fruit marketing (X_2=0.000) were significant at 0.05. Standard transport facility was a major problem (92.0%) encountered by fruit marketers and ranked 1st. The study concluded that if fruit spoilage is avoided, fruit marketers will have more profits and Edo state will be more food secured. It was recommended that efforts should be intensified in establishing good road network in Edo State so as to reduce fruit wastages and enhance marketing capacity of fruit marketers.

Key Words: Fruit Marketers, Fruit Wastage, Edo State, Fruit Perishability, Fruit Loss.

IJAFS 2018 (5), 8: 1182-1190
Accepted for publication
April 2018

INTRODUCTION

Botanically, a fruit is a seed-bearing structure that develops from the ovary of a flowering plant. They could be succulent or dry and fleshy when ripened (Live Science, 2012). They are widely cultivated and consumed globally. There are archaeological evidences which prove their existence since pre-historic times. Fruits such as citrus, banana, apple, pear, almond, cherry, peach, and plum were domesticated in Central and East Asia. With domestication and breeding came bigger, sweeter and more flavorful fruits with less astringency. Despite some exceptions, most fruits have an obvious appeal of taste, which is a combination of sweetness and acidity considered delicious because of the aromatic constituents. This appealing, sweet taste is associated with their natural selection for propagation (Janick, 2008).

Fruits are vital components of a balanced diet because they supply essential vitamins and minerals such as calcium and iron to the body. These nutrients, such as vitamins A and C are not abundant in the staple foods of many tropical areas. They are therefore required in diets to enhance the nutrition of diverse categories of the population e.g. children and pregnant women. They serve as raw materials in food drink industries and

possess a huge potential for any nation to diversify its economy through foreign exchange earnings (Ayandiji and Omotoso, 2009).

However, fruits are perishable crops and this makes them susceptible to wastage due to spoilage and infestation. As a result, large quantities are lost even before reaching the final consumers (SPORE, 2011; Olayemi *et al.*, 2012). ACF (2014) argued that food wastage, fruits inclusive, constitutes significant postharvest loss. The term "postharvest loss" refers to measurable quantitative and qualitative food loss in the postharvest system. This system comprises interconnected activities from the time of harvest through crop processing, marketing and food preparation, to the final decision by the consumer to eat or discard the food. Olayemi *et al.*, (2012) contended that food wastage occurs at all stages in the post-harvest chain. In some countries, including Africa, where tropical weather and poor infrastructure contribute to the problem, food wastage can regularly be as high as 40-50% (SPORE, 2011). For instance, in Nigeria, over 55 percent of the fruits and vegetables produced perish before consumption (AFPGEAN, 2016). This makes food supply, especially that of fruits, highly unstable; thereby exacerbating food insecurity. Moreover, food wastage amounts to loss of effort and profit along the agricultural value chain (Olayemi *et al.*, 2012).

Food loss, food waste and food wastage are important components of postharvest losses. Food waste is regarded as a subset of food loss and refers to discarding food or making use of food that is safe and nutritious for human consumption in alternative (non-food) ways. It occurs along the entire food supply chain, from primary production to household consumer level. Food loss describes the decrease in quantity or quality of food occurring at the production, harvest, post-harvest and processing phases and is more common in developing countries, due to poor infrastructure and low investment in food production systems (FAO, 2014; UN, 2017). However, according to EU FUSIONS (2016), FAO (2013) stated that food wastage refers to any food lost by deterioration or waste. Thus, the term "wastage" encompasses both food loss and food waste.

In Africa, postharvest losses in some crops including fruits can be as high as 50 percent (Voices Newsletter, 2006). Nigeria is one country where fruits and vegetables grow in and out of season but the problem of processing and preservation leads to post-harvest losses. Records by the National Bureau of Statistics (NBS), the Central Bank of Nigeria (CBN) and the Federal Ministry of Agriculture and Rural Development (FMARD) have shown that as a result of poor or absence of Good Agricultural Practices (GAP) and poor post-harvest handling, the acceptance of local products from Africa and other developing Countries has been difficult to find their way in the international market.

According to Nellemann *et al.*, (2009), damage to fruits at the marketing stage can occur during transport; spoilage; poor handling or losses caused by poor storage. Storage and packaging in wrong materials can bruise fruits causing damage and leading to wastage. During transport to point of sale, bad road conditions can cause vibrations in the vehicles conveying the fruits which can cause damage or spillage onto the road. Most marketers have micro and small scale businesses and are lacking in basic infrastructures like processing and storage equipment. This is because the incessant electricity supply common in most developing countries makes such a venture an expensive one (Taylor, 2017).

ACF (2014) argued that weather is a key issue at harvest. Hot weather reduces the shelf life, causing deterioration at a faster rate. In developing countries with hot climates, most small-holder farmers rely on sun drying to ensure that crops are well dried before storage. If unfavourable weather conditions prevent crops from drying sufficiently, then losses will be high along the food supply chain.

Moreover, poorly developed technology in processing, storage and transportation are closely linked to the poor conditions of infrastructure such as power, roads, communication and even research institutions in many developing countries. Due to lack of theses identified basic infrastructure, postharvest losses will be on the high side which can add to sizable quantity to the global food. Insecurity thus leading to hunger and malnutrition among others. It is against this backdrop, that the study therefore aims to examine factors influencing fruit wastage among fruit marketers in Edo state. The hypothesis tested for this study was stated in the null form; there is no significant relationship between the socioeconomic characteristics of fruit marketers and level of fruit wastage.

METHODOLOGY

The study was carried out in Edo State, a multistage sampling technique was used. Purposive sampling technique was used in the first stage to select Benin City being the major producer of fruits such as pineapple and plantain, in the second stage, purposive sampling technique was also used to select three (3) major markets and fifty (50) fruit marketers were selected purposively in the last stage. Data was collected through the use of a well-structured questionnaire and analyzed using both descriptive and inferential statistics. The descriptive statistics include frequency distribution, percentages and mean scores. The inferential statistics utilized was regression analysis to determine the extent of fruit wastage caused by certain independent variables such as sex, educational level and years of fruit marketing experience among the respondents.

RESULTS AND DISCUSSION

Table 1 presents the socioeconomic characteristics of the respondents. Most (44%) of them were aged between 26 and 35 years with a mean age of about 37 years. This is corroborated by Akwiwu *et al.,* (2005) that the youth are characterized by vigour and strength. This implies that most of the respondents are still in their youthful age and therefore, have the strength to pursue their fruit marketing business. Table 1 also shows that majority (64%) are females while 36% are males. This could imply that more females are involved in fruit marketing than males. This is in line with the assertion of the World Bank (2003) and Olayemi *et al*., (2012) that women are more involved in agricultural value chain than men. This is necessary in their financial empowerment to boost the welfare of their families. About 48% of them were married. This implies that the income realized from fruit marketing will be useful for the upkeep of their families. Also, 48% of the respondents had a household size of between 1and 3 persons. Most (44%) of the respondents stopped at the secondary school level of education.

This literacy level possessed is expected to have a positive influence on their hygiene and quality maintenance practices as education aids the adoption of innovations (Onemolease, 2005). 50% of the respondents engaged in farming as their other occupation. This implies that agriculture remains the predominant occupation in Nigeria as in other parts of sub-Saharan Africa (FAO, 2014; Taylor, 2017). About 36% earned between ₦15, 000 and ₦25,000 a month with an average earnings of ₦31,360 monthly.

Table 1: Socio Economic Characteristics of Respondents (N=50)

Socio-Economic Characteristics	Frequency (Percentage)	Mean score
Age		
<25	6(12.0)	
26-35	22(44.0)	37.4
36-45	12(24.0)	
46-55	1(2.0)	
>55	9(18.0)	
Sex		
Male	18(36.0)	
Female	32(64.0)	
Marital Status		
Single	19(38.0)	
Married	24(48.0)	
Divorced	1(2.0)	
Widow	6(12.0)	
Household Size		
1-3	24(48.0)	
4-6	16(32.0)	3.36
7-9	10(20.0)	
Level of Education		
No Formal education	5(10.0)	
Primary Education	9(18.0)	
Secondary Education	22(44.0)	
Tertiary Education	9(18.0)	
Adult Education	5(10.0)	
Other Occupation		
Civil Service	10(20.0)	
Farming	25(50.0)	
Teaching	15(30.0)	
Average Monthly Income		
> ₦15,000	2(4.0)	
₦15,000-₦25,000	18(36.0)	
₦26,000-₦35,000	14(24.0)	₦31,360
₦36,000-₦45,0000	12(24.0)	
₦46,000-₦55,000	1(2.0)	
>₦55,000	3(6.0)	

Source: Field Survey (2017)

Table 2 shows that majority (76%) of the respondents started selling fruits between 2007 and 2016. The proliferation of fruit marketing industry in recent years could be as a result of recent awareness on healthy living which encourages people to consume more of fruits and vegetables hence increasing the demand and marketing of fruits. According to FAO (2014), postharvest activities such as marketing and agro processing are regarded by African youth as modern and not as laborious as the primary production activities. About 36% sold pineapple only. This could be related to its high nutritive content and fine flavor which makes it the choice of many juice industries (Ugwu, 2018). Most (48%) of the respondents indicated that they experienced fruit wastage on a weekly basis. Also, most (42%) of them obtained their fruits from wholesalers. This is in agreement with the submission of Tracey-White (2003) that wholesalers are the bulk buyers of fruits and they in turn sell to retailers and even consumers. Half (50%) of the respondents indicated that they experienced low fruit wastage while transporting the fruits and most (46%) of the respondents sold to final consumers. The display of fruits by roadsides was employed by about 38% of fruit marketers in order to market their wares.

Majority (60%) of fruit marketers could not afford to store the fruits to prolong their shelf-life. Poor electricity supply makes storage an expensive venture (Olayemi *et al*., 2012). Majority (80%) indicated that the quality of the fruits, i.e. the freshness, determined the price offered for the fruits as indicated in Table 3, while about 54% of respondents claimed pineapple perishes in less than a day, about 72% claimed either banana or plantain perishes in less than a day, majority (74%) claimed orange is the most perishable fruit. Lack of standard transport facility ranked highest on the list of marketing problems by majority (92%) as shown in Table 4. Conveying fruits in specialized vehicles with the right equipment in order to preserve their quality will help to reduce fruit damage during transport (ACF, 2014).

Table 2: Distribution of Respondents According to Fruit wastage, Fruit sales and Patronage (N=50)

	Frequency(Percentage)
Year of Starting Fruit Marketing	
1987-1996	3(6.0)
1997-2006	9(18.0)
2007-2016	38(76.0)
Types of Fruit Sold	
Pineapple	
Banana/plantain	18(36.0)
Orange	11(22.0)
Others	10(20.0)
Banana/plantain and others	2(4.0)
Pineapple and banana/plantain	3(6.0)
Orange and others	1(2.0)
Pineapple and others	2(4.0)
Fruit Wastage	3(6.0)
Daily	
Every other day	7(14.0)
Weekly	15(30.0)
Fortnight	24(48.0)
Sources of Fruit	4(8.0)
Wholesaler	
Retailer	21(42.0)
Farm Gate	16(32.0)
Wastage During Transportation	13(26.0)
High	
Moderate	6(12.0)
Low	19(38.0)
Method of Marketing Fruits	25(50.0)
Hawking	
Wheel barrowing	5(10.0)
Roadside	9(18.0)
Supply companies	19(38.0)
Supply companies and others	16(32.0)
	1(2.0)

Source: Field Survey (2017)

Table 3 shows that orange ranked 1st (74%) in perishability, deteriorating in less than a day due to punctures from postharvest handling which enhances spoilage. This finding supports the findings of Brown (1998) who discovered that oranges and lemons are vulnerable to spoilage caused by physical injury. He further explained that peel oil released from oil glands in the rind is phytotoxic and causes necrosis and collapse of surrounding

healthy epidermal cells resulting in spoilage. Corroborating this assertion Fakayode *et al* (2010) emphasized on the perishability nature of sweet orange in Nigeria resulting from poor storage/shelf life of the fruit as a major problem facing sweet orange market in Nigeria. In the light of the foregoing to reduce fruit spoilage and wastage it is therefore expedient to provide fruit marketers with adequate storage and processing facilities that can enhance fruit marketing in the study area.

Table 3: Distribution of Respondents According to the Perishability of Fruits (N=50)

Fruits	Less than a day f (%)	1-3 days f (%)	4-5 days f (%)	6-7 days f (%)	Above 7 days f (%)	Rank
Pineapple	27(54%)	1(2.0%)	11(22.0%)	8(16.0%)	3(6.0%)	3rd
Banana/plantain	36(72.0%)	3(6.0%)	6(12.0%)	5(10.0%)	0(0.0%)	2nd
Orange	37(74.0%)	2(4.0%)	3(6.0%)	4(8.0%)	4(8.0%)	1st

Table 4 shows problems affecting fruit marketing in the study area. As at the time of the study standard transportation facility ranked 1st (92%) among problems affecting fruit marketing in the study area. This implies that transportation system is very germane to reducing fruit wastage among fruit marketers in Edo state as transportation of agricultural produce plays a vital role in agricultural marketing as Identified by Weitz (2003) that transportation is a final function of the marketing system that connect almost all the stages of production ranging from production to distribution of agricultural products. Storage facility problem ranked 2nd (88%) alongside seasonality of fruit (88%). Fruits are seasonal and when harvested bountifully in season, it is bound to waste in the absence of adequate storage and processing facilities. To curb the problem of food wastage among fruit marketers and enhance sustainable fruit production, it is therefore necessary to provide adequate fruit storage and processing facilities for fruit marketers.

Table 4: Distribution of Respondents According to Problems Affecting Fruit Marketing (N=50)

Problems	Yes F (%)	No F (%)	Rank
Bad pricing	40(80.0%)	10(20.0%)	5th
Seasonal problem	44(88.0%)	6(12.0%)	2nd
Nutritional information problem	18(36.0%)	32(64.0%)	6th
Level of demand problem	41(82.0%)	9(18.0%)	4th
Standard transport facility problem	46(92.0%)	4(8.0%)	1st
Storage facility problem	44(88.0%)	6(12.0%)	2nd

Source: Field Survey (2017)

Regression Result

Regression model was used to estimate the variable that determines the level of wastage of fruits among marketers and the mode is stated thus:

$Y= b_0+ b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots e_i$

Where:

Y = Level of Fruit wastage during transportation

X_1 = Sex (Male/Female)

X_2 = Age (Years)

X_3 = Marital Status

X_4 = Highest Educational Level

X_5 = Household Size (Persons)

X_6 = Years of Experience in Fruit Marketing
X_7 = Methods of Fruit Marketing

(0.845) (0.242) (0.015) (0.157) (0.092) (0.057) (0.000) (0.099)

$$Y= -0.393- 0.569X_1 + 0.024X_2 – 0.005X_3 + 0.103X_4 + 0.004X_5 + 0.001X_6 + 0.036X_7$$

$\bar{R}^2 = 0.320$ $R^2 = 0.207$ $F = 2.828$

The regression model shows that sex of the respondents and the year of starting fruit marketing were significant at 0.05 level of significance. This could imply that female marketers are likely to decrease the level of fruit wastage since they are more involved and experienced in fruit marketing. Furthermore, the year of starting fruit marketing was likewise significant to fruit wastage level among fruit marketers. This could imply that the number of years in the fruit marketing venture contributes significantly to the level of fruit wastage among marketers. In other words, fruit marketers with quality years of experience can curb the effect of fruit wastage appropriately.

R^2 is the coefficient multiple of determination and it specifically measures the goodness of fit of the regression model. The R^2 value is 0.320, this implies that 32.0% of the variables in output is being accounted for by the specified independent variables. From the regression model, the positive sign associated with age of respondents, educational level, household size, year of starting fruit marketing, and how respondents market fruits means that the higher the magnitude of these variables, the lower the level of fruit wastage by the marketer. On the other hand, the negative sign associated with sex and marital status implies that the higher the magnitude of these variables, the higher the level of fruit wastage.

Conclusion

Fruit wastage level is dependent on certain factors which are the sex of the marketer, level of education, storage facility or technique in use, years of experience in the marketing venture, transportation facility, category of people who patronize the marketers, method of marketing fruit and selling techniques. The study concludes that if fruit spoilage is avoided, fruit marketers will have more profits and the state will be more food secured. It was recommended that efforts should be intensified in establishing fruit processing companies in Edo State so as to reduce fruit wastages and enhance marketing capacity of fruit marketers.

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PRODUCTION EFFICIENCY OF CASSAVA WASTE (PEELS), IN OGUN STATE, NIGERIA

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ABSTRACT
This study examined the value chain of cassava peels in Ogun State Nigeria. Multistage sampling technique was used to select 180 cassava processors and marketers. Socio-economic data were obtained from respondents with the use of pre-tested questionnaires. Data were analyzed using descriptive statistics, budgetary technique, and Stochastic Frontier Analysis (SFA) and Student t-test. The study found that majority (84.3% and 52.8%) of cassava processors and marketers were female. In addition, 60.2% of the processors and 51.4% of the marketers had secondary education. The value chain activities carried out by processors were transportation, drying and packaging while marketers transported, packaged and put the peels in storage for future sales. The SFA revealed that cost of labour ($p<0.01$) and quantity of fresh cassava peels ($p<0.01$) were the main determinants of output of dried cassava peels by the processors. The inefficiency model revealed that the efficiency of producing dried cassava peels increased with increase in age ($p<0.01$), credit access ($p<0.01$), household size ($p<0.01$) and membership of cooperative society ($p<0.01$). Furthermore, the cost function revealed that cost of sieving ($p<0.05$) and depreciation on capital item ($p<0.01$) increased the production cost of dried cassava peels. The mean technical, allocative and economic efficiency of producing dried cassava peels were estimated as 94%, 83% and 78% respectively. This study concluded that production of cassava peels is efficient and its trade is profitable. The study recommends that cassava processors and marketers should form cooperative groups to increase access to credit for higher output and trade of peels.

Keywords: Production competence, Cassava value chain, Depreciation cost system, Ogun state

IJAFS 2018 (6), 8: 1191-1201
Accepted for publication
September 2018

Introduction
A serious competition exists between the feed industry and other channels in the food chain (especially man) over conventional feed ingredients such as Maize and Soya bean (Tuleun *et al*., 2005). This had resulted in the high cost and scarcity of these conventional feedstuffs. Poultry feed producers are thus faced with the task of finding alternative feedstuffs that will not compromise quality. The search of such alternatives has exercised Animal Nutritionists in Nigeria for over a decade (Onyimonyi and Okeke, 2005).

Such alternative feedstuffs as cassava peel do not have any direct food requirement by man. They are waste and even constitute health hazards and nuisance in waste disposal of these industries (Onyimonyi and Onukwufor, 2003). Since these peels could make up to 10-20% of the wet weight of the roots, they constitute an important potential resource for animal feeds, if properly processed by a bio-system. Research results

indicate that, cassava peel if properly processed can constitute up to 40 percent of the diets of rabbits (Omole and Sonaiya, 1981).

However, the transformation of cassava waste into various forms for food, feed, and industrial raw material has the potential to help developing countries improve food security, create additional value in rural settings, generate income and employment and develop a more favourable balance of trade. In addition, reported that there are opportunities to utilize agro-processing wastes such as cassava peels to generate wealth. The wealth so generated from waste can lead to reduction of poverty among the rural entrepreneur especially the women processing the herbal soap in particular. This concept is called the "waste to wealth" initiative to improve the economic and health status of the beneficiaries. (Oluwalana, 2011)

A value chain can be defined as the full range of activities which are required to bring a product orservice from conception, through the different phases of production (involving acombination of physical transformation and the input of various producer services),delivery to final customers, and final disposal after use (Elegbede, *et al*., 2018). Value chain activities of cassava peels begins with the processing activities which includes; collecting of peels, drying, blowing, sieving and packaging. The marketing activities includes; transportation, bagging, and putting the peels in storage for future sales (Elegbede, *et al*., 2018).

This article examines the value chain of cassava peels in Ogun State Nigeria. Stochastic Frontier Analysis, Budgetary Technique and a T-test were used to analyze the economic efficiency of cassava peels processors, estimate the financial outcome and profitability in value chain of cassava peels and test the significant difference between the profit levels of cassava chain actors in Ogun State Nigeria.

Methodology

This study was based on primary data obtained through structured questionnaire from the main value chain actors in ogun state Nigeria (Elegbede, *et al*., 2018). This was designed to obtain relevant information that will help in the actualization of the stated objectives in Ogun State Nigeria. Multistage sampling technique was used to select 180 cassava processors and marketers. The first stage involved a purposive selection of two Agricultural Zones in Ogun State this is due to the predominance of cassava process and marketing activities in the chosen zones (Elegbede, *et al*., 2018) while the second stage involved a proportionate sampling of six blocks. The third and fourth stages respectively involved a simple random sampling of two cells from each block and nine processors and six marketers.

The study data were analysed by descriptive and stochastic frontier technique. The stochastic frontier analysis based on Coelli, 1995 were used to estimate coefficients of the parameters of production function and to analyse the economic efficiency of cassava peel processors in Ogun State Nigeria. The theoretical model underlying the analysis includes the technical efficiency and allocative efficiency. The relationship of the afore mentioned model will give us the overall performance measure (economic efficiency) of the cassava peels processors in the study area. Detailed specifications of the theoretical framework are common in literature (Coelli, 1995).

Model Specification

Specification of the Stochastic Frontier Production Model

For the purpose of analyzing the economic efficiency of cassava peels to various useful consumer products in the study area. The stochastic frontier production function model for estimating value chain level technical efficiency is specified as: following Amaza and Olayemi (2001):

$Yi=f(Xi;\beta) + \varepsilon_i = l, 2,.....n$ …… (1)

Here Yi is output, Xi denotes the actual input vector, β is vector of parameters to be estimated/production function and ε_i is the error term that is composed of two elements, that is: $\varepsilon_i = V_i - U_i$

Where Vi is the symmetric disturbances assumed to be identically, independently and normally distributed as $N(0, \sigma^2_v)$ given the stochastic structure of the frontier. The second component UI is a one-sided error term that is independent of V and is normally distributed as $(0, \sigma^2_u)$, allowing the actual production to fall below the frontier but without attributing all short falls in output from the frontier as inefficiency.

$\sigma^2 = \sigma^2_u + \sigma^2_v$ ……..(2)

Furthermore, $\gamma = \frac{\sigma^2_u}{\sigma^2}$ ……..(3)

The variance ratio parameter y (Gamma) according to Dawson, P.J., and Lingard, J. (1991). '$\gamma = (0 \leq \gamma \leq 1)$.
The variance ratio parameter y has two important characteristics:

i. when σ^2 tends to zero, then u is the predominant error in equation (1) and γ tends to 1, implying that the output of the sampled farmers differs from the maximum output mainly because of difference in technical efficiency.

ii. when σ^2_u tends to zero, then the symmetric error v is the predominant error in equation (1) and so γ tends to 0. Thus based on the value of γ, it is possible to identify whether the difference between a farmer's output and the efficient output is principally due to random errors (γ tends to 0) or the inefficient use of resources (γ tends to 1) (Kalirajan, k.p., Shand, R.T. (1988). Following Belbase, K., and Grabwoski, R. (1985), the technical efficiency estimation is given by the mean of the conditional distribution of inefficiency term Ui given ε_i and thus defined by:

$$E(U_i|\varepsilon_i) = \frac{\sigma_u \sigma_v}{\sigma}\left[\frac{f(\varepsilon_i \lambda/\sigma)}{1 - f(\varepsilon_i \lambda/\sigma)} - \frac{\varepsilon_i \lambda}{\sigma}\right] \quad \ldots\ldots\ldots\ldots(4)$$

Where $\lambda = \sigma^2_u / \sigma^2_v$, $\sigma^2 = \sigma^2 + \sigma^2$ while f and F represents the standard normal density and cumulative distribution function respectively evaluated at e/a

The farm specific technical efficiency is defined in terms of observed output (Y1) to the corresponding frontier output (Y_i*) using the available technology derived from the result of equation (5) below as:

$$TE = \frac{Y_i}{Y_i *} = \frac{E(Y_i \mid u_i, X_i)}{E(Y_i \mid u_i = 0, X_i)} = E\left[\exp(-Ui/\varepsilon)\right] \quad \ldots\ldots\ldots\ldots(5)$$

Therefore, $TE = \exp(-U_i)$

TE takes values within the interval zero and one (i.e between 0 and 1), where 1 indicates a fully efficient farm.

Technical and allocative inefficiency effects is the result of behavioral factors which could be controlled by efficient management ((Coelli, 1996)) they are assumed to be independent of the error term.

The estimated technical and allocative inefficiency model is presented explicitly by

$$\mu_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

Where: μ_i = inefficiency effect, δ = a vector of unknown parameters to be estimated, Z_i = Factors contributing to inefficiency

The stochastic frontier cost functions model for estimating farm level overall economic efficiency is specified as:

$$C_i = g(Y_i, P_i; \alpha) + \varepsilon_i \quad i = 1, 2, \ldots\ldots\ldots n \qquad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Where C_i represents total production cost, Y_i represents output produced, P_i represents prices of inputs, ct represents the parameters of the cost function and ε_i represents the error term that is composed of two elements, that is:

$$\varepsilon_i = V_i + U_i$$

Here V_i and U_i are as defined earlier. However because inefficiencies are assumed to always increase costs, error components have positive signs Sharma, K. R., Pingsun, L., and Halina M. Z. (1999).
The farm specific economic efficiency (EE) is defined as the ratio of minimum observed total production cost (C*) to actual total production cost (C) using the result of equation 15 above. That is:

$$EE = \frac{C_i}{C_i^*} = \frac{E(C_i \mid u_i = 0, Y_i P_i)}{E(Y_i \mid u_i, Y_i P)} = E\left[\exp(-Ui \mid \varepsilon)\right] \qquad \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Here EE takes values between O and 1.
Hence a measure of farm specific allocative efficiency (AE) is thus obtained from technical and economic efficiencies estimated as:

$$AE = \frac{EE}{TE}$$

Estimation Techniques

A total of 180 respondents supplied data used in this study. The following subsections present results of various analyses carried out on the study data.

Results and Discussions

Socioeconomic Characteristics of the Cassava Waste Processor and Marketers along the Chain

The socioeconomic characteristics of cassava value chain actors such as the age, sex, educational level, years of experience, household size, membership of association and other occupation etc., as summarized in table 1. Below, reveals the influence of the personal characteristics of the respondents in the study.

Table1: Distribution of Age, Sex, Educational Level, Household Size, Years of Experience, Membership of Association and Potential Buyers of Cassava Peels in the study Area.

Variable	Processors Frequency	Percentage	Marketers Frequency	Percentage	Pooled Frequency	Percentage
Age Group (Years)						
21-30	21	19.4	22	30.6	23	**12.8**
31-40	30	27.8	23	31.9	53	**29.4**
41-50	29	30.7	14	18.7	43	**23.9**
51-60	17	15.7	5	6.9	22	**12.2**
>60	11	10.2	0	0.0	11	**6.1**
Total	**108**	**100.0**	**72**	**100.0**	**180**	**100.0**
Mean		**44**		**38**		
Sex						
Male	17	15.7	34	28.3	51	**28.3**
Female	91	84.3	34	52.8	129	**71.7**
Total	**108**	**100.0**	**72**	**100.0**	**180**	**100.0**
Educational Level						
No Formal Education	6	5.6	4	5.6	10	**5.6**
Primary	37	34.3	31	43.1	68	**37.8**
Secondary	65	60.2	37	51.4	102	**56.7**
Experience (years)						
≤ 5	11	10.2	7	9.7	18	**10.0**
6-10	30	27.8	24	33.3	54	**30.0**
11-15	16	14.8	19	26.4	35	**19.4**
16-20	19	17.6	10	13.9	29	**16.1**
21-25	7	6.5	5	6.9	12	**6.7**
26-30	14	13.0	7	9.7	21	**11.7**
≥ 31	11	10.0	0	0.0	11	**6.1**
Total	**108**	**100.0**	**72**	**100.0**	**180**	**100.0**
Household size						
≤ 4 persons	29	26.9	28	38.9	57	**31.7**
5-8	69	63.9	44	61.1	113	**62.8**
≥ 9 persons	10	9.3	0	0.0	10	**5.6**
Total	**108**	**100.0**	**72**	**100.0**	**180**	**100.0**
Mean		**6**		**5**		
Membership of Cassava Association						
Members	81	75.0	50	69.4	131	**72.8**
Non-Members	27	25.0	22	30.6	49	**27.2**
Total	**108**	**100.0**	**72**	**100.0**	**180**	**100.0**
Other						
Occupation						
None	64	59.2	33	45.8	97	**53.9**
Farming	14	13.0	7	9.8	21	**11.7**
Trading	30	27.8	32	44.4	62	**34.4**
Total	**108**	**100.0**	**72**	**100.0**	**180**	**100.0**

Source: Field Survey, 2019

Table 2: The Stochastic Frontier Production Function Results for cassava peels processing along the chain

Variable	**Regression Coefficient for Cassava peels**	**T-Value**
Production Function		
Constant	5.56^{***} (0.0894)	62.2
Cost of Labour (X_1)	-0.0370^{***} (0.0379)	-3.57
Qty of cassava peels (X_2)	-0.3071^{***} (0.0652)	-8.10
Depreciation (X_3)	0.0041 (0.0079)	0.517
Inefficiency Model		
Constant	-8.59^{***} (0.978)	-8.79
Age (D_1)	-0.168^{***} (0..0115)	-14.57
Education level (D_2)	0.124^{***} (0.056)	2.19
Years of experience (D_3)	0.0751^{***} (0.0199)	3.76
Credit access (D_4)	-1.24^{***} (0.3955)	-3.126
Household size (D_5)	-0.590^{***} (0.0948)	-6.223
Membership of Association (D_6)	-6.64^{***} (0.564)	-11.77
Diagnoistic Statistics		
Sigma-squared (δ^2)	0.188^{***} (0.2968)	6.36
Gamma (γ)	0.996^{***} (0.00213)	466.69
Cost function		
Constant	2.003^{***} (0.419)	4.77
Price of Packing (P_1)	0.275^{*} (0.153)	1.792
Price of labour (P_2)	-0.205^{*} (0.102)	-2.009
Price of sieve (P_3)	0.694^{***} (0.133)	5.22
Depreciation on capital item (P_5)	0.127^{**} (0.045)	2.831
Diagnostic Statistics		
Constant	1.967^{**} (0.805)	2.443
Age (Z_1)	-0.0075 (0.017)	-0.642
Education Level (Z_2)	0.202^{***} (0.0486)	4.157
Years of experience (Z_3)	0.00168 (0.0136)	0.1228
Credit access (Z_4)	-0.3709 (0.251)	-0.475
Household size (Z_5)	-0.106 (0.0669)	-1.59
Membership of Association (Z_6)	-0.535^{*} (0.300)	1.78
Sigma-squared (δ^2)	1.025 (0.300)	1.42
Gamma(γ)	0.99^{***} (0.0000212)	47029.1

Source: Field Survey, 2019

Table3. Distribution of Technical, Allocative and Economic Efficiency of Cassava peels Processing along the Value Chain

Class	Frequency	Percentage
Technical Efficiency		
≤ 0.40	8	7.4
0.41-0.50	6	5.6
0.51-0.60	12	11.1
0.61-0.70	14	13.0
0.71-0.80	25	23.1
0.81-0.90	26	24.1
≥ 0.91	17	15.7
Total	**108**	**100**
Mean	**0.94**	
Minimum	**0.057**	
Maximum	**0.968**	
Allocative Efficiency		
≤ 0.10	41	38.0
0.11-0.20	27	25.0
0.21-0.30	15	13.9
0.31-0.40	10	9.3
0.41-0.50	6	5.6
≥ 0.51	9	8.3
Total	**108**	**100**
Mean	**0.83**	
Minimum	**0.018**	
Maximum	**0.996**	
Economic Efficiency		
≤ 0.10	46	42.6
0.11-020	36	33.3
0.21-0.30	15	13.9
0.31-0.40	4	3.7
≥ 0.41	7	6.5
Total	**108**	**100**
Mean	**0.78**	
Minimum	**0.0012**	
Maximum	**0.6779**	

Source: Field Survey, 2019

Chain of cassava peels actors, as well as the economic efficiency of cassava peel processing are presented in table 1, 2 & 3. The findings showed that the mean age of the cassava value chain actors was 44 years and 38 years for processors and marketers respectively. Also 77.9 percent and 81.2 percent of processors and marketers are aged below 50 years. This implies that majority of the farmers are in their active age. This also informs their skill, ability and wiliness to adopt new innovations and technologies which can be used to transform the cassava industry in the study area. In terms of sex, the study revealed that 15.7 percent are male

while 84.3 percent are female for processors of cassava while for cassava marketers 28.3 percent are male and 52.8 percent are female respectively. The result revealed that majority of the actors in cassava value chain in the study area are female and this may be due to the fact that female are predominant in processors and marketers while the male are basically into production of the cassava. Results from the study also revealed that majority (60.2 percent) of the processors have secondary education while 51.4 percent of the marketers also have secondary education. It was discovered that for both processors and marketers 5.6 percent are found to have no formal education. The level of education among the processors and marketers could be due to the major contributions of the actors along the value chain.

Furthermore, The result of the survey showed that (38.0 percent of processors and 43.0 marketers) of cassava respectively are between 1 and 10 years' experience while 14.8 percent of processors and 26.4 percent of marketers had between 11 and 15 years of experience in the processing and marketing of cassava product and bye products. On the other hand only 10.2 percent of processor had above 31 years' experience in cassava processing and marketing respectively. The years of experience of the actors along the node is supposed to have a positive influence on the profitability of cassava value chain *ceteris paribus.* The study further showed that majority (63.9 percent) of processors and 61.0 percent of marketers have their household size falling between 5 and 8 members with a mean of 6 and 5 household members for processors and marketers respectively. It is expected that the larger household size of both processors and marketers along the value chain should translate to higher output and eventual profit. The result further showed that majority as accounted for both processors (75.0 percent) and marketers (69.4 percent) of cassava are members of a cassava processors and marketers association while 25.0 percent for processors and 30.6 percent for marketers are not member of any of the cassava association. It was also gathered from the study that 59.3 percent and 45.8 percent for the processors and marketers respectively do not have any other association other than cassava processing and marketing. Also, the study revealed that 27.8 percent of processors and 44.4 percent of marketers are traders. This means that they can plough back their returns these other sources back into the cassava processing thereby increasing their profit margin along the value chain.

The stochastic frontier production, cost and efficiency analysis of cassava peels processing.

The parameter estimate obtained from the maximum Likelihood Estimate for cassava waste processors revealed that only Depreciation on capital (X_3) have positive relationship with total output. The result also showed that Labour (X_1) and Quantity of cassava peel (X_2) have negative relationship with output and significantly influence it at 1% respectively. The negative signs of the coefficient of labour and quantity of cassava peels showed that the total revenue from cassava peels processing decrease with increase in labour and quantity of cassava peels along the chain.

The result of the maximum likelihood estimates from the Stochastic Frontier Cost Function of the cassava peels processors shows the relative importance of the variable inputs in terms of the allocative efficiency of the cassava peels processors. It further revealed that the price of packing ($P<0.10$), Price of sieve ($P<0.05$) and depreciation on capital item ($P<0.01$) for cassava peels processors, conform to the a *priori* expectation with positive signs while other variables as Price of labour ($P<0.10$) have negative signs. The magnitude of the price of packing, price of sieve and depreciation on capital items imply that an increase in the unit cost of these variables will lead to an increase in the total cost of production *ceteris paribus.* From the price of packing which has a positive coefficient of 0.275, this means that a 100% change in variable will bring about 27.5% changes in the allocative efficiency of the cassava peels processors. Also, for price of sieve and depreciation

on capital item of 0.694 and 0.127 respectively, this means that 100% change in each of these variables while other things are held constant will bring about 69.4% and 12.7% change in the allocative efficiency of the cassava processors. More so, the price of labour with a negative sign is a decreasing factor to the farmers' allocative efficiency, hence the cassava peels processors along the cassava peels value chain in the study area need to be prudent in allocation of resources in their hiring of labour to carry out their activities along the value chain.

The mean technical efficiency of cassava peels processors was estimated to be 0.94. The mean output of 94 percent revealed that there is the potential for the cassava peels processors to increase their output by 6 percent under the present technology along the cassava waste value chain. More so, the mean allocative efficiency of 83 percent for the cassava peels processors along the chain revealed that there is room for 17 percent improvement in their output. Finally, the mean economic efficiency of 78 percent for the cassava waste (peel) processors implies that there is room for improvement by 22 percent and that there was a great potential for increasing the gross output and profit with the existing level of technology along chain.

Regarding the inefficiency model, the study concluded that processors education and years of experience, contributed significantly and positively to technical inefficiency, while age, credit access, household size and membership of association had an inverse relationship with technical inefficiency. In terms of allocative efficiency only educational level was significant and years of experience though not significant contributed positively to allocative inefficiency. The coefficient of age, credit access, household size and membership of association was negative for allocative inefficiency. These results suggest that experience in cassava peels processing, increased credit, household size and membership of association could jointly contribute positively to an improvement in efficiency of cassava peels processors in Ogun State of Nigeria.

One of the most important policy implications of this study is that there is enough potential to increase the present level of efficiencies for cassava peels processing along the chain in the study area. Furthermore, this study shows that cassava peels processors and marketers are faced with several constraints along the chain. These constraints negatively affect the efficiency of cassava peels processing and marketing in the study area. Notable among them are poor value added technology, low awareness of economic potentials of value added products, lack of extension services, inaccessibility of formal credit source because of high interest rate, poor road network, non-availability of modern equipment, low price of value added products, poor level of education and poor health issues. For efficient processing and marketing of cassava peels in the study area, these constraints must be drastically reduced to the barest minimum. This can be done through provision of more and better economic infrastructure, proper supervision of cassava peels and marketing programme along the chain, effective extension service and proper agricultural financing. It would pave a way to increase profit and will help alleviate poverty in Ogun State.

Conclusion

The result of the study revealed that majority of Cassava processors and marketers are female. Also, the mean age of the cassava value chain actors was discovered to be 44 years and 38 years for processors and marketers respectively. Furthermore, the stochastic frontier analysis revealed that labour and quantity of cassava peels increases the output of the cassava peels processors. The inefficiency model revealed that the efficiency of producing dried cassava peels increased with increase in age ($p<0.01$), credit access ($p<0.01$), household size ($p<0.01$) and membership of co-operative society ($p<0.01$).The mean technical efficiency of cassava peels processors was estimated to be 0.94. The mean output of 94% revealed that there is the potential for the cassava

peels processors to increase their output by 6% under the present technology along the cassava peels value chain. However, the mean allocative efficiency of 83% for the cassava peels processors along the chain revealed that there is room for 17% improvement in their output. More so, the mean economic efficiency of 78% for the cassava peel processors implies that there is room for improvement by 22% and that there was a great potential for increasing the gross output and profit with the existing level of technology along chain. This shows that the cassava processors are economically efficient along the cassava peels value chain in the study area.

Recommendation

Based on findings of this study, the following policy recommendations were advanced to positively bring about improvement in the cassava peels value chain especially redirecting the interest of the masses and the government to cassava peel.

1. From the socio-economic characteristics of the respondents, the majority are in active age bracket. This attraction for the younger people should be a deliberate effort on the part of all stakeholders to encourage and promote this aspect of the people's culture among the youth. The stakeholders (local, state and federal government of Nigeria should involve the youth (economic agents of change) in the transformation programme of the economy.
2. The varying levels of technical efficiency, allocative and economic efficiencies of cassava peels processors in the study area are ample opportunity to improve on the current level of efficiency. Cassava peels processors and marketers in the study area should therefore be encouraged to form cooperative group(s) to have access to credit from bank(s) for letter capital base for higher output. Also, government should invest more in making credit available to cassava peel processors at low interest rate and without collateral so that they can be able to maximize profit generated from the cassava peels and reduce productive inefficiencies.

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HISTOLOGY OF GILL AND LIVER OF Clarias gariepinus FINGERLINGS EXPOSED TO TOXIC LEVELS OF DIZENSATE (GLYPHOSATE HERBICIDE).

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ABSTRACT
The toxicity of Dizensate herbicide on the fingerlings was investigated with emphasis on histopathological effects of African catfish Clarias gariepinus juvenile. Static bioassay was conducted to determine the LC_{50} of Dizensate herbicide to African catfish fingerlings. The fishes were exposed to 0, 9.6, 14.4, 19.2, 21.6 and 24.0 mg/l of Dizensate herbicide. Histopathological examinations were performed on the gill and liver of test organisms exposed to Dizensate glyphosate under standard laboratory condition. 144 live and apparently healthy C. gariepinus fingerlings measuring 9.3-10.6cm standard length and weighed between 5.8g and 6.5g were randomly distributed into twelve (40cm x 29cm x 28cm) glass tanks of 60 litres capacity each were filled with 20litres aerated unchlorinated well water at twelve fish/tank for the experiment. The toxicant was introduced at the different concentrations stated above in triplicate per treatment. The lethal concentration (LC_{50}) value of Dizensate herbicide was 18.07mg/l for 96h of exposure. Mean mortality was 0, 17, 58, 75 and 92% in the concentration of 9.6, 14.4, 19.2, 21.6 and 24.0mg/l respectively, while there was no mortality in the control treatment. Toxic reactions exhibited by the fish include erratic movement, air gulping, and loss of reflex, molting, barbell deformation, hemorrhage and excessive mucus secretion in fish exposed to higher concentration of Dizensate glyphosate. Observations on the bioassay test indicated hyper excitability and the eagerness of the test fish to jump out of the pollutant. The study reveal that Dizensate glyphosate is highly toxic to C. gariepinus, therefore it's use directly in water bodies, near fish farms or in areas close to aquatic bodies should be moderated and regulated.

Keywords: Dizensate glyphosate, *toxicity*, African catfish (*Clarias gariepinus*), *histopathological*

IJAFS 2018 (7), 8:1202-1209
Accepted for publication
August 2018

Introduction
Majority of environmental problems of concern today are attributed to the production and eventual release of toxic chemicals which are not only capable of interacting with the environment but also disrupting the ecosystem. Various activities by man of which indiscriminate discharge of herbicides forms agricultural run-off and ended up in aquatic environment affects non target organisms such as fish and other aquatic organism which are of great economic importance to humans. Pollutants in water significantly affect the ability of fish to detect and respond to chemical stimulus. Feeding, Growth, and reproductive performances could also be seriously affected by such polluted habitat. Pollution of aquatic habitat may result in mass fish mortality or their failure to breed in the polluted environment. These chemical affects not only the physiology and survival of aquatic organisms including fish but also can interact with their genetic material which may lead to the mutations and/or carcinogenesis (Goksoyr, 1991).

Toxicity testing of chemicals on animals has been used for a long time to detect the potential hazards posed by chemicals to man. Bioassay technique has been the cornerstone of programmes on environmental health and chemical safety. Aquatic bioassays are necessary in water pollution control to determine whether a

potential toxicant is dangerous to aquatic life and if so, to find the relationship between the toxicant concentration and its effect on aquatic animals (Olaifa et al., 2003). Nowak, 1992 reported that histopathological changes of gills such as hyperplasia and hypertrophy, epithelial lifting, aneurysm and increase in mucus secretion occurred after the exposure of fish to a variety of noxious agents in the water, such as pesticides, phenol and heavy metal. The gill is the first internal organ that has interface with the polluted water body whereas the liver performs a critical role of breaking down of toxic chemicals and hence the most affected organ in the case of pollution.

The likely impact of indiscriminate and uncontrolled use of glyphosate herbicide in sub-Sahara Africa necessitated the need to study the aquatic side-effects of glyphosate herbicide on some vital organs of African catfish. The objectives of this study is to determine the lethal concentration (so as to determine the safe level of the chemical) and the acute toxic effect of glyphosate herbicide with emphasis on the histopathology on *Clarias gariepinus.*

Methodology

According to ASTM (1977), a static bioassay (96–hour) was carried out in the laboratory with the fingerlings of *Clarias gariepinus* (9.3 and 10.6cm standard length and weighing between 5.8g and 6.5g) as the test organisms. This enables us measure parameters to study the toxicity of glyphosate herbicide on the fish, and determine allowable levels of concentrations of glyphosate herbicide within short exposures. The method employed is based on the recommendation for test of acute toxicity of pollutants to fish described by Sprague (1973) as sited by Babatunde et.al (2014)

Experimental fish

Clarias gariepinus is the most commonly cultivated in Nigeria with its ability to withstand stress, attain good weight within short period of time and high commercial value of US$800 (Chika and Nathaniel, 2014). This informed the use of this fish for the study. The fish was obtained from a private hatchery and transported in plastic bowl were used for the experiment. The bioassay experiment was carried out using the laboratory of Federal College of Fisheries and Marine Technology, Victoria Island, Lagos. Histological analysis was done at Histology Unit, Department of Anatomy, College of Medicine, and University of Lagos.

Acclimation of fish

An aquarium of 40cm by 29cm by 28cm, containing non-chlorinated well water were used for the experiment. The fish were allowed to acclimatize for 7 days under laboratory conditions to allow them adapt to experimental conditions (27 ± 2 °C) and to also ensure that the test organism is in good condition of health. The fish were fed during the period of acclimatization and the water was changed every day in order to remove faecal and unconsumed feeds. There was no feeding at the commencement of the experiment.

The determination of the physico–chemical parameters of the water

Data of the physico–chemical parameters of the water used were obtained. Three parameters which included temperature, dissolved oxygen (DO) and the hydrogen ion concentration (pH) were monitored all through the 96-hour period of the experiment. The temperature was measured with a clinical thermometer and the dissolved oxygen of the water was measured with a digital meter (Jenway9071), while the pH was measured using the HANNA HI 9813 GRO CHEK meter.

Procedure

The bioassay was carried out in a rectangular glass tank. Each tank size of 40cm X 29cm X 28cm of 60 liters capacity were filled with 20 litres unchlorinated well water contained twelve fish each. After a range – finding test (the preliminary test), the concentrations prepared for the experiment were 0 mg/L, 9.6 mg/L, 14.4 mg/L, 19.2 mg/L, 21.6 mg/L and 24.0 mg/L, with three replicates. The amount of herbicide which contained the require miligram of Dizensate herbicide was determined from the 480 g/L of Dizensate herbicide formulation. The behavioural pattern of the fish and other external changes in the body of fish were observed accordingly. Dead fish were identified by an absolute lack of movement. They were removed as soon as this was noticed, and disposed. The LC_{50} value of the *Clarias gariepinus* for 96 hrs was calculated using the probit analysis.

Histopathological Studies

At the end of the experiments, one fish per treatment were sampled after 96hour of exposure to glyphosate herbicide for histological analysis. The fish was sacrificed with a blow on the head, using a mallet and was dissected to remove the liver and the gill. Dissection of fish was performed according to the international standard procedures provided in the EMERGE Protocol (Rosseland et al., 2003). All histological were prepared according to a standard procedure for light microscopy analysis (Gautier, 2011). Each of the organs sampled were fixed in 10 % formalin for 3 days after which the tissue was dehydrated in periodic acid Schiff's reagent (PAS) following the method of Hughes and Perry (1976) in graded levels of 50%,70%,90% and 100% alcohol for 3 days, to allow paraffin wax to penetrate the tissue during embedding. The organs were then embedded in molten wax. Tissue was sectioned into a thin section (5-7µm) by means of a rotator microtome and were dehydrated and stained with Harris haematoxyllin-Eosin (H&E) stain as proposed by Bancroft and Cook, (1994) using a microtone and each section was cleared by placing in warm water (38^0C) where it was picked with clean slide and oven dried at 58^0C for 30 minutes to melt the wax. Slides containing sectioned materials/tissue was cleared using xylene and graded levels of (50%, 70%, 90% and 100%) of alcohol for 2 minutes each.

The section was stained in haematoxyline Eosin for ten minutes. The stained slides were observed under a light microscope. At varying X100 magnification, sections were examined and photographed using an Olympus BH2 microscope fitted with photographic attachment (Olympus PM C35 AD4) a camera (OlympusC40 AB -4). The histological lesions were assessed according to the semi-quantitative system proposed by Bernet *et al*. (1999).

Statistical Analysis: Experimental Design

The experiment was laid out in a completely randomized design (CRD) with six treatments for each. The experiment involves the use of fingerlings as test organism and has the following treatment: 0.0mg/l as control and five other treatments (9.6mg/l; 14.4mg/l;19.2mg/l;21.6mg/l and24mg/l). Phase I for the experiment involved the range finding test where fish were exposed to various concentrations of the toxicant until 50% mortality was attained while phase II was a chronic bioassay study that lasted for 96hours. 144 live and apparently healthy *C. gariepinus* fingerlings measuring between 9.3 and 10.6cm standard length and weighing between 5.8g and 6.5g were randomly distributed into twelve (40cm x 29cm x 28cm) rectangular glass tanks of 60 litres capacity each filled with 20 litres aerated unchlorinated well water at twelve fish/tank for the experiment. The dose response of mortality was analyzed by probit analysis (Finney, 1971) based on a computer programme by Ge Le PaHoure, Imperial College, London and adopted by Otitoju (2001), This was used to derive the LC_{50}.

LC_{50} = Median lethal concentration that causes 50% mortality of exposed animals.

Results

The physico-chemical characteristics of the water

Tables 1 showed the results of the water parameters after Dizensate herbicide esposure of C.gariepinus fingerlings and adult. The pH, temperature and dissolved oxygen were determined at different time interval. The results obtained before the test were found to be close to the water quality parameters of the control experiment. The pH value obtained shows that Dizensate herbicide has slight effect on the pH of water. The pH reduced slightly from 7.2±0.2 in control to 6.4±0.1 in test treatment of concentration 24.0mg/l after the whole experiment as shown in tables 1. Temperature varies between 25±0.1to 28±0.2 in the 9.6mg/l concentration. The DO_2 decrease slight from 5.9±0.1 in control experiment to 4.4±0.1 in test treatment of concentration of 24.0mg/l

TABLE 1: Summary of Water Quality Parameters of glyphosate herbicide on fingerlings of C. gariepinus {Definitive test} (Mean ± S.D)

TIME	PARAMETERS	0 mg/l	9.6mg/l	14.4mg/l	19.2mg/l	21.6mg/l	24.0mg/l
1hr	Temp (0^oC)	25±0.1	25±0.1	25±0.1	25±0.1	26±0.2	26±0.1
	Ph	7.0±0.2	7.0±0.2	7.0±0.2	7.0±0.2	7.2±0.2	7.2±0.2
	DO_2 (mg/l)	5.9±0.1	5.9±0.1	5.9±0.1	5.9±0.2	5.8±0.1	5.9±0.1
2hr	Temp (0^oC)	25±0.2	25±0.2	26±0.1	25±0.1	26±0.1	26±0.1
	Ph	7.0±0.2	7.0±0.1	7.0±0.2	7.0±0.2	7.2±0.1	7.2±0.1
	DO_2 (mg/l)	5.9±0.1	5.9±0.1	5.9±0.1	5.8±0.1	5.9±0.1	5.9±0.1
3hr	Temp (0^oC)	25±0.1	26±0.1	25±0.1	26±0.1	27±0.1	26±0.2
	Ph	7.2±0.2	7.1±0.1	7.1±0.1	7.1±0.1	7.2±0.2	7.2±0.2
	DO_2 (mg/l)	5.9±0.1	5.9±0.1	5.9±0.2	5.8±0.2	5.9±0.1	5.9±0.1
4hr	Temp (0^oC)	26±0.2	27±0.2	27±0.1	27±0.1	27±0.1	27±0.1
	Ph	7.2±0.1	7.2±0.2	7.2±0.2	7.2±0.2	6.9±0.1	6.9±0.1
	DO_2 (mg/l)	5.9±0.1	5.9±0.1	5.9±0.1	5.8±0.1	5.7±0.1	5.8±0.1
8hrs	Temp (0^oC)	25±0.1	27±0.2	27±0.2	27±0.2	27±0.1	27±0.1
	Ph	7.2±0.2	7.2±0.1	7.2±0.1	7.2±0.1	6.8±0.1	6.9±0.1
	DO_2 (mg/l)	7.9±0.1	5.9±0.1	5.9±0.2	5.8±0.2	5.7±0.1	5.7±0.1
12hrs	Temp (0^oC)	26±0.2	26±0.1	26±0.2	26±0.2	27±0.1	27±0.2
	Ph	7.0±0.2	7.2±0.1	7.2±0.1	7.2±0.1	6.8±0.2	6.8±0.2
	DO_2 (mg/l)	7.9±0.1	5.9±0.1	5.9±0.2	5.8±0.2	5.7±0.1	5.7±0.1
16hrs	Temp (0^oC)	25±0.1	25±0.2	25±0.2	25±0.2	28±0.1	28±0.1
	Ph	7.0±0.2	7.2±0.2	7.2±0.1	7.2±0.1	6.7±0.2	6.7±0.2
	DO_2 (mg/l)	7.9±0.1	5.9±0.1	5.9±0.1	5.7±0.1	5.7±0.1	5.6±0.1
20hrs	Temp (0^oC)	25±0.1	25±0.2	25±0.2	25±0.2	28±0.2	28±0.2
	Ph	7.0±0.1	7.2±0.1	7.2±0.1	7.2±0.1	6.8±0.1	6.8±0.1
	DO_2 (mg/l)	7.9±0.1	5.9±0.1	5.8±0.2	5.5±0.2	5.6±0.1	5.6±0.1
24hrs	Temp (0^oC)	27±0.0	27±0.1	27±0.1	27±0.1	28±0.2	27±0.1
	Ph	7.2±0.0	7.2±0.1	7.2±0.1	7.2±0.1	6.8±0.1	6.8±0.1
	DO_2 (mg/l)	7.9±0.1	5.5±0.1	5.9±0.1	5.5±0.1	5.3±0.1	5.3±0.1
48hrs	Temp (0^oC)	27±0.1	27±0.2	27±0.2	27±0.2	29±0.2	28±0.2
	Ph	7.2±0.3	6.8±0.1	6.8±0.1	6.8±0.1	6.5±0.2	6.5±0.2
	DO_2 (mg/l)	6.9±0.1	5.5±0.1	5.9±0.1	5.5±0.1	5.2±0.1	5.2±0.1
72hrs	Temp (0^oC)	27±0.1	27±0.1	27±0.1	27±0.1	27±0.2	27±0.2
	Ph	7.2±0.1	7.2±0.2	7.2±0.2	7.2±0.2	6.6±0.1	6.6±0.1
	DO_2 (mg/l)	6.5±0.1	5.5±0.1	5.9±0.1	5.3±0.1	4.9±0.1	4.9±0.2
96hrs	Temp (0^oC)	27±0.2	28±0.2	27±0.1	27±0.1	27±0.2	27±0.2
	Ph	7.2±0.1	7.2±0.2	7.2±0.2	7.2±0.2	6.4±0.2	6.4±0.1
	DO_2 (mg/l)	6.4±0.1	5.4±0.1	5.7±0.1	5.3±0.1	4.4±0.1	4.4±0.1

Source: Field Survey, 2017

Acute Toxicity

The results of the acute toxicity test are presented in Tables 2&3. The LC_{50} value based on probit analysis was found to be 18.07 mg/L for 96 hrs of exposure to the glyphosate herbicide (Fig.1). The results obtained showed that there was no mortality (Table 2) of fish in the control experiment throughout the 96 hrs. There was 17% mortality of the fish exposed to 14.4 mg/L while at 24 mg/L, 92% mortality was observed. During this study the behaviour of the control fish was normal, while the fish introduced into the different concentrates of the herbicides showed different abnormal behaviour. Abnormal behaviour such as erratic swimming, sudden quick movements and restlessness were observed in fish exposed to the chemical. At high concentration of 24mg/L, the fish became very weak and settled at the bottom. Normal colour and behavioural response was observed in the control experiment.

Table 2: Lethal concentrations (96h- LC_{50}) values of glyphosate to which *C. gariepinus* fingerlings were treated after several hours' exposure time.

TIME (hours)	Log C Value	LC_{50}
24	1.387	24.38mg/l
48	1.366	23.23mg/l
72	1.318	20.80mg/l
96	1.257	18.07mg/l

KEY:
LC_{50}= Lethal Concentrations
Log C Value = Logarithm of the concentrations

Table 3: Estimation of the Log C and the LC_{50} value of glyphosate to which *C. gariepinus* fingerlings were treated after 96 hours exposure time.

Conc. (mg/l)	Log $_{10}$ Conc.	Total No	No.Dead	% Mortality	Corrected % mortality	Probit
T0 = 0	-	12	0	0		-
T1 = 9.6	0.982	12	0	0		-
T2 = 14.4	1.158	12	2	17		4.05
T3 = 19.2	1.283	12	7	58		5.20
T4 = 21.6	1.335	12	9	75		5.67
T5 = 24.0	1.380	12	11	92		6.41

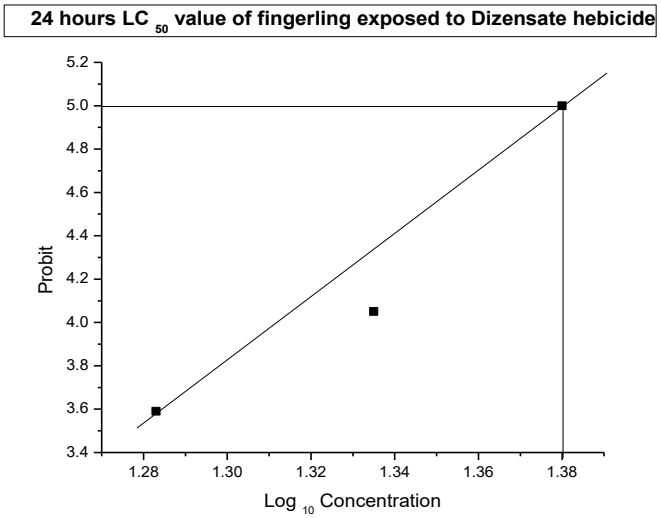

Fig. 1: LC_{50} for fingerlings of *C. gariepinus* at 24h exposure time to glyphosate

Mortality (%) of C. gariepinus fingerlings exposed to different concentrations of glyphosate herbicide (bioassay test) (Table 3) showed that the fish was sensitive to concentrations from 14.4 – 24.0 mg L^{-1}. The table indicated that within 96h, about 17% of the fish died in concentration of 14.4mg L^{-1}, while 58% died in concentration of 19.2mg L^{-1}, suggesting that the 96h LC_{50} of glyphosate herbicide might lie between 14.4 and 19.2mg L^{-1}. The concentration values were converted to Logit, while the mortality (%) was converted to Probit values according to methods of Hewlett & Plackett (1979), and the transformed values were used to determine the 96h LC_{50} graphically. Figure 1 presents the LC_{50} graph with the regression equation Y = 10.233x – 7.8583, where y = probit response and x = logit (log-dose). From the equation, the 96h LC_{50} was calculated as 18.07 mg L^{-1}.

Histopathological effect

LIVER: Transverse section through the liver showed no pathological lesion. Normal cellular pattern, normal central vein, billary epithelium, hepatic plate and hepatocytes. No lesion, necrosis, pigments, malignancy, inflammation or inclusion bodies were seen in the control (Fig.D1). However, patches of slight lesion, necrosis, malignancy, pigment and inflammation in the livers exposed to the glyphosate herbicide at 14.4mg/l and 19.2mg/l were observed (Fig D3 and D4). Vacuolation and hepatocyte enlargement of tissue was seen in concentration of 21.6mg/l of glyphosate herbicide treated fish. Shrinkage of cell and hyperplasia of cell was also observed. Complete degenerated tissue was observed in this highest concentration of 24.0mg/l within 96 hours (fig. D6)

GILL: There was normal cellular pattern in the control experiment. The gill arch, gill rakers, filament, sinus, and cartilaginous support were in order. Pseudo-brachial lamella, ceratobrachial bone of the arch, mucous epithelium lining on the membrane and branches of the afferent and efferent arterioles were all normal (Fig.A1). No lesion, necrosis, pigments, malignancy, inflammation or inclusion bodies were seen. However, as the concentration of the toxicant increase, Moderate and severe areas of lesion, necrosis, malignancy, pigment and inclusion bodies were observed. Fig. A2, A3 and A4 revealed degeneration of lamellar and hypertrophy of cellx. Complete degeneration was observed in concentration of 21.6mg/l of glyphosate

herbicide treated fish. Hypertrophy of gill arch and complete degeneration of filament was observed in highest concentration of 24mg/l of glyphosate herbicide treated fish within 96 hours period.

Discussion

The glyphosate herbicide exerted toxic effect on the fish in the present study and toxicity increased with increased concentration. The physico-chemical properties of glyphosate herbicide clearly indicated that it is a pollutant, as its presence in water changed the physical and chemical qualities of water to critical levels that could hardly support aquatic productivity. The maximum safe concentration (96h LC_{50}) range for fingerlings fish samples (18.23mg/l) compared favourable with those of Omitoyin et.al (2006) that reported the effect of gramoxone (paraquat) juvenile *Clarias gariepinus* with LC_{50} value of 18mg/l for 96h exposure. As expected, high concentration of glyphosate herbicide in the areas resulted in increased water temperature with corresponding reduction in dissolved oxygen concentrations.

Abnormal behaviours such as incessant jumping and gulping of air, restlessness, loss of equilibrium, increase opercular activities, surface to bottom movement, sudden quick movement and resting at the bottom observed in this study were similar to the observations of Ajani, *et. al.* (2002) and Fafioye (2001). The fish were stressed progressively with time before eventually dying. The stressful ailment of respiratory impairment due to the toxic effect of glyphosate herbicide on the gills was similar to the report of Omitoyin et al. (2006). The observed increasing state of inactivity with both increasing concentrations and exposure period agree with the report of Ayoola (2008). Water quality parameters had little variation, physicochemical parameter measured seemed to be within optimum range for fish culture as reported by Omitoyin et al. (2006) and Olaifa *et al.* (2003).

Accumulation of mucus in the gills of fish exposed to the different concentrations of Dizensate herbicide in this study might be responsible for the mortality recorded. This report was similar to the work of Muniyan and Veeraraghavan, 1990 who worked on the effect of insecticide ethofenprox on Nile Tilapia. Konar 1975 reported that the accumulation of mucus on the gills reduces respiratory activities in fish. Histopathology of the organs after 96 hours exposure revealed cell proliferation, lamellar fusion, lamellar, cell hyperplasia, and epithelial lifting. In the liver, there was vacuolation of hepatocytes and necrosis. The changes in these tissues occur predominantly in the 96 hours exposure. Respiratory stress, erratic swimming and instant death of fish were observed in exposed fish, which varied with the concentration of the toxicant.

Histopathological examination of the gill and liver of *C. gariepinus* fingerlings showed varied degrees of degenerative changes including vacuolation and necrosis which worsened with increasing concentration of the toxicant. The inability of the gill surface to actively carry out gaseous exchange might be responsible for the observed mortalities.

The mortality pattern recorded corroborates with that reported by Rand and Pectrocelli (1985) which stated that there should be less than 35% mortality in one of the concentrations and at least more than 65% mortality in the highest concentration.

Conclusion

The results of this study revealed that glyphosate herbicide is toxic to fish organs and causes histopathological changes in different vital organs such as Liver, a centre of deamination of toxic substances; gills, an interface for the exchange of gases; skin, an organ for protection and heart that is responsible for circulation of blood. They all had different levels of degeneration after exposure to the toxicant. This further establishes the

detrimental effects this toxicant has on the African catfish. Therefore, indiscriminate discharge into water bodies by farmers should be discouraged particularly in aquatic bodies.

Acknowledgement: The laboratory staff of Federal College of Fisheries and Marine Technology, Lagos-Nigeria is appreciated for their assistance during this work.

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RESPONSES OF SOIL NUTRIENT AND MICROBIAL POPULATION TO THE APPLICATION OF DIURON FOR WEED CONTROL IN MAIZE IN AN ALFISOL.

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Abstract
Diuron, is one of the commonly used herbicides for weed control in cereals in most parts of the world, but continuous use may leave residues in the soil, which are likely to alter soil biological and chemical properties. This study evaluates the influence of diuron treatments at 1.2, 1.8, 2.4, 3.0, 3.6 and 4.2 kg a.i. / ha including a weedy and weed-free control on soil chemical properties and microbial population. A field experiment was conducted using randomized complete block design at the Crop Type Museum of the department of Crop, Soil and Pest Management in the Teaching and Research Farm of the Federal University of Technology, Akure (FUTA). FUTA is located in the rainforest vegetation zone of Nigeria. Results showed that bacterial population was significantly reduced by diuron irrespective of rate of application compared to the untreated plots, and this decrease in bacterial population appeared to be directly related to the rate of application of the herbicide. Diuron was also found to reduced fungal population by 60.8, 58.8, 56.7, 68.0, 66.0 and 67.0 % for diuron application at 1.2, 1.8, 2.4, 30. 3.6 and 4.2 kg a i/ha respectively. Results further showed that soil pH, organic matter and the major nutrients were also reduced by the application of the herbicide. Results also indicated that diuron at 3.6 and 4.2 kg a.i. / ha provided effective weed control and significantly ($p<0.05$) increased maize grain yield over the weedy control at almost a similar level with the weed-free control. It is therefore concluded that application of diuron though has the potential to boost maize yield may not be favorable to the soil microbial community. Practices that can enhance diuron degradation should therefore accompany its application so as to reduce toxicity to non-target organisms.

Key words: Diuron, chemical properties, soil microbial population, maize

IJAFS 2018 (8), 8:1210-1219
Accepted for publication
August 2018

INTRODUCTION

Diuron, commonly sold under the brand names Karmex, Direx, and Diuron, is widely used for vegetation control along rights of way. Other significant uses include weed control in citrus orchards and alfafa fields (Cox, 2003). In Nigeria, the herbicide is used for post emergent control of weeds in maize and cassava. Diuron has however been found to be moderately to highly persistent in soils, and the commonly reported average field dissipation half-life is 90 days (USDA, 1995). Soil persistence of diuron is presumably dose dependent. Phytotoxic residues generally dissipate within a season when applied at low selective rates. At higher application rates, residues may persist for more than one year (Kidd and James, 1991). While persistence is a good indicator of weed control effectiveness in some herbicides, the carryover effects of such herbicides on soil productivity indicators should also be emphasized. When sustainable crop production is a priority, herbicides should be scored on their ability to conserve or improve both biotic and abiotic soil productivity indicators.

Much has been reported on the responses of soil microbial and enzymatic activities to diuron applications. Diuron is able to disrupt the complex ecological community of soil microorganisms, including algae and fungi. These effects have been demonstrated in a variety of ecosystems around the world. Biologists at the University of Havana (Cuba)

showed that the dominant soil fungus in sugar cane fields did not occur on a diuron treated field and was replaced by another genus of fungi (Cox,2003). Scientists at the University of Regina (Canada) found that treatment of soil with diuron in concentrations equivalent to those used by farmers reduced algae populations by 99 percent in the top layer of the soil, and this reduction occurred in both clay and sandy loam soils (Pipe and Cullimore, 1980; 1984). Researchers at the Instituto de Química (Brazil) showed that diuron inhibits microbial activity in soil, even at concentrations as low as several parts per million, causing "conditions adverse to restoring soil fertility" (Prado and Airoldi, 2001). In addition, diuron reduces the activity of phytase, an enzyme that mineralizes the plant nutrient phosphorus in soil. (Cervelli and. Perna, 1985).

Nothing has however been reported on the effects of diuron on soil microbial properties in the afrisol soil of south western Nigeria. The present study therefore aims at gaining an insight into the weed control effectiveness of varying application rates of diuron in maize, as well as the effects of their residues on soil chemical properties and microbial population in south western Nigeria.

MATERIALS AND METHODS

Study area

The study was conducted at the Crop Type Museum of the department of Crop, Soil and Pest Management of the Federal University of Technology, Akure (7°16′N, 5°12′E) located in the rain forest vegetation zone of Nigeria during the early (April-July) cropping seasons of 2011. The average annual rainfall is about 1300mm with a mean temperature of 27°C and the climate is of the sub-humid type. The soil at the experiment site was a sandy clay loam. Chemical analysis of the top soil at 5cm depth before sowing maize are given in Table 1.

Experiment plan and crop establishment

A field trial involving application of diuron in maize at 1.2, 1.8, 2.4, 3.0, 3.6 and 4.2kg a.i. / ha was laid out in a randomized complete block design (RCBD) with three replications per treatment. Treatments also included a weed-free control (where weeding occurred once per week till harvest at 12 WAP) and a weedy control (where no weeding occurred during the period of the experiment). Two seeds of Downy mildew resistant (DMR), and early maturing maize variety were sown per stand but later thinned to one seedling per stand at 2 weeks after planting (WAP). Planting was done on plots measuring 4 × 4 m at a spacing of 75 × 25 cm with 1 m alleyway between plots. Diuron (80DF), a dry flowable formulation, was applied pre-emergence to both weed and crop at the foregoing rates with a knapsack sprayer fitted with Polijet nozzles calibrated to deliver 250 l / ha of the spray solution at a pressure of 2.5 kg / cm^2.

Data Collection

Weed assessment was conducted twice at 3 weeks after treatment (WAT) and at harvest to determine the weed spectrum, density and weight of total weed species using two fixed 50 × 50 cm quadrats along a diagonal in each plot from which weed samples were collected and analyzed for the foregoing parameters. Collected weed samples were bulked and subsequently weighed. At harvest, all the plots were clean-weeded regardless of previous weeding treatments, and the weeds weighed, thus allowing a comparison to be made of the total weed growth from the time of sowing till harvest for the different treatments. Soil samples were also collected at harvest at 0-15 cm depth in all the plots to determine the soil pH and nutrient status using standard methods (AOAC, 1990). Enumeration of soil microbial population was also done using standard methods.

Soil chemical Analysis

Composite soil samples collected after land clearing and soil samples collected at harvest from treatment plots were air-dried, ground and sieved using 2 mm sieve mesh. They were chemically analysed as described by Tel (1984). Organic matter was determined by wet oxidation method through chromic acid digestion. Nitrogen was determined by microkjeldahl approach; P was extracted by Bray-P1 solution and determined using the spectrophotometric

method. Exchangeable K, Ca and Mg were extracted using ammonium acetate; K was determined using flame photometer, and Ca and Mg by EDTA titration method. Soil pH in ratio 1:2 water suspension was determined using a glass electrode.

Determination of soil microbial population

Numbers of microflora were estimated by soil dilution technique on Nutrient and
Potato Dextrose Agars as isolation media for bacteria and fungi respectively.

To achieve serial dilution, 5 grams of soil was suspended in 150 ml Erlenmeyer flask containing 95 ml of sterilized distilled water to obtain a 10^{-1} dilution and was kept under shaking conditions at 120 rpm for 15 minutes. From the flask 1 ml of suspension was transferred to 9 ml water blank to make 10^{-2} dilution. The water blank was vortexed and then again 1 ml of the suspension was transferred to a new water blank (9 ml) tube to obtain 10^{-3} dilution. In the similar manner dilutions were made up to 10^{-8}. The nutrient agar medium was composed of peptone 5 g, meat extract 3 g, agar agar 15 g and 1000 mL distilled water. For bacterial count 0.1 ml aliquot of the dilution to 10^{-8} was spread plated on Nutrient Agar medium petri plates in triplicates. Then the plates were incubated in an inverted position at 28˚C for 2 days. The constituents of the Potato Dextrose Agar (gL^{-1}) were Peptone 5.0, potato extract 5.0, dextrose 10.0, Agar 20.0, and Distilled water 1000.0 ml at pH 6.5. A mixture of 1g soil and 10mL of saline solution was shaken on a mechanical shaker for 10 minutes to dislodge fungal propagules into the solution.

This was followed by serial dilutions to the concentrations of 10^{-5}. 0.5 mL of the aliquot was spread on Potato dextrose extract agars to isolate fungal spores and this was incubated at 28^{0C} for 4 days. Dilution factors of 8 and 5 were used to determine the bacterial colony and fungal spore units respectively. Yield was assessed from fifteen randomly selected plants per plot. The harvested cobs were shelled, weighed and grain weight adjusted to 13% moisture. Data collected from the experiments were subjected to an analysis of variance while treatment means were compared using the standard error of mean differences. Simple linear correlation and regression analysis between increasing dose of diuron (X) and soil pH, soil nutrient content, growth or yield parameters (Y) of maize was performed with a scientific calculator (Casio *fx*-7400G PLUS POWER GRAPHIC Model).

RESULTS

The soil at the study site was slightly acidic, low in organic matter, N, K and Mg (Table 1). Exchangeable Ca was also marginal.

Table 1. Nutrient status and soil pH of experimental sites before treatment application

Parameters	Soil concentration
pH	5.52
Organic matter (%)	2.02
Nitrogen (%)	0.15
Available P ($mgkg^{-1}$)	3.18
K ($cmolkg^{-1}$)	0.32
Ca ($cmolkg^{-1}$)	2.11
Mg ($cmolkg^{-1}$)	1.20

Significant differences were recorded amongst the treatments in soil pH and nutrients other than potassium (Table 2). The weedy control resulted in significantly higher soil pH than the weed-free control and the diuron treatments, among which there were no significant differences. Hand weeding however lowered soil pH significantly compared to all the other treatments. Organic matter content was significantly higher in the weedy and weed-free controls than observed in the diuron treatments. Significant reductions in N content were noted for diuron treatments compared to the remaining treatments. Weedy control treatment significantly increased phosphorus values compared with the diuron treatments. K was not significantly influenced by any of the treatments at the end of the experiment. Mg and Ca were also significantly affected by the treatments but not in any consistent manner. Regressing soil nutrient

parameters (Y) against increasing dose of diuron (X) indicated positive relationships (Table 3) except N that appeared to be inversely related to the increasing rates of the herbicides.

Table 2 Organic matter and nutrient composition of the soil sample at maize harvest

	Soil pH	OM (%)	N (%)	P (mg/kg)	K (cmol/kg)	Mg (cmol/kg)	Ca (cmol/kg)
Diuron at 1.2kg a.i/ha	5.74b	2.67b	0.18b	2.22d	0.31a	1.96a	2.76ab
Duiron at 1.8kg a.i/ha	5.76b	2.51c	0.19b	3.39c	0.38a	1.45ab	2.47b
Diuron at 2.4kga.i/ha	5.85ab	2.56b	0.13c	3.89b	0.36a	1.31b	2.24b
Diuron at 3.0kg a.i/ha	5.80b	2.29bc	0.18b	3.80b	0.39a	1.56ab	2.72ab
Diuron at 3.6kg a.i/ha	5.89b	1.72d	0.17b	3.56b	0.35a	1.36ab	2.39b
Diuron at 4.2kg a.i/ha	5.74b	0.61e	0.17b	3.85b	0.36a	1.42ab	2.94a
Hand weeding	5.20c	2.90a	0.22a	3.87b	0.2a	1.02c	2.33b
Weedy check	6.2a	3.2a	0.25a	5.00a	0.40a	1.30b	2.96a

Means in a column with the same letter (s) are not significantly different by Tukey's test ($p \leq 05$)

Effects of soil microbial population as influenced by the varying rates of diuron application are presented in figure 1. Bacterial population was significantly reduced by diuron irrespective of rate of application compared to the untreated plots. The highest bacterial population was recorded in the weedy control followed by the hand weeded plots. Among the diuron treatments, bacterial population appeared to decrease with increase in the rate of application of the herbicide. Hand weeding reduced bacterial population by 27.5% whereas percentage reduction caused by diuron application was above 80% irrespective of the rate of application.

Table 3: Linear correlation and regression analysis between increasing rates of diuron (X) and soil nutrient content (Y) at harvest

Soil parameter	Correlation coefficient(r)	Regression equation
Soil pH	0.30	Y=5.7+0.016X
Organic matter (%)	0.42	Y=5.83+0.07X
N (%)	-0.15	Y=0.18-0.003
P(mg/kg)	0.69	Y=27.13+2.96
K (cMol/kg soil)	0.41	Y=33.55+1.02X
Ca (cMol/kg soil)	0.19	Y=4.48+0.01X
Mg (cMol/kg soil)	0.28	Y=4.15+0.17X
Na (cMol/kg soil)	-0.45	Y=15.62-0.27X

The soil fungal population did not respond to diuron treatment in any consistent manner with respect to rate of application. Diuron application however reduced fungal population with respect to the weedy control irrespective of application rate, and percentage reduction in fungal count were lower than those recorded for bacteria. Diuron reduced fungal population by 60.8, 58.8, 56.7, 68.0, 66.0 and 67.0 % for diuron application at 1.2, 1.8, 2.4, 30. 3.6 and 4.2 kg a i/ha respectively, whereas hand weeding reduced fungal population only by 15.5% compared to the weed check control.

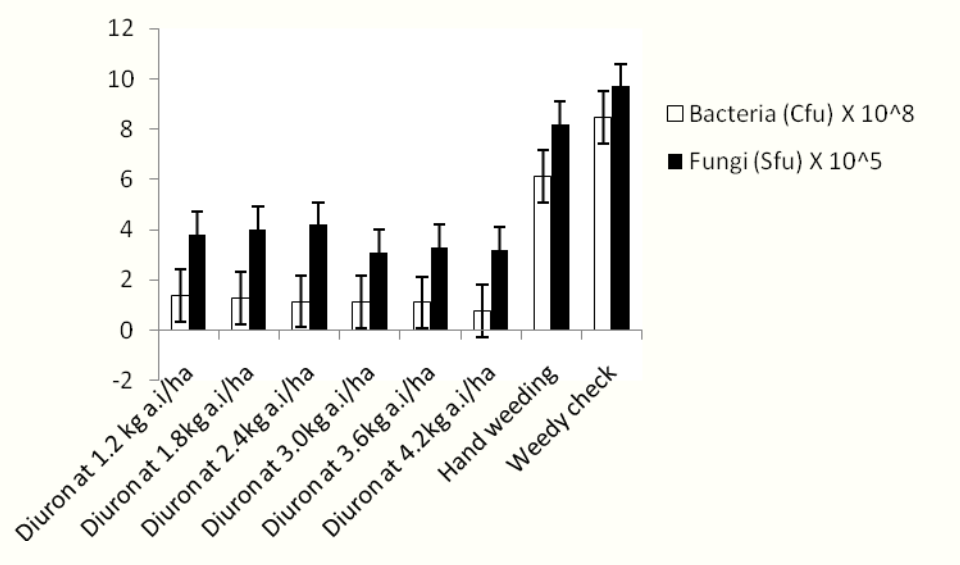

Figure 1. Effects of increasing rates of diuron on the bacterial and fungal population

Figure 2 shows the effects of the treatments on the plant height of maize measured in dynamics from 2 to 10 WAP. There were no significant differences noticed among the various treatments in the first 4 weeks after treatment application.

Diuron treatments however started to affect the heights of maize plants as from the eight week after planting (WAP), and these variations among the varying rates of plant height continued until the 9th week. The tallest plants were obtained from the hand weeding treatment at maize harvest. Among the herbicide treatments, rates from 3.0ka a I / ha and above performed excellently well in terms of plant growth enhancement. The lowest rate of diuron treatment reduced plant height at week 10 after planting compared to the weedy control. Average number of leaves per plant was however affected by the herbicides treatments in different manner (figure 3). For this parameter, significant differences were only noticed among the diuron treatments at 2 and 5 weeks after application of diuron to the soil. At harvest, the tallest maize plants were found in the hand weeded plots, and among the diuron treatments.

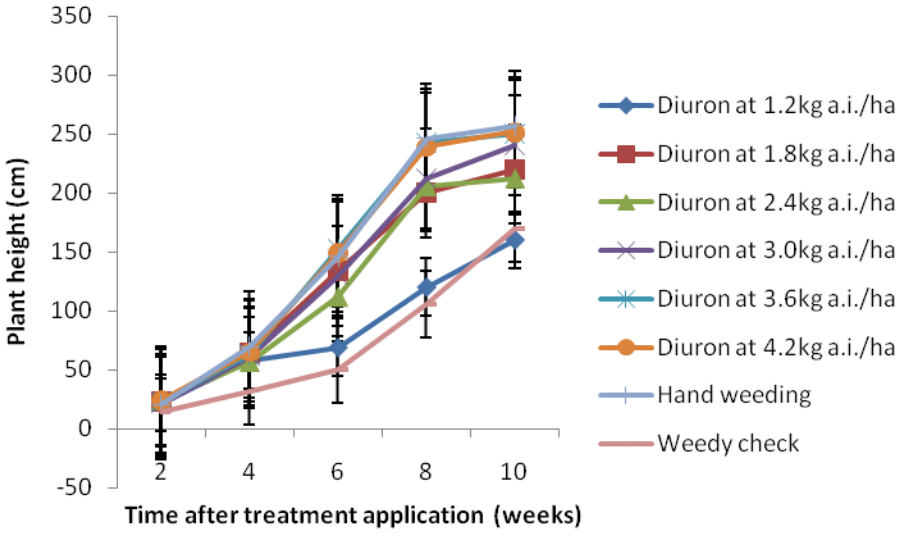

Figure 2. Effects of diuron treatments on maize plant height

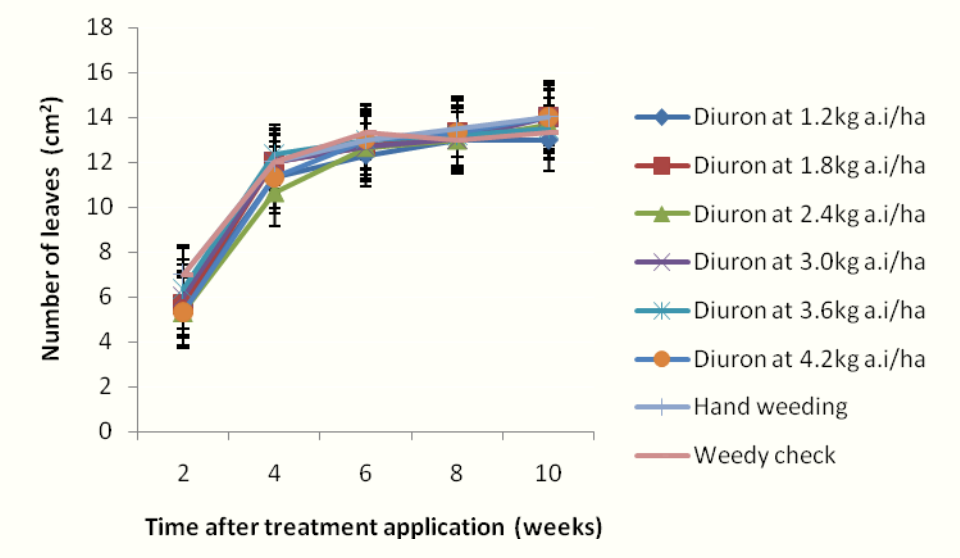

Figure 3. Effects of diuron treatments on average number of leaves of maize

There were significant differences amongst treatments regarding their influences on maize grain yield recorded at harvest as shown in table 6. Among the treatment, total grains weight obtained from hand weeded plot was the highest compared to other treatments. Maize grain weight obtained from weedy check plots were lower than that obtained from diuron treated plots. There were no significant difference between diuron at 1.2kg a.i/ha and 1.8kg a.i/ha in term of maize grain yield. Also, there were no significance difference between diuron at 3.6kg a.i/ha and 4.2kg a.i/ha in term of maize grain yield but hand weeded was significantly higher when compared to other treatments in terms of maize grain yield. Among the diuron treatments, increasing dose of the appeared to increase maize yield.

Table 4. Effects of diuron treatments on maize yield

Treatment	Yield
Diuron at 1.2 kg a.i/ha	868.33d
Diuron at 1.8kg a.i/ha	891.33d
Diuron at 2.4kg a.i/ha	975.00c
Diuron at 3.0kg a.i/ha	1038.33c
Diuron at 3.6kg a.i/ha	1115.00b
Diuron at 4.2kg a.i/ha	1175.67b
Hand weeding	1333.33a
Weedy check	744.33e

Source: Laboratory analysis results

There were significant ($p<0.05$) differences amongst treatments in weed weight recorded at 3 WAT and at harvest including the cumulative weed weights (Table 2). In both years, total weed growth as measured by cumulative weed fresh weight was significantly reduced in the weed-free control, when weeds were removed once per week till harvest at 10 WAP compared with the weedy control and the diuron treatments. Specifically, application of diuron at 1.2 kg a.i. /ha resulted in higher total weed weight removed compared with the other treatments including the weedy

control, while weed weight removed were similar for diuron from 2.4 to 3.6 kg a.i. / ha and the weedy control in. Regressing weed fresh weight (Y*)* against increasing dose of atrazine (X) showed negative relationships with prediction equations shown in Table 3.

Table 5: Effects of varying rates of diuron on fresh weight in g/m^2 of weed removed in maize plots

Treatment	Fresh weight at 4 WAT	Fresh weight at harvest	Cumulative weight
Diuron at 1.2kg a.i/ha	38.67a	45.00a	83.67a
Diuron at 1.8kg a.i/ha	28.33bc	36.67b	65.00b
Diuron at 2.4kg a.i/ha	20.00abc	30.67c	50.67bc
Diuron at 3.0kg a.i/ha	18.67cd	25.67d	44.34c
Diuron at 3.6kg a.i/ha	15.67d	20.33e	36.00d
Diuron at 4.2kg a.i/ha	11.67de	17.67f	29.34d
Hand weeding	3.67e	9.66f	13.33e
Weedy check	29.00b	42.33a	71.33a

Source: Laboratory analysis results

Table 3: Linear correlation and regression analysis between increasing rates of diuron (X) and fresh weight (Y)

Weed fresh weight	Correlation coefficient(r)	Regressions equation
At 3WAP	-0.97	Y= 37.3 - 6.3x
At harvest	-0.99	Y= 52.58 – 8.9x
Cumulative	-0.99	Y= 89.89 – 15.16x

Source: Laboratory analysis results

DISCUSSIONS

This study has clearly demonstrated that the diuron herbicide exerts divers' influences on the soil chemical and microbial status, and this confirmed the conflicting nature of results obtained from previous studies on the influences of herbicide treatment on soil chemical properties. For instance, several triazine herbicides have been found not to exert any significant influence on soil nutrient content in field trials conducted in established crop rotations (Gruzdyev, 1974). In contrast, significant increases in soil nutrient content over the unsprayed plots have been recorded following repeated applications of triazine herbicides in the field (Kruglov *et al*., 1975; Sidorov, 1974). The discrepancies in responses of soil nutrient content to atrazine application often reported in the literature appear to be related to, among other factors, differences in soil edaphic and climatic conditions under which these studies were conducted and any lack of uniformity in the physical conduct of the experiments (Lebedeva *et al*., 1990). The relatively low soil pH recorded in this experiment in the weed-free and the diuron-treated plots at maize harvest presumably arose from water erosion of the exposed soil in the early period of crop growth which led to leaching out of much of the base-forming cations, leaving the exchange complex dominated by aluminum and hydrogen ions (Brady & Weil, 1999). This might also be responsible for the low values recorded for these exchangeable bases (K, Mg and Ca) at the time of sampling. The higher pH recorded in the weedy check control might have resulted from

accumulation of liters during the course of the experiment because the plot was left unheeded. Decomposition of these liters had definitely added organic matter to the soil, and this would have in turn raised the pH of the soil.

This may also be adduced as the reason the untreated weedy control had higher OM concentration compared with the weeded plots either with diuron or hand weeding. Addition of organic manure has been found to move soil pH towards neutrality in acidic (Benke *et al*. 2009) and alkaline (Chang *et al*. 1990; Hao and Chang 2002) soils, thus improving nutrient availability especially for P and micronutrients. This may also be responsible for the boost in OM, N and P in weedy check compared to the other treatments. N and P are among the nutrients known to be furnished by the soil organic matter. Furthermore, diuron has been found to reduce the populations of certain strains of nitrogen fixing bacteria including algae (Flores, and Barbachano 1992) as well as ammonia oxidizing bacteria (*Nitrosomonas*) (Gadkari,1988), thus grossly reducing the possibilities of external N fixation to the soil. In addition, diuron reduces the activity of phytase, an enzyme that mineralizes the plant nutrient phosphorus in soil (Cervelli and Perna, 1985). Decrease in the levels of soil organic matter and basic soil nutrients in the diuron treated plots could be as a result of the decrease in soil microbial population earlier discuss. The delay in activity and the decrease of the total microbial activity of soil affects the decomposition of crop residues and the soil organic matter that are an essential contribution of the nutrient cycling process in the soil (Prado and Airodi, 2001). In general, pesticides that have toxic effects on soil microbial activity, such as diuron, give rise to the possibility of adverse consequences on long-term soil fertility (Moorman, 1989).

Reduction in soil bacterial and fungal population irrespective of the rate of diuron application to soil indicated that a fraction of the soil microbial community did not adapt to the herbicide. Similar results were obtained by Adejoro (2016) when soil samples were treated with cypertmethrin, a synthetic pyrethoid insecticide. This is in consonance with previous findings that diuron is able to disrupt the complex ecological community of soil microorganisms, including algae and fungi (Prado and Airoldi , 2001) in a variety of ecosystems. Diuron in concentrations equivalent to those used by farmers has also been reported to reduce algae populations by 99 percent in the top layer of the soil in both clay and sandy loam soil (Pipe and Cullimore, 1980; 1984). The herbicide has also been shown to inhibit microbial activity in soil, even at concentrations as low as several parts per million, causing conditions averse to restoring soil fertility (Prado and Airoldi, 2001).

This decrease in the soil microbial population compared to the control treatment can therefore be associated with toxic effects of diuron on soil microorganisms. The higher microbial population recorded in the weedy check control was not unexpected. This may not be unconnected with the rhizosphere effect obtainable at the root zones of diverse weed species, and the colonizing organisms were likely to possess good rhizosphere competences (Kennedy, 2005). Microbial population in the hand-weeded plots was almost at pal with the unheeded plots. Microbial count might have been increased by hoeing in this study through increased aeration and water movement in the soil (Iremiren, 1988), which are good conditions for microorganisms to thrive. The observation that diuron exerted more toxicity to the soil bacterial than the fungal community in this study may not be unconnected with the fact that degradation of the herbicide in soil is carried out by fungi. Three fungal strains (*B. bassiana, C. elegans*, and *M. isabellina*) have been identified as being able to transform diuron to any extent (up to 50%) after 7 days of incubation (Bogarets *et al*., 2000). The two metabolites identified after the degradation (N- (3,4-dichlorophenyl)-N-methylurea and N-3, 4-dichlorophenylurea) was however reported to present a three times higher toxicity than that of diuron (Bogarets *et al*., 2000).

The weed free control and the higher rates of diuron significantly increased maize plant height and grain yield over the weedy control and the treatments involving lower rates of diuron. These were in response to the differential weed growth between the foregoing treatments. The highest maize grain yield occurred in the weed-free plots, indicating that it is necessary to protect the crop from weed competition throughout most of its growth to ensure maximum

yield. As stated earlier, aeration and water movement caused by hand weeding engendered by hoeing might have been responsible for the yield increase. Diuron at 3.0 to 4.2 kg a.i/ha provided optimum weed control and improved maize grain yield close to that obtained in the weed-free plots. The significant differences observed amongst the diuron treatments in terms of weed weight at 3 WAT and at harvest including the cumulative weed weights indicate that the extent of weed growth in the treatments was dose-dependent.

Weed growth decreased more or less significantly in the order of increasing dose of diuron presumably because higher doses imply a higher quantity of active components available to cause control. The very poor weed control and consequent low maize yield from the lowest rate (1.2 kg a.i./ha) of the herbicide confirmed earlier observation that many herbicides commonly used for weed control show growth-stimulating or hormone-like properties at sublethal concentrations (hormesis) (Akobundu, 1987). Wiedman & Appleby (1972) screened several herbicides in the greenhouse and indicated that many of them from different herbicide groups stimulated plant growth at sublethal concentrations. Plant response to sublethal doses has been extensively reviewed by Ries (1976), who also discussed the possible implication of this phenomenon in agriculture and herbicide rotations (Akobundu, 1987).

CONCLUSIONS

Application of diuron at the standard rate of 3.0 kg a.i.ha and above compared favourably with the weed free control in terms of growth and yield enhancement in maize. This was because these rates of the herbicide provided optimum weed control in the crop. Soil nutrient and microbial status were however adversely affected by the herbicide irrespective of rate of application. It is therefore recommended that practices or inputs that can reduce the toxicity of diuron to soil microorganisms, which may in turn lead to improvement in soil nutrient status, be integrated into diuron weeding programmes as reduction in its rate of application may not achieve the desired weed control efficacy.

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EVALUATION OF THE REPRODUCTIVE PERFORMANCE OF THREE SELECTED RABBIT BREEDS (CHINCHILLA, DUTCH AND NEW ZEALAND WHITE DOES MATED WITH DUTCH BUCK

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Abstract

The study evaluated the reproductive performance of three rabbit breeds; New Zealand White, Chinchilla and Dutch. Rabbit animals were paired and a total of eighteen rabbits were used for the study. Findings revealed that average litter size at birth in the genetic groups NZW x DUT was between 6.40 ± 0.40, while DUT x DUT was between 4.00 ± 0.45 and CHN x DUT was 5.60 ± 0.41 respectively. Average litter weight at birth of the NZW x DUT was 0.03 ± 0.08, also the DUT x DUT was 0.04 ± 0.08 and CHN x DUT genetic group was 0.03 ± 0.07. Average litter size at weaning in the genetic groups ranged from 3.40 ± 0.54 to 5.40 ± 0.64, while average litter weight at weaning in all genetic groups ranged from 0.28 ± 0.03 to 0.38 ± 0.03. Gestation period of the rabbit breeds used ranged from 28.80 ± 0.37 to 30.00 ± 0.32 days. CHN x DUT had the lowest average weight at birth and at weaning, DUT x DUT had the highest average weight at weaning.CHN x DUT, had the highest percentage survivability and NZW x DUT, had the highest percentage mortality. The study concluded that the chinchilla rabbit doe has a relatively better mothering ability and a highest survival rate. It was therefore recommended that farmers should adopt the cross breed of Dutch buck and New Zealand and Dutch Buck and Dutch does for better overall performance.

Keywords: Rabbit breeds (Chinchilla, Dutch, New Zealand White), reproductive performance,

IJAFS 2018 (9), 8:1220-1225
Accepted for publication
August 2018

INTRODUCTION

The rabbit has been domesticated for several years and is adaptable to confinement rearing and close association with humans (Lebas *et al*., 1986). According to Biobaku and Dosunmu (2003) and Fayeye and Ayorinde (2003), the increasing human population especially in developing countries coupled with inadequate supply of animal source of protein from the principal livestock species (cattle, sheep, goats, pigs and poultry) has made it imperative that attention be shifted to other micro-livestock such as rabbit. This is because rabbit production has the potential in alleviating the problem of inadequate animal protein supply in developing economies. This, according to Ghosh *et al*. (2008) is attributed largely to the rabbit's high rate of reproduction, early maturity, rapid growth rate, efficient food utilization and meat of high nutritional value. Its meat is highly digestible, wholesome, tasty and low in cholesterol, sodium and fat with high protein content (Herbert, 2011). Rabbits, because of the enormous benefits associated with their production, and with the belief that the unconventional livestock will certainly bridge the animal protein gap being experienced by man, it is imperative to give available rabbit breeds the needed attention just like other animal genetic resources so as to have more animal products that could supply the immediate needs of man. The production efficiency of

commercial rabbit farms is largely dependent on the litter size at kindling and the survivability of the bunnies up to weaning (Odeyinka *et al*., 2008. Among the available adaptable foreign breeds of rabbits reared for meat production in Nigeria are Chinchilla, Dutch and New Zealand white.

Rabbit farming is gaining momentum in Nigeria due to its high production potentials, high mothering ability, adaptability to a wide range of conditions, high genetic variability, high roughage utilization and low cost of production. Rabbit production appears as an attractive proposition for the supply of high quality meat. The increased livestock production can be achieved by rearing animals of short generation interval like rabbits by small scale farmers.

There is also paucity of information on the growth and reproductive efficiency of the available breeds in Nigeria. Therefore, the present study was undertaken to assess the growth and reproduction performances of Dutch, New Zealand white and Chinchilla breeds as influenced by breeds and parity in order to come out with the best strategies for improving the productivity of these rabbits in Nigeria. Consequently, the broad objective of the study was to evaluate the reproductive performance of Chinchilla, Dutch and New Zealand White does mated with Dutch buck.

MATERIALS AND METHODS

The experiment was carried out at the Rabbit Unit, Directorate of University Farm (DUFARMS), at Federal University of Agriculture Alabata road, Abeokuta. Alabata (70 10’ and 30 2’ E) is in Odeda Local Government Area of Ogun State Nigeria. Three breeds of rabbits Chinchilla, Dutch and New Zealand White were used for the study. A total number of 18 rabbits were used for this study. Out of the18 rabbits, 5 were Chinchilla does, 5 Dutch does and 5 were New Zealand White does. The bucks were of the Dutch breed. The experimental animals were breeders. The does and the buck used for the research, which were 3 breeds of rabbit, were obtained from a reputable farm in Alabata, along Ogun – Osun road, Abeokuta, Ogun State. The breed for the buck were Dutch and the breeds for the does used were New Zealand White, Chinchilla and Dutch. The experimental animals used in the course of this project were raised under the intensive system of housing. The rabbit housed were made of wooden plank known as the hutch. Each of the bucks and the does occupied hutch singly and mating exercise occurred at the bucks’ hutches. The experimental animals were supplied fresh, cool and clean water and both concentrate feed and forages were supply to them in the hutches respectively. The animals were fed such that, concentrated and pelletized feed were given in the morning while the forage harvested are given in the evening. Forages were harvested and spread early to get rid of microbes that might be ingested together with it. The ratio of does to buck were 1:5, because the breeding programme were hierarchic design in which several does were mated to one buck only.

Table 1: Mating Pattern involving the New Zealand White, Dutch and Chinchilla Breeds of Rabbit in Abeokuta, Nigeria.

Number of crossing	Sex			Resulting genotype or genetic group
	Buck		Doe	
	DUT	×	NZW (5)	NZWDUT
	DUT	×	DUT (5)	DUT
	DUT	×	CHN (5)	CHNDUT

Source: Laboratory analysis results

* NZW= New Zealand White, DUT= Dutch, and CHN= Chinchilla rabbits
Number in parenthesis represents number of does used.

Management of pregnant does

The does, after mating and successive conception were prevented from mating. Prior to parturition (kindling), adequate preparations were made in terms of provision of kindling box. Good concentrate feed and forages, clean and cool water were made available.

Method of Data Collection

The newly kindled kittens from different genotypes were weighed on a weekly basis from week 1 to week 5 on a weighing scale. Litter size at birth and at weaning as well as litter weight at birth and at weaning, gestation period in each rabbit doe, percentage mortality during pre-weaning in each genetic group and percentage survivability till weaning were considered for each crossing. Data collected were descriptively analyzed.

Data collected include;

Average litter size at birth and weaning
Average litter weight at birth at weaning
Average gestation period
Percentage survivability at weaning
Percentage mortality
Litter Size: This is the number of newly born at birth and at weaning.
Litter Weight: this was recorded as the weight of kittens at 7days after birth and at weaning.
Gestation period: This is the period of time between mating and kindling.
Percentage Mortality (%): This is obtained by the ratio of the number of dead kittens to the total number of kittens multiplied by 100.
Percentage Survivability at weaning: 100 – % mortality.

Statistical analysis

Descriptive statistics were carried out on the data generated. All results were expressed as average and their standard error of means. Percentage survivability was depicted as %M. Average litter size at birth was depicted as ALS at B and average litter size at weaning was depicted as ALS at W. Also, average litter weights at birth and at weaning were depicted as ALW at B and at W respectively.

Results

The mating patterns involving the New Zealand White, Dutch and Chinchilla rabbit breeds, together with the result of the reproductive performance of these three breeds of rabbits were recorded. In the study conducted, the average mean litter size at birth in all the genetic groups ranged from 4.00 ± 0.45 to 6.40 ± 0.40 and average litter size at weaning in all the genetic groups ranged from 3.40 ± 0.54 to 5.40± 0.64. Also, the average litter

weight at birth (kg) in all the genetic groups ranged from 0.03 ± 0.007 to 0.04 ± 0.08 and the average litter weight at weaning (kg) ranges from 0.28 ± 0.03 to 0.38 ± 0.03. The percentage Mortality (%) ranges from 7.14 to 15.62, Percentage Survivability (%) ranges from 84.38 to 92.86 and the gestation period varied in the three genetic groups ranging from 28.8 ± 0.37 to 30.00 ± 0.32 days.

Outcome of crossing New Zealand White does with a Dutch buck

The New Zealand White does had the highest litter size at birth which has the value of 6.40 ± 0.40, they also had the highest average litter size at weaning, they also have a moderate average litter weight at birth and at weaning. The genetic group NZWDUT had the highest percentage mortality and also the lowest survivability percentage alongside with a moderate gestation period among the genetic group

Outcome of crossing Dutch does with a Dutch buck.

The Dutch does have generally the lowest average litter size at birth, average litter size at weaning and average weight at birth. Also, they have highest average litter weight at weaning. Among the genetic groups the DUT had a moderate mortality and survivability percentage. The Dutch breed has the shortest gestation period among all the genetic groups having 28.8 ± 0.37 (days).

Outcome of crossing Chinchilla does with Dutch buck

The CHN × DUT genetic group had the highest average litter size at birth and average litter weight at birth among the genetic groups. The average litter size at weaning is moderate, coupled with the average litter weight at weaning which was the lowest of all; this genetic group had the longest gestation period. The Chinchilla breed mated with the Dutch buck has the lowest percentage mortality and of course has the highest survivability rate.

Discussion

This study showed that it is very viable to practice crossbreeding and inbreeding among rabbits breeds. The observation of the New Zealand does generally shows they have generally the highest litter size at birth and average litter size at weaning and moderate average litter weight at birth and at weaning, when crossed with the Dutch buck is in contrast with what had been reported by Sorensen *et al* (2001). Also, the observation that the gestation period of the New Zealand doe has a value of 29.80 ± 0.37, corresponds favorably to the 28.10 which had been earlier reported by Odeyinka *et al* (2008), for some breeds of rabbits. Also the percentage mortality for NZW × DUT genetic group was 15.62%, which is in correlation and range of the 16 to 19% previously reported by Sorense *et al* (2001) for breeds of rabbit. This could be as a result of poor mothering ability of the doe `and also means that kits generated from this group needs proper handling, adequate balanced diet, favorable environmental conditions, proper management strategies and sound medications at all times in order to reduce the high rate of mortality among the kittens generated in the New Zealand White rabbit.

The observation that the DUT x DUT genetic group had a low average litter size at birth and low average size at weaning due to pre-weaning, due to pre-weaning mortality oscillates with what had been reported by Sorense *et al* (2001) for rabbit breed. The range of values of the average litter weight at birth and at weaning were the highest for this genetic groups, and this genetic groups, and values were 0.04 ± 0.08 is in contrast to that 3.89 which was reported in literature by (Fayeye and Ayomide, 2012). The gestation period of this group was in the range of 28.8 ± 0.37 which was in agreement to that of 3.89 to 42.3 which was reported in literature by Odeyinka (2008) for some breeds of rabbit but oscillates with 28.8 to 32days for breeds of rabbit which is the standard gestation lenght of rabbits. Also the percentage mortality for this genetic group was 15.00% and it oscillates around 16 to 19% previously reported by Sorensen *et al* (2001).The observation that the CHN vs.

DUT genetic group had a moderate litter size at birth and at weaning, due to pre-weaning mortality which is in agreement with what had been reported by Sorense *et al* (2001) for rabbit breeds, the fact that this genetic group also had a moderate average litter weight at birth but lowest average litter weight at weaning may be due to environment conditions and management techniques / strategies. The gestation period of this genetic group was 30.00 ± 0.32, which was slightly greater than 28.10 ± 30.40 days, earlier proposed by Odeyinka *et al* (2008) for some breeds of rabbit, but in total agreement to the 28 to 32days, which is the standard for all breeds of rabbits. Also, the percentage mortality for this genetic group was 7.14 which is greatly low to the 16 to 19% previously reported by Sorense *et al* (2001). And the survivability rate of this breed is the highest.

Conclusion

When considering parameters such as litter size at birth and at weaning, litter weight at birth and at weaning, gestation period, percentage mortality and percentage survivability. This study also shows that Chinchilla rabbit doe has a relatively better mothering ability and it's the mother superior of the three different breeds. Also using the percentage survivability rate shows that the Chinchilla rabbit has small percentage mortality and of course the highest survival rate.

Recommendations

For increased rabbit production in Abeokuta Nigeria genetic grouping of NZW vs. DUT, DUT vs. DUT and CHN vs. DUT should be put into consideration due to the following facts;

Crossing Dutch buck with New Zealand White (cross-breeding) results is relatively high litter size at birth and average litter size at weaning. This is profitable for breeders who sell after weaning: more kittens to be sold thereby increasing the breeder's profit.

Crossing Dutch buck with a Dutch doe result in kittens with relatively high average weight and birth at weaning. This is profitable for farmers which sells their rabbits for meat purposes.

Crossing of Dutch buck and Chinchilla doe (cross breeding), this results in kitten from this genotypic cross having a relatively high survivability percentage and relatively small mortality, this depicts that the Chinchilla doe is the mother superior which encourages availability of rabbit to the farmer year-in-year-out thereby increasing profitability in the Rabbit enterprise.

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Table 2: Summary Statistics of the reproductive performance of New Zealand White, Dutch and Chinchilla does mated with Dutch buck in Abeokuta, Nigeria

Breeds of rabbit	Average litter size at birth (ALS at B)	Average litter size at weaning (ALS at W)	Average litter weight at birth (ALW at B) (kg)	Average litter weight at weaning (ALS at W) (kg)	Percentage Mortality (%)	Percentage Survivability (%)	Gestation Period (in days)
NZW	6.40 ± 0.40	5.40 ± 0.64	0.03 ± 0.08	0.31 ± 0.02	15.62	84.38	29.80 ± 0.37
DUT	4.00 ± 0.45	3.40 ± 0.54	0.04 ± 0.08	0.38 ± 0.03	15.00	85.00	28.80 ± 0.37
CHIN	5.60 ± 0.41	5.20 ± 0.45	0.03 ± 0.07	0.28 ± 0.03	7.14	92.86	30.00 ± 0.32

Source: Laboratory analysis results

Ethnographic Assessment of Fishes Used by Traditional Health Workers for Treatment of Reproductive Dysfunction Among Respondents in Southwest Nigeria. Olagoke, O.O. JABU International Journal of Agriculture and Food Science (IJAFS); 2018: Vol., 08

ETHNOGRAPHIC ASSESSMENT OF FISHES USED BY TRADITIONAL HEALTH WORKERS FOR TREATMENT OF REPRODUCTIVE DYSFUNCTION AMONG RESPONDENTS IN SOUTHWEST NIGERIA

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Abstract

This study examines fishes used by traditional health workers for treatment of reproductive dysfunction among health workers in Southwest Nigeria. Participant observations, case studies, in- depth interviews, archival materials and ethnographic observations were used to generate qualitative and quantitative data on fish species utilized and their sources. Interview schedule was used to obtain data on socio-economic characteristics and sources of fishes from 215 selected traditional health workers through multistage sampling technique. Data were analysed using frequency count, percentages, means and standard deviations and analysis of variance. Findings revealed that 80.0% of the respondents were male, 96.3% married, 52.1% were Muslims, and 48.8% had 11 years of experience in indigenous healing practices. Also, 62.5% had secondary education, 30.2% were engaged in farming with a mean age and household size of 45 years and 12 persons respectively. Commonly used fishes were: Clarias gariepinus, Clarias anguillaris, Malapterurus electricus, Parachanna striata, Tilapia guineensis, Monodactylus sebae and Phractolaemus ansorgii. The result from ANOVA shows that there were significant differences in sources of knowledge (F =4.007, P =0.019), years of experience (F= 4.042, P= 0.046) and number of trainees (F- 35.022, P=0.000) across the study are

Keywords:

IJAFS 2018 (10), 8:1226:1236
Accepted for publication
September 2018

INTRODUCTION

Aquaculture is an important component of agriculture providing required protein to ensure healthy living among humans (Adewale, 2011). It is confirmed by literature to be of immense significance in traditional healing across Yoruba speaking people of Southwest Nigeria. Good health is an impetus to the overall development of the rural populace (Ladele and Amosun, 2014). In Southwest Nigeria, the use of herbs has been revivified and is regaining its prominence and honour across socio- economic strata of the populace (Ladele and Amosun, 2014). There had been practical utilization of herbs to cure ailments; in fact, the renaissance of medicinal herbs is due to the fact that herbs offer solutions without stumbling blocks for everyday disorders (Sofowora, 1997). Diseases are being treated with concoctions made from herbs and animal derivatives. Sahelia, (2010) reported that traditional healers add herbs to the fish oil in the course of remediation of a disease condition. In Yoruba land, palm oil is referred to as ero (i.e. antidote). Since the major reason for using fish is not just for consumption, the oil in the fish does the healing by mixing it with herbs (Orilogbon and Adewole, 2011). A number of fish species are of immense importance in unorthodox medicine (Sahelia, 2010). Clarias spp. " eja aro" is found to be multipurpose as it is used to cure insanity and other mysterious ailments. For instance," Orunmila" a deity, loves " Eja Aro" clarias when sacrificing against enemy,

Fish is used by Ifa priests as an object for idol worship, spiritual rites and also native medicine for healing (Orilogbon and Adewale,2011).

Family stability in rural community hinges on a number of factors of which reproduction is one, in the same vein, Anastasia Gage-Brandon. (1992) established a strong relationship between polygyny and fertility, and that sexual prowess determines the number of wives in rural households. He further submitted that childlessness and sexual dissatisfaction often contribute significantly to family instability in rural communities in Nigeria. Agriculture is always at the receiving end of issues at family level as family provides most of the labour used in agricultural operation.

Ontological and epistemological orientations of ethnography with the ethnographic hosts in research and researcher, to a greater extent helped to unearth the benefits extracted from fishes and put into use in indigenous traditional ways (Orilogbon and Adewale, 2011). Hence, a number of debilitating health situations most especially reproductive dysfunction juxtapose the findings from the field work and literature. This expository helped to establish a nexus in the curative potentials of the fish-based ethnomedicine for the benefits and use for mankind. . It is in view of the above, that the following research questions were addressed, what are the types and parts of fishes used in traditional medicine? And how these fish's species were utilized for the treatment of reproductive dysfunctions among respondents in the study area?

Hypothesis of the study

$H0_1$: There is no significant difference in selected socioeconomic characteristics of traditional health workers across the states in the study area.

METHODOLOGY

Description of the Study Area

The study was carried out in Southwest part of Nigeria which lies between latitude 6^0 and 9^0N of the equator and longitude 2^0 and 7^0E of the Greenwich meridian occupying an area of 76,851 square kilometers. The region is made up of six states namely: Lagos, Ekiti, Ogun, Ondo, Osun and Oyo states. The total population of the area is 27,581,992 with Lagos state having 9,013,534; Oyo -5,591,589; Ondo 3,441,024; Osun 3,423,535; Ogun 3,728,098 and Ekiti 2,384,212 (World Population Prospects, 2006). It is bounded in the south by Atlantic Ocean, in the west by the Republic of Benin, in the east by Edo and Delta States, and to the north by Kwara and Kogi States (National Bureau of Statistics, 2010). The area is mainly dominated by the Yoruba ethnic group. There were two phases in the research design for this study which were qualitative and quantitative methodological approaches. In qualitative approach, participant observation, interviewing, archival research and case study were used. It involves note taking, pictures and voice recording of every stage of preparation of traditional medicine having fish as their active ingredient. In quantitative methodology, Interview guides were prepared and used at to determine the socio economic characteristics of the ethnographic hosts in the study area.

Multistage sampling procedure was used to select the respondents in the study area. First stage; 50% of the Southwest states were purposively selected- (Ondo, Lagos and Oyo). The chosen states were stratified into riverine and non-riverine areas, giving Ondo and Lagos as riverine states, while Oyo represented non-riverine state. The second stage, Ilaje Local Government; Epe and Badagry Local Governments were purposively selected because of the fact that the subject-matter is fish and that there is an intense fishing activities in Ondo and Lagos states, respectively. At stage three, the respondents were sampled proportionate to size where 25% were obtained from the available sample frame where a total of 215 respondents were used for the study.

Ethnographic hosts used for the research were those that volunteered to avail the researchers the processes and procedures for the preparation of ethno medicine having fishes as active ingredients for treating reproductive dysfunctions and other health challenges.

Socio economic parameters such as: age, marital status, religion, household size, secondary occupation, educational status, nativity and sex of traditional medical practitioners were considered as independent variables. A list of five possible sources of fishes were provided which included: fishermen, fish traders, traditional pharmacists, self-sourcing and fellow traditional practitioners. Respondents were requested to indicate how often they sourced for fishes whenever they were needed in the preparation of fish-based medicine. This was rated in a three- point rating scale of regularly (3), occasionally (2) and never (1). The mean score of each source was computed and used in ranking the sources of fishes used in traditional medicine from the most used to the least used.

The qualitative data derived from the ethnographic engagement with ethnographic hosts where participant observation, in-depth interview were spontaneously adopted and analyzed manually by the researcher. This was done using the thematic and content analysis. Data obtained through ethnographic processes such as observation, participant observation, in-depth interview, pictures and tape recording were subjected to content analysis which is a procedure for the categorization of verbal or behavioural data, for purposes of classification, summarization and tabulation. The analysis involved a more interpretive analysis that is concerned with the response as well as what may have been inferred or implied.

The quantitative data collected were subjected to descriptive statistics such as frequency counts, percentages, means and standard deviation. The mean of the data was obtained by summing all the data values (scores) divided by the total numbers of values data value or scores (N). Also, Analysis of Variance (ANOVA) was used to test for the differences in the socioeconomic characteristics of traditional health workers across the states in the study area.

RESULTS AND DISCUSSION

Socio- economic characteristics of traditional health workers

Data presented in Table 1 shows the mean age of the respondent 46 years. In Lagos state, an appreciable percentage (69.2%) of the respondents was below 50 years, in Ondo state, slightly below average (42.8%) of traditional health workers were below 50 years of age, while in Oyo state, majority (67.1%) had their ages below 50 years. The description infers the active involvement of relatively young people in traditional medicine practices in the Yoruba dominated Southwest Nigeria. This is a positive development as the involvement of vibrant youth will ensure the preservation of the age-long practice and ensure its sustainability. In other words, it prevents the extinction of traditional ingenuity of immense therapeutic significance in the rural community. It is evident that people are not deterred despite the much hype geared towards the discouragement of the practice and use by some elites and practitioners of western medicine degrading the indigenous medicine as an anachronistic profession or practice (Ehinmore and Ogunode, 2013). They therefore put no premium on it. This is connected with some factors such as inadequate scientific proofs, beliefs in ancestors, nemesis, superstitions and other anecdotal evidences (Omachonu, 2009: Erinmore and Ogunode, 2013). Also, the involvement of active ages of the population is a pointer to the fact that people are becoming more aware of the efficacy of the traditional medicine and the fear of its transmission to the younger generation is allayed.

Table 1 reveals that majority (80.0%) of the traditional health workers were male, while 20.0% were female. Ondo state has the highest (82.9%), while Lagos and Oyo had 80.0% and 79.1% respectively. This is evident that the practice is not gender biased, and that female are getting involved in the practice of ethnomedicine unlike what was obtainable in the ancient time where the profession was absolutely reserved for elderly men in the community (Borokinni and lawal, 2014). Women are mostly dominating traditional birth attendance, and they hardly specialize only on this but in combination with other aspect of healing carried out by the traditional doctors. They have different names such as *Iya Osun*,chief priest of Osun religion *Agbomola* the woman that provides salvation for one in spiritual captivity, *yeye orisa* chief priest of the oracle. The epistemology of traditional healing does not reside only with men. The ingenuity of the practice could be got from varying sources without gender affinity and affiliation. It may be got from mystical sources such as encounter with angels, supernatural contact with spirits, dreams, intuition, revelation, trance and ancestral profession (Borokini and Lawal, 2014).. Women also participate not only in the collection of herbs, but some are intensively involved in the prescription and application of the ingenious epistemology. (Borokini and Lawal, 2014).

Table 1 further shows that three states, it appears that the practice of ethnomedicine is championed by married people that were married as revealed that the majority (96.3%) were responsible male and female. Ondo state has the highest (97.1%) number of married members of traditional health workers. It can also be subsumed that traditional medicinal practice is meant for the mature and responsible class of the society which is in tandem with the submission of Fakoya (2000) that marriage attaches a very high degree of responsibility on individual. In the same vain, Ekong, 2003 also justifies the consideration of ages across culture as a precondition for marriage. It also implies that the practice of ethnomedicine in Southwestern Nigeria is a family affair and every member of the family is involved both in the collection of herbs and animal derivatives and in the processing of traditional concoctions providing healings for their patients. Importantly, traditional medicine is said to be a sacred profession that is completely intolerant to and abhor abominable acts like adultery with the belief that engagement in such acts may have spiritual implication effect on the efficacy of his herbal products (Taye, 2009).

The results revealed that the traditional health workers had mean household size of 8 people. Majority (78.1%) across the three states had household size of not less than 8 people. Oyo has the highest proportion of 83.4% of people per household not less than 8 people. Ondo and Lagos states mustered 74.3% and 70.8% having at least 8 people in their various households respectively. It is inferred that traditional medical practitioners do not attach any importance to the contemporary issue of family planning; also they are mostly polygamists with the resultant effects on increased number of children per family.

Results from the Table 1 further reveals that slightly above average (52.1%) of traditional health workers were adherents of Islamic religion in southwestern Nigeria, while Christians and traditional religions had 33.9% and 14.0% respectively. This implies that their involvement in traditional medicine as a profession did not deter them from practicing either of the prominent religions in Nigeria. This is contrary to the submission of Sofowora, (2008) that most of the traditional doctors are stakeholders in traditional religions such as Osanyin, Sango, Ogun, Oya, Osun and Obatala. It could be deduced that religion has no effect on the practice of traditional medicine.

Table 1 shows that 62.8% of the traditional medical practitioners had formal education not below secondary school across the three states considered. The results also showed that Ondo state had the highest proportion of traditional medical practitioners who had secondary education followed by Lagos and Oyo in the order of

60.0%, 55.4% and 49.3% respectively. This implies that the traditional medical experts were fairly educated, and this in no small measure, must have been contributing significantly in their application of basic hygiene principles in the preparation of concoctions used in the treatment of patients undergoing traditional therapeutic process of healing. This is against the submissions of Akunyili, (2009), Borokinin and Lawal, (2013) that most of the traditional health workers were illiterate, and in the process compromising hygiene and health conditions of their patients. This was corroborated in the words of one of the ethnographic hosts."*I had wanted to take up the job of my father who was a very strong traditional healer immediately after his demise; I could not, no thanks to the demand of office. Immediately I meritoriously retired from service, I took up the profession which has proven to be satisfactory and financially rewarding."* The above lends credence to the fact that the profession is not dominated by stack illiterates.

On years of experience, the table 1 shows that 35.8% of the traditional medical practitioners had been involved in traditional medical practices for between 11 and 15 years. Some (26,5%) had the experience of practice of between 6-10 years, while 17.2% and 13.0% had been in the profession for 16-20 and 21 years and above respectively across the three states investigated. The above implies that the influx of the relatively young people into the indigenous medical practice is responsible for the relatively short period of engagement.

The results from the Table 4 revealed that majority (80.7%) of the traditional medical practitioners had trainees across the three states. Also, slightly above average (51.1%) of the herbalist did not have less than 6 trainees. Also, 63.5%, 50.9% and 11.4% of the herbalists from Oyo, Lagos and Ondo respectively had not less than 6 trainees. This kind of indigenous educational opportunity provides a sustainable means of preserving cultural heritage and traditional ingenuity of ensuring the wellbeing of people especially in rural communities.

***Other income generating engagement*:**
The results from the Table 1 show the findings on the income generating activities by the respondents apart from traditional medicine practices. Farming was the most (30.2%) engaged of other income generating activities embraced by the traditional health practitioners; it is trailed by trading because 25.1% of the respondents took to trading as other income generating engagement, some engaged in marketing of herbal products while others engaged in trading of unrelated commodities as revealed during the study. Also, 22.3% of the respondents did engage in artisanship and craftwork.This implies that traditional health workers in the southwestern Nigeria engaged in different kinds of income generating activities to support and improve the wellbeing. In Oyo state, 42.9% of the traditional health workers had farming as their livelihood activities, 28.7% engaged in trading, 18.3% took to craft work and artisanship, while 8.7% were civil servants. For Ondo state, 45.7% engaged in fishing as their livelihood activity, 20.0% took to farming to guarantee food security, while artisanship/craft and trading had 14.3% apiece

Table 1: Distribution of respondents by socioeconomic characteristics

Variables	Categories	Lagos (n=65) Freq. (%)	Ondo (n=35) Freq.(%)	Oyo (n=115) Freq.(%)	Pooled (n=215) Freq. (%)
Age (Years)	31 - 40	6(9.2)	4(11.4)	12(9.7)	22(10.2)
	41 – 50	39(60.0)	21(60.0)	66(57.4)	126(58.6)
	51 – 60	10(15.4)	9(25.7)	34(29.6)	53(24.7) mean=46
	61 - 70	8(12,3)	1(2.9)	2(1.7)	11(5.1)
	71- and above	2(3.1)	none	1(0.8)	3(1.4)
	Mean	46 years	45 years	45 years	45 years
Sex	Male	52(80.0)	29(82.9)	91(79.1)	172(80.0)
	Female	13(20.0)	6(17.1)	24(20.9)	43(20.0)
Marital status	Single	None	None	None	
	Married	62(95.4)	34(97.1)	111(96.5)	207(96.3)
	Widowed	3(4.6)	1(2.9)	4(3.5)	8(3.7)
Religion	Christianity	21(32.3)	12(34.3)	40(34.8)	73(33.9)
	Islam	37(56.9)	18(51.4)	57(49.6)	112(52.1)
	Traditional	7(10.8)	5(14.3)	18(15.6)	30(14.0)
Educational status	No formal Education	6(9.2)	2(5.7)	13(11.3)	21(9.8)
	Adult education	3(4.6)	None	16(13.9)	19(8.8)
	Primary Education	12(18.5)	8(22.9)	20(17.4)	40(18.6)
	Secondary Education	36(55.4)	21(60.0)	49(42.6)	106(49.3)
	Tertiary education	8(12.3)	4(11.4)	17(14.8)	29(13.5)
Household size	3-7	19(29.2)	9(25.7)	19(16.5)	47(21.9)
	8-12	29(44.6)	21(60.0)	84(73.0)	134(62.3) mean=8
	13 and above	17(26.2)	5(14.3)	12(10.4)	34(15.8)
Years of Experience in traditional medicine	1-5	4(6.2)	3(8.6)	9(7.8)	16(7.4)
	6-10	8(12.3)	7(20.0)	42(36.5)	57(26.5)
	11-15	26(40.0)	19(54.3)	32(27.8)	77(35.8) mean=12
	16-20	13(20.0)	2(5.7)	22(19.1)	37(17.2)
	20 and above	14(21.5)	4(11.4)	10(8.7)	28(13.0)
	None	8(12.3)	26(74.3)	7(6.1)	41(19.3)
Number of trainees	1-5	24(36.9)	5(14.3)	35(30.4)	64(29.8) mean=8
	6-10	12(18.5)	2(5.7)	51(44.3)	65(30.2)
	11-15	17(26.2)	2(5.7)	21(18.3)	40(18.6)
	16 and above	4(6.2)	none	1((0.9)	5(2.3)
Other income generating activities	farming	9(13.9)	7(20.0)	49(42.6)	65(30.2)
	trading	16(24.6)	5(14.3)	33(28.7)	54(25.1)
	civil service	10(15.4)	2(5.7)	10(8.7)	22(10.2)
	Fishing	8(12.3)	16(45.7)	2(1.7)	26(12.1)
	Artisans/crafts	22(33.8)	5(14.3	21(18.3)	48(22.3)

Source: Field survey, 2017
Freq. =frequency, % = percentages:

Sources of fishes used in traditional medicine

Table 2 presents the sources of fishes used in traditional medicine by the respondents. It reveals that traditional pharmacists, fish traders, self-sourcing, fishermen and gift from fellow traditional doctors have weighted mean 1.29, 1.44, 2.21, 2.40 and 2.41 respectively as the various sources of fishes used in traditional medicine. The results further shows that in Lagos and Ondo states, fish traders had weighted mean of 1.18 and 1.00 respectively and were ranked first in each of the two states. Traditional pharmacists in Oyo state had weighted mean of 1.12 ranked first among the various sources. This implies that fish trading is a major livelihood activity in riverine states. Therefore traditional medical practitioners have unrestricted access to numerous fish traders who have been seeing different kinds of fishes and are well familiar with their names and their peculiar characteristics in the fishing community. In Oyo state which is non-fishing area, fishing is not a prominent and

fashionable income generating activity except in dams across the state, this is responsible for the influx of their sourcing majorly with Traditional Pharmacists (*lekuleja)*. Traditional pharmacists play pivotal roles in the development of traditional medicine; they are the sources of ingredients and materials combined in the preparation of traditional medicine. It is obvious that traditional pharmacists often play substantial roles in the development of traditional medicine among the traditional medicine practitioners in southwestern Nigeria as they relentlessly provide ingredients and other materials for the preparations of traditional concoctions for those who know their uses.

Table 2. Sources of fishes utilized in traditional medicine

Sources of fishes	Lagos state					Ondo state					Oyo state				
	RE %	OC %	NV %	Mean	Rank	RE %	OC %	NV %	Mean	Rank	RE %	OC %	NV %	Mean	Rank
1. Fishermen	18.5	69.2	12.3	1.94	3rd	17.1	28.6	54.1	2.37	5th	5.2	0.9	93.9	2.89	5th
2. Fish traders	84.6	12.3	3.1	1.18	1st	100.0	0.0	0.0	1.00	1st	22.6	38.3	39.1	2.16	2nd
3. Traditional pharmacists	53.8	40.0	6.2	1.52	2nd	77.1	22.9	0.0	1.23	2nd	87.8	12.2	0.0	1.12	1st
4 Self sourcing	18.5	53.8	27.7	2.09	4th	34.3	31.4	34.3	2.00	3rd	7.0	30.4	62.8	2.55	4th
5 Gift from fellow traditionalist	4.6	46.2	47.7	2.89	5th	8.6	62.9	28.6	2.20	4th	13.9	56.5	29.6	2.16	2nd

Source: Field Survey, 2017

RE=Regularly, OC= Occasionally, NV= Never, % percentage

Identification of different fish species utilized for the treatment of reproductive dysfunctions in the study area Catfish (Clarias anguillaris) (Eja Abori)

From the ethnographic engagement, majority of the ethnographic hosts emphasized the significance of Clarias anguilaries in ethnomedicine. Typical responses of the discussants are given below:

- *the fish is of immense uses given to us by god to provide antidote to a number of infirmity traceable to witches and wizards*
- *It is important in most of rituals to guarantee peaceful and successful living. Booming of businesses and prevention of delay delivery is at the mercy of the use of Clarias anguilaries*
- *It paves way that might be practically impossible for others, it does not work alone but in conjugation with some herbs and empowered with incantations*
- *The fish is often used by Ifa oracles to appease god in preferring solutions to preternatural challenges*
- *Mostly used for the pregnant women to ensure peaceful delivery. I have used it on several occasions to free pregnant women from spiritual bondages associated with delivery, says*
  "my father taught me the use of eja abori to cure insanity. I have healed about four people having insanity traceable to attack by people they offended with the use of fish and other materials. The caveat emptor is that the traditional doctor should not collect money from the family of the psychiatric patient after healing, otherwise one of the traditional doctor's family members will become insane in no distant time"

From the above verbatim submissions that were translated, all of the ethnographic hosts lent credence to the fact that this species of fish is used in diverse of purposes. (Sowumi, 2007) affirmed that that Clarias was the choice fish both in terms of occurrence of usage in recipes and the number of medical conditions for which different preparations containing this fish can provide relief.

(*Malapterurus electricus*) Electric catfish (Eja Ojiji)

From the ethnographic sojourn, the experts in traditional medicine have these to say with regards to the usefulness of electric fish:

- *"Electric fish is multipurpose and its power resides in its electric power. With or without incantations, there are several ways it could be combined".*
- *"My grandfather taught me various ways through which it could be put to use. It had been used to cure ailments like stroke and for enhancing mental alertness"*
- *"Electric fish alone cannot give the desired result but in combination with herbs and some incantations"*
- *"Electric fish is combined with herbs to seek favour of elders in life endeavour with incisions around various region of the body"*
- *"Mental acuity is guaranteed with the use of electric fish"*
- *"Treatment of sexual dysfunction in man is guaranteed with electric fish"*
- *A medical doctor invited me to help him when he was having issues while taking delivery, I prepared a concoction for him and the newborn baby came out five minutes after administered the concoction having electric fish as the major ingredient"*
- *"I offered permanent treatment for stroke with ease with the use of electric fish only if the sick person can withstand the shock in response to the electric discharge by the fish in a bowl of water. It is guaranteed, life would be restored and the dead nerves would be activated in no distant time"*

All the interviewees lent credence to the fact that electric fish is a good source of traditional medicine as submitted verbatim above. Some attached the prowess of electric fish especially with the efficacy of the concoctions having it as the active ingredient to its unique ability to discharge electric current.

Tilapia : *Tilapia guineensis (Eja Epiya)*

Tilapia is one of the hundred species of cichlid fish from the tilapine cichlid tribe. Tilapia is mainly freshwater fish inhabiting shallow streams, ponds, rivers and lakes and hardly found in brackish water.

Tilapia is used in Yoruba traditional medicine in curing cancer of the breast, and for controlling chicken pox

***Phractolaemus ansorgii* (Eja Ogidigbo)**

This species of fish is ethnomedically used to prepare concoction against poison. The fish remains the major ingredient in providing immunity against antics of enemies finding means of exterminating one's life. However, there are other animal derivatives included in ensuring the efficacy of the concoction.

***Monodactylus sebae* African moony (Eja Apagha)**

Monodactylus sebae, the African moony, is a species of moonyfish native to fresh, brackish and marine waters from West Africa. It is a diamond shaped fish with a larger anal fin. It is abundant in Lagoons and coaster areas. It also used in remedy reproductive dysfunction

Clarias gariepinus*(*Eja Aro)

- *"it is always very difficult to differentiate Clarias anguilaris from Clarias gariepinus, size and colour often aid classification of the species of clarias. It is always given to pregnant women to ease delivery.*
- *It also aids mental alertness (ori ni eja fi n la ibu) it is the head of fish that helps it navigating the deep of the sea.*
- *"the fish is multipurpose for those who know its uses"*
- *" traditionally, it is used in social events like naming ceremony and marriages"*

Table 3: Fishes and their health uses

Fises	Diseases/illnesses they treat or control
Clarias gariepinus (Eja aro)	Fertilization enhancer. Safe delivery, stillbirth control, preterm birth prevention, maigraine, measles, erectile dysfunction
Clarias anguillaries(Eja Abori)	Insanity, overdue pregnancy
Malapterurus electricus Electric catfish (Eja Ojiji)	Stillbirth, stroke, hypertension, mental alertness, fetal movement, erectile dysfunction
Monodactylus sebae . (Eja Apagha)	Erectile dysfunction
Tilapia. guineensis (Eja Ipiya)	Breast cancer
*Phractolaemus ansorgii. (*Eja ogidigbo)	Erectile dysfunction, anti-poison
Parachanna striata. Snakehead fish (Eja Okodo)	Measles

Source: Ethnographic survey, 2017

Reports of focus group discussions (FGDs)

The participants were arranged in a relaxed atmosphere. They were asked to freely express their opinion about the uses of fish in traditional medicine. The summary of the discussions were presented as follows:

Lagos state: All the participants (100.0%) agreed that fish has been used from ancient time in treating ailments, rituals and ceremony. They all agreed (100.0%) that fish are very useful in treating reproductive dysfunctions. Majority (75.0%) were of the opinion that fish is used in treating reproductive dysfunctions. For its utilization in treating erectile dysfunction, slightly above average (55.0%) had used *Malapterurus electricus* for the treatment of erectile dysfunction. With regards to the use of fish to forestall difficulty in delivery, all (100.0%) the participants attested to the usefulness of *Clarias anguilaris* and *Clarias gariepinus* as very important aquatic animals used in the preparation of concoction to be offered to the pregnant woman starting from the seventh month of the pregnancy. For the treatment of breast cancer, only (25.0%) had the knowledge of the use of *Tilapia guineensis* in combination with other ingredients. In the same vein, others (75.0%) were familiar with the use of *Clarias anguilaris* for the purpose of treating breast related growths. For the prevention of sperm discharge after sexual intercourse, only (10.0%) of the participants had the knowledge of the use of fish for the purpose of sperm retention to enhance fertilization. For overdue pregnancy, the participants opined that any fish could be used depends upon what one was directed to use by *Ifa* priest, in trance or experience over time. In sourcing fish for medicinal uses, majority (85.0%) of the participants sourced for fish from fishermen, while the rest used to partronize traditional pharmacists for that purpose.

Ondo State: All the participants (100.0%) agreed that fish has been so beneficial in the treatment of a number of reproductive difficulties. The participants also attested (100.0%) to the use of fish for rituals, ceremony and in combination with herbs to take care of illnesses. Majority (75.0%) were of the opinion that fish is used in treating reproductive dysfunctions. For its utilization in treating erectile dysfunction, all (100.0%) the participants had used different types of fish for the treatment of erectile dysfunction.

In remedying difficulty in delivery, all (100.0%) the participants attested to the usefulness of *Clarias anguilaris* and *Clarias gariepinus* as very important aquatic animals used in the preparation of concoction to be offered to the pregnant woman starting from the seventh month of the pregnancy. For the treatment of breast cancer, none of the participants had used fish for the purpose of treating breast related issues. For the prevention of sperm discharge after sexual intercourse, average (50.0%) of the participants had the knowledge of the use of fish for the purpose of sperm retention to enhance fertilization. For overdue pregnancy, the participants opined

that any fish could be used depends upon what one was directed to use by *Ifa* priest, in trance or experience over time.

Oyo State: The participants attested to the usefulness of fish in traditional medicine. All the participants (100.0%) submitted fish is commonly used in combination with herbs for pregnancy related issues and to guarantee peaceful delivery. All (100.0%) affirmed that *Malapterurus electricus* is very essential in treating erectile dysfunction, and that other fish species could be used depends on the knowledge of their combination with other herbs and experience of the use.. The participants also attested (100.0%) to the use of fish for rituals, ceremony and in combination with herbs to take care of other health related issues aside reproductive dysfunction.

In remedying difficulty in delivery, all (100.0%) the participants attested to the usefulness of *Clarias anguilaris* and *Clarias gariepinus* as very important aquatic animals used in the preparation of concoction to be offered to the pregnant woman starting from the seventh month of the pregnancy. For the treatment of breast cancer, none of the participants had used fish for the purpose of treating breast related issues. For the prevention of sperm discharge after sexual intercourse, average (75.0%) of the participants had the knowledge of the use of fish for the purpose of sperm retention to enhance fertilization. For overdue pregnancy, the participants opined that any fish could be used depends upon what one was directed to use by *Ifa* priest, in trance or experience over time. Majority (85.0%) of the participants sourced for fish from traditional pharmacists for use in traditional medicine. Also, majority (90.0%) got the knowledge of traditional medicine from their ancestors or as a family profession.

Test of Hypotheses

The hypotheses for the study were stated and results were hereby presented below. It is to be noted that all the hypotheses were stated in null form.

Hypothesis 1

There is no significant difference in selected socio economic characteristics of traditional health workers across the states in the study area

The result of Analysis of Variance in Table 4 shows that there was a significant difference in source of knowledge of traditional health workers across the states in the study area because f= 4.007 and p= 0.019 which is less than 0.05 level of significance. This implies that sources of knowledge of the indigenous medical practice were not similar across the states in the study area. Hence, the null hypothesis that there is no significant difference is rejected. This could be as a result of the fact that some traditional health workers got the knowledge as ancestral occupation which eventually becomes family business, while some gained the knowledge of the practice through training as apprentices under a master who is assumed to be well knowledgeable in traditional medicine. This finding is in line with Lawal and Borokini, (2014) who submitted that the knowledge of the practice of traditional knowledge could be gained from ancestral inclination, could be revealed in the dream or vision, by trance, through learning and through supernatural contact with spirit or occultism. However, that the practice of traditional medicine has gained appreciable recognition from the government, there has been an influx of people into the practice thereby becoming a lucrative business.

Table 4 ; Summary of Analysis of Variance showing differences in sources of knowledge of traditional medicine by traditional health workers across the states in the study area

Variable	Sources of variation	Sum of squares	Df	Mean squares	F- value	p-value	Decision
Source of knowledge	Between Groups	1.805	2	0.902	4.042	0.019	S
	Within groups	47.330	212	0.223			
	Total	49.135	214				

Source: Field survey, 2017.

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ANALYSIS OF FARM HOUSEHOLD INCOME DISTRIBUTION AMONG YAM FARMERS IN NIGER STATE, NIGERIA

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Abstract
The study examines the income distribution among yam farmers is selected Local Government Areas of Niger State. The study also determines the source and level of income, ascertain the extent of income inequality among the yam farmers household. The study adopted the multi-stage random sampling technique in the selection of respondents. In the first stage, three Local Government Areas were selected randomly from agro ecological zone II of the State based on the preponderance of yam production in these Local Government Areas which are located in the zone. The second stage involved a random selection of three villages from each of the Local Government Areas summing up to nine villages. The third stage involved a random selection of yam farmers from each of the villages using simplified formula to calculate sample size (n) from N population of the yam farmers in the study areas. The gross farm income techniques was used to determine the total farm income and Gini coefficient was used for the estimation of income distribution. The results reveal that 90% of the respondents were male, 45% were within the age range of 40 – 49 years and mean of 43.1%. 91% of them were married, 44% of them had average household size of 8 members. 42% of household had no education and 58% of them source their fund from personal savings. The result also showed that annual farm income was higher (₦45, 692,034) as to annual off-farm income (₦13, 895,670). Income distribution showed minimal level of inequality in farm income (0.572), high level in off-farm income (0.612) and low level in total income (Gini coefficient = 0.329). The study concluded by recommending among others that yam farmers should be encouraged to undergo literacy education which in turn help in boosting their yam activities and income growth; government at all level should provide credit facilities and other incentives such as fertilizer, seed among others to the yam farmers as this will enhance their yam productivity; and farm household should not depend only on farm income as this may reduce their income generation.

Key Words: Farm Household, Income Distribution, Yam farmers

IJAFS 2018 (11), 8: 1237-1248
Accepted for publication
September 2018

INTRODUCTION
The significance of equal access to opportunities, assets, and income plays important role in reducing income inequality and encouraging economic growth (Oluwatayo 2008). Income disparities are all about the dispersion of a distribution either in terms of consumption, income or any other quality or attribute, that shows the welfare status of a population (Autor 2012). The accentuated socio- economic problem of income inequality has led to unequal access to food, shelter, education, health and other essentials of life (Oguniyi,Adepoju and Olapade 2011). A high level of income inequality exists in many low-income countries including Nigeria. It is also widely believed that majority of Nigerians live in rural areas (Babatunde 2009). These rural communities are majorly agrarian with majority of them owning just small pieces of land on which they grow crops hardly sufficient to feed themselves, let alone to sell in order to generate income. They therefore, live on small and meager income as compared to urban dwellers who earn more due to their higher literacy level among others (Oguniyi *et al*.). Usually, people in the urban areas invest their time and money to acquire skills and hence, earn higher income

(Oluwatayo, 2008). The poverty situation in Niger State, according to prior national research, portrayed a scenario of low dependency ratio, undesirable household economic welfare and pathetic self-classified poverty assessment (Saidu, Ahmed and Sani, 2013).

Poverty and income inequality are closely related and several literatures have shown that income disparity is a manifestation as well as a strong cause of poverty. Disparities in the income level of the people in rural economy are on the increase which could be due to poverty. Using the 2004 national living standard survey (NLSS) data, Oyekale, Adeoti and Ogunnupe (2006), found out that the overall Gini index for Nigeria was 0.580. In sectoral sense, the study found income inequality to be higher in rural areas compared to urban areas and that employment income increases income inequality while agricultural income decreases it (Oyinde *et al*.). The people living in the rural areas are in one way or the other more prone to poverty. Income inequality has social, security and economic implications which engender rural people to think of themselves as being marginalized in terms of income distribution and provision of social amenities, which may lead to increased grievances and situational unrest (Saidu, Ahmed and Sani 2012). The introduction of various poverty and income redistribution policies by the government was to reduce high cost of living among its populace which will in turn improve their standard of living. Despite all these programs introduced, the living standard among the populace has not improved tremendously (Agbaeze and Onwuka 2011). Base on the foregoing, the specific objectives of this study are to determine the source and level of income distribution among the yam farmers in the study area and ascertain the extent of income inequality among yam farmers in the study area.

METHODOLOGY

The Study Area

Niger State is located in the north central zone of the country. The State has a population of 3,950,249 (population census 2006) and the projected value of 4,702,376 at the end of 2013 (CBN 2.38 percent annual projection). The State is ranked 8thout of 36 in terms of population density. The State lies between latitudes 8^0.11' N and 11^0.20' N and longitudes 4^0.30'E and 7^0.20'E occupying a land mass of about 74,244km^2 (Niger State Geographic Information System, 2007) . The State is bordered to the north by Zamfara State, West by Kebbi State, south by Kogi State, south west by Kwara State, north-east by Kaduna State and south-east by the Federal Capital Territory. It also has an international boundary with the Republic of Benin along Agwara and Borgu Local Government Areas to the North West (Niger State Geographic Information System). The Maximum temperature, usually not more than 32^{0}C, is recorded in March and June, while the minimum is usually between December and January. The fertile soil and hydrology of the State permits the cultivation of most of Nigeria's crops and still allows sufficient opportunities for grazing, fresh water fishing and forestry development. The soil types in the State are of two types, Ku and Ya soils. The Ku soil has little erosion hazards, while the Ya soil has better water holding capacity which makes it more suitable for agricultural activities.

Sampling Technique and Sample Size.

The study adopted the multi-stage random sampling technique in the selection of respondents. In the first stage, three Local Government Areas were selected randomly from agro ecological zone II of the State based on the preponderance of yam production in these Local Government Areas which are located in the zone. The second stage involved a random selection of three villages from each of the Local Government Areas summing up to nine villages. The third stage involved a random selection of yam farmers from each of the villages using simplified formula to calculate sample size (n) from N population of the yam farmers in the study areas as adopted by Tanko and Kpange (2014).

$$nh = \frac{n.NH}{N} \qquad (1)$$

Where nh is the sample size determined, NH is the population size (sampling frame), n is the number of the targeted respondents and N is the total population of yam farmers in the study area. The sampling frames of villages and farmers were obtained through the National Farmers Census (2011), National Farmers Database, Niger State Agricultural Mechanization and Development Authority, village heads and farmers' association, through a reconnaissance survey.

Method of Data Collection

Primary data were used in this study and were collected through the aid of pre-tested questionnaire. Information gathered included the following:

(a) Socio-economic data: This included information on age of household head, sex of the household head, years of education, marital status, household size, source of fund among others.

(b) Household income data; This included information on crop income, livestock income, agricultural wage income, agricultural wage labour to other farms, non-agricultural wage income from both formal and informal employment, self-employed income from own businesses, remittance income received from relatives and friends not presently living with the household, other incomes, mostly comprising capital earnings and pension.

Method of Data Analysis

Descriptive statistics

These tools were used to analyze the socio-economic characteristics of the respondents (objective 1). These include frequencies, means, percentages, tables and chart.

***Farm budget technique*:**

This was used to determine the level of income of the yam farmers. Gross Farm Income (GFI) = price x quantity **Miscellaneous, Man-hour/ Man-day:** This was used to analyze the off-farm income of the yam farmers.

Measurement of Income Distribution of Respondents

1. The Gini coefficient and the Lorenz curve:

This was used to ascertain the extent of income inequality among the respondents (objective 4). The Gini coefficient is a measure of statistical dispersion most prominently used as measure of inequality among value of a frequency distribution. For example, level of income, wealth among others (Dixon, Weiner, Mitchell and Woodley 1988). It has value from 0 to 1. Therefore a low Gini coefficient indicates a more equal distribution of income or wealth with zero corresponding to complete equality while higher Gini Coefficient indicates more unequal distribution with one corresponding to complete inequality (Bakare 2012). Lorenz curve plots the proportion of the total income of the population (y-axis) that is cumulatively earned by the bottom X% of the population (Bakare 2012).

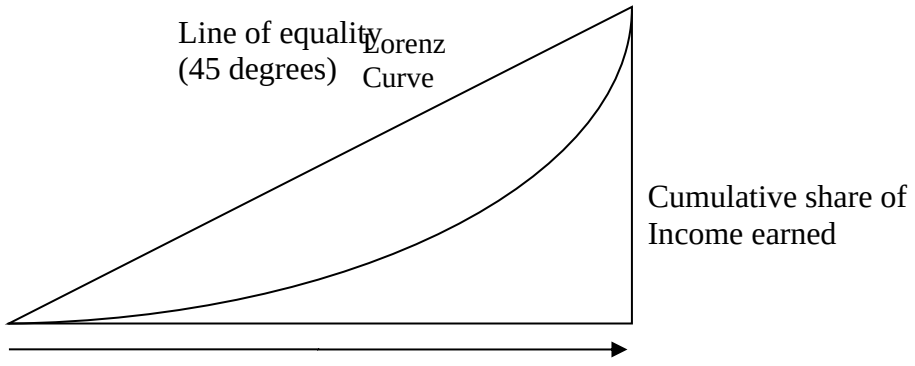

Fig 1: The Lorenz curve

The Gini index is the ratio of area between the curve and the line of perfect equality to the total area under the diagonal line of perfect equality. It varies from 0 (perfect equality) to 1 (complete inequality, where one individual hold 100% of the income). And is also defined as;

$G=1-\sum x\ y$

Where: G= Gini coefficient

X= cumulative percent of farmers in income group

Y= cumulative percent of income

RESULTS AND DISCUSSION

Socio-economic Characteristics of Yam farmers

The distribution of respondents according to their socio-economic profiles is presented in Table 1. The results revealed that 90% of the yam farmers were male while 10% were female. This is an indication that most of the yam farmers were male. The reason for this is as a result of exertion of physical energy required in the business. This result aligns with the findings of Oguniyi *et al.* (2011) in their study on comparative analysis of poverty and income inequality among food crop and livestock farmers in Ilesa metropolis, Osun State which revealed that 86 percent of food crop farmers were males, that the reason behind this, was because agricultural production is tedious in nature especially food crop production compared to other agricultural enterprises. The result also revealed that the average age of the respondents was 43 years. About 45% of the respondents were between the ages of 40 and 49 years. This implies that high percentage of these farmers was in their productive age and therefore they can participate actively in various agricultural production activities. In line with this, Mbanasor *et al.* (2010) found that about fifty percent of their respondents were within the age range of 40 and 59 years. By implication, they had high likelihood to earn high incomes as they were at the peak of their active years. Majority of the respondents (91%) were married. This indicates that married people were more involved in agricultural production in the study area.

The higher percentage of married respondent agrees with Agbaeze and Onwuka (2014) who reported that higher percentage of yam farmers (74.3%) were married. The Table also reveals that 44% of the yam farmers had about 6 to 10 household member households with an average household size of 8. This implies that high percentage of the farming households in the study area do not have large household sizes, hence income earned from farming activities will be expended on these members only which will consequently improve their welfare. In line with this, Baba and Wando (1998) had earlier reported that large family size tends to draw more on income which could have been used for future investment.

The table further reveals that only about 42% of the yam farmers had no education. Literacy level among the respondents was high which may affect their productivity positively. The distribution of respondents based on source of funding for their agricultural activities shows that personal saving (55%) was the predominant source of funding for the yam farmers. Funding from formal source accounted for lowest percentage i.e 20%. The result revealed that formal sources were less patronized for financial support for yam farming in the study area. This may be due to high interest rate on loans. This finding also agrees with Ndanitsa (2014) who stated that farmers sourced their funding from their personal savings. And that it may due to avoidance of high interest rate on loan as well as banks insistence on the provision of collateral facilities. In the same vein Oguniyi *et al.* (2011) found out that the distribution of respondents based on source of funding for their agricultural activities showed that personal saving (76.0%, 55.0%, and73%) and cooperative (46.0%,32.5% and 42.7%) were the predominant sources of funding for food crop and livestock farmers.

Table 1: Distribution of respondents based on their socio-economic profiles.

Variables		Frequency	Percentage
Sex:	Male	108	90
	Female	12	10
Age:	< 40	44	37
	40 – 49	54	45
	50 – 59	20	17
	60 and above	2	1
Marital Status:	Single	11	9
	Married	109	91
Household Size:	≤ 5	16	13
	6 – 10	53	44
	Above 10	51	43
Education Level:	No Education	50	42
	Qur'anic Education	13	11
	Primary Education	23	19
	Secondary Education	20	17
	Tertiary Education	14	11
Source of Funding:	Personal Saving	70	58
	Informal Source	26	22
	Formal Source	24	20
Ownership of House:	Rented apartment	4	3
	Personal	56	47
	Extended family	60	50
Type of residential building:	Mud and Unplastered	34	28
	Mud and Plastered	79	66
	Block and Plastered	6	5
	Block and Unplastered	1	1
Toilet Type:	Water Closet	2	2
	Pit Latrine	70	58
	Stream/Bush disposal	48	40
Source of Drinking Water:	Tap	3	3
	Borehole	75	62
	Well	14	12
	Stream	28	23
Accessibility of Roads:	Tarred	28	23
	Not tarred	86	72
	Not motorable	6	5
Means of Transportation:	Trekking	10	8
	Bicycle	15	12
	Private Motorbike	50	42
	Public Transport	38	32
	Private Vehicle	7	6

Source: Field Survey (2014)

Income Sources and Income Level of Yam Farmers

Table 2 shows the sources of income and the annual income of the sampled households in the study area. By decomposing the overall income between farm and off-farm income, revealed that the farm income as a whole accounted for 76.68% while off-farm income accounted for 23.32% of total income. This result corroborates the findings of Vanden Berg and Kumbi (2006), who reported that farm income contributed more than off-farm income to inequality in rural Ethiopia.

Table 2: Income sources and income levels of yam farmers in the study area.

Income source	Per capita income share	Percentage
Total household income	496,384.2	76.68
Total farm income	380,766.96	
Crop income	349,036.41	
Yam	107,038.76	
Maize	34,379.35	
Guinea corn	38,379,55	
Millet	36,962.88	
Mellon	37,594.92	
Cowpea	35,296.22	
Inter cropping	36,046.22	
Others	18,332.5	
Livestock income	31,730.54	
Cow	12,099.30	
Goat	10,031.94	
Sheep	5,833.33	
Poultry	3,765.97	23.32
Total off-farm income	115,797.25	
Agric wage income	28,949.31	
Non-agric wage income	16,082.95	
Self-employed income	57,898.63	
Remittance	9,649.77	
Other income	3,216.59	100

Source: Field survey (2014)

Estimation of Inequality in Income Distribution: Farm Income Distribution

The analysis of yam farmers' farm income distribution in Table 3 shows that 17.5% of the households earned annual farm income between of ₦200, 001 to ₦300, 000 brackets on annually. This was followed by 16.7% of the total sampled household which received ≤₦100, 000. This result is in agreement with Adewunmi *et al.* (2011) who found that farm households rely strongly on farm income source but still, 28 percent of their total income is from non-farm source. Waqar *et al.* (2011) also observed higher proportion of lower income households were found among households depending only on farm income. Also, that, the proportion of lower income households was lower in the households that adopted both farm and non-farm occupation as compared to households with dependence on only one occupation.

Table 3. Distribution of farm income and estimation of Gini coefficient of yam farmers

Income (₦)	Number of farmers (Freq)	% of farmers in income group	Cum % of farmers in income group (X)	Total income	% of their income	Cum % of income (Y)	XY
≤ 100,100	20	16.7	16.7	2,980,000	6.4	6.4	0.0010688
100,001-200,000	13	10.8	27.5	1,610,000	3.5	9.9	0.0027225
200,001-300,000	21	17.5	45	4,899,000	10.7	20.4	0.00918
300,001-400,000	15	12.5	57.5	4,991,000	10.7	31.1	0.0178208
400,001-500,000	19	15.8	73.3	7,722,000	16.6	47.7	0.0349641
500,001-600,000	09	7.5	80.8	5,307,000	11.4	59.1	0.0477528
600,001-700,000	07	5.8	86.6	4,352,000	9.3	68.4	0.0592344
700,001-800,000	06	5	91.6	4,400,000	9.4	77.8	0.0712648
800,001-900-000	05	4.2	95.8	4,752,000	10.2	88	0.084304
> 900,000	05	4.2	100	5,579,034	12	100	0.1
Total	**120**	**100**		**46,592,034**	**100**		**0.4283122**

Gini Coefficient = 1- 0.4283122 = 0.5716878

Source: Field Survey (2014)

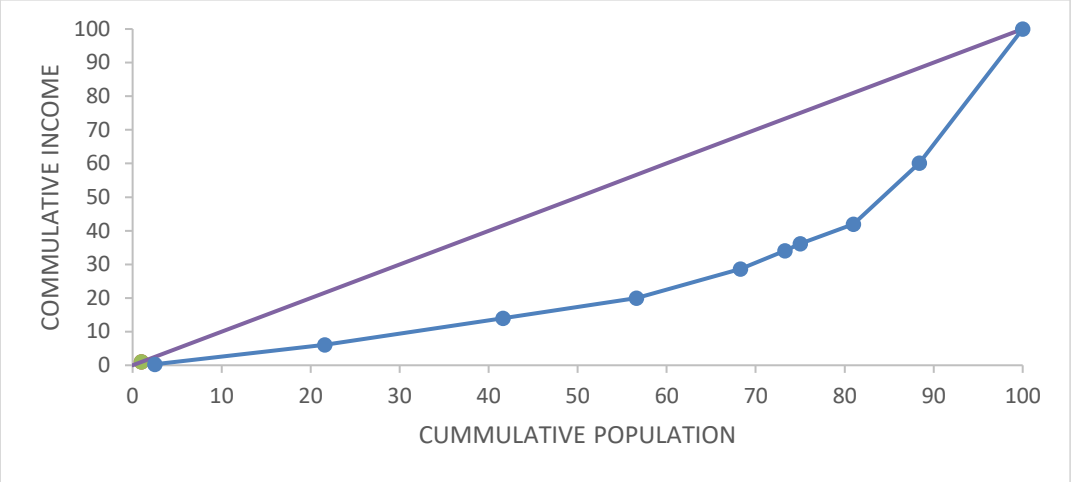

Figure 2: Lorenz curve for farm income distribution of yam farmers.

Table 4 shows that the farm income was unequally distributed among the sampled households. The lowest 45% of the population owned just 20% of the total farm income whereas highest 14% households owned 32% of the total farm income. These findings corroborated the findings of Naeemur- Rehman and Anwar (2008) that the bottom 20% of sampled farmers had got only 1.4% of total money income followed by top 20% receiving 60.80% of the total income. Similarly, the bottom 50% of the sampled farmer received only 9.40% of the total income representing higher degree of severity existing rural rice farmers of district Swat.

Table 4: Farm income distribution among sampled households

Household Number)	**Population%**	**Cum.%**	**Income**	**Income %**	**Cum.%**
Lowest10	16.6	16.7	2980000	6.4	6.4
Next 10	10.8	27.5	1610000	3.5	9.9
Next 10	17.5	45	4899000	10.5	20.4
Next 10	12.5	57.5	4991000	10.7	31.1
Next 10	15.8	73.3	7722000	16.6	47.7
Next 10	7.5	80.8	5307000	11.5	59.1
Next 10	5.8	86.6	4352000	9.3	68.4
Next 10	5	91.6	4400000	9.4	77.8
Next 10	4.2	95.8	4752000	10.2	88
Next 10	4.2	100	5579034	12	100
			46592034	100	

Source: Field Survey, 2014

Gini coefficient for farm income

When Gini coefficient is zero, it implies that there is perfect equality in income distribution i.e income is evenly distributed and when it is one, it is perfect inequality. Table 5 shows that the income was distributed unequally among sampled households with Gini coefficient of 0.572, the result agrees with the findings of Aigbokhan (2008) who found a Gini coefficient of 0.488 in his studies on growth, inequality and poverty in Nigeria.

Off-farm Income Distribution among Yam Farmers

Table 6 shows the distribution of income that composes the overall off-farm income among the yam farmers. The result reveals that those yam farmers that fell within the range of ≤₦100,000 had 23.3% of the total income, then followed by 15.0% which was recorded by the income earners that fell within the income range of ₦300,001 to ₦400,000, while ₦800,000 to ₦900,000 recorded the least percentage of 1.3%. In vein with the findings of Waqar *et al.* (2011) showed that highest proportion of lower income households were found among households depending on non-farm income.

Table 5: Distribution of Off-farm income and estimation of Gini Coefficient of yam farmers

Income (₦)	Number of farmers (Freq)	% of farmers in income group	Cum % of farmers in income group (X)	Total income	% of their income	Cum % of income (Y)
≤ 100,100	87	72.5	72.5	650,000	4.7	4.7
100,001-200,000	10	8.3	80.8	1,000,500	7.2	11.9
200,001-300,000	5	4.1	84.9	1,000,200	7.2	19.1
300,001-400,000	3	2.5	87.4	900,400	6.5	25.6
400,001-500,000	2	1.7	89.1	800,600	5.8	31.4
500,001-600,000	2	1.7	90.8	1,000,100	7.2	38.6
600,001-700,000	2	1.7	92.5	1,200,000	8.7	47.3
700,001-800,000	3	2.5	95	2,100,300	15.2	62.5
800,001-900-000	2	1.7	96.7	1,600,200	11.6	74.1
> 900,000	4	3.3	100	3,600,079	25.6	100
Total	**120**	**100**		**13,852,379**	**100**	

Gini Coefficient = 1- 0.38942117 = 0.6105786
Source: Field Survey (2014)

Lorenz curve for off-farm income

Table 3.6 shows that the off-farm income was distributed on unequally among the sampled households. The lowest 85% of the total respondents owned just 19% of the total off-farm income while the lowest 7% of the respondents owned 53% of the total off-farm income. These findings corroborated the findings of Babatunde (2009) who stated in his work that the richest quintile of respondents earned 12.3 times the total income earned by the poorest quintile. These fold-values are 12.6 and 17.6 when we consider farm incomes from irrigated agriculture and rain fed agriculture, respectively. As far as non-farm income is concerned, the richest quintile earned 99 times the amount of non-farm income earned by the poorest quintile. This Indicated that non-farm income is distributed more unequally than the other two types in rural Nigeria.

Table 6 Off-farm income distribution among yam farmers

Households (Number)	Population %	Cum Pop. %	Total Income	Income %	Cum. Income%
Lowest 10	72.5	72.5	650000	4.7	4.7
Next 10	8.3	80.8	1000500	7.2	11.9
Next 10	4.1	84.9	1000200	7.2	19.1
Next 10	2.5	87.4	900400	6.5	25.6
Next 10	1.7	89.1	800600	5.8	31.4
Next 10	1.7	90.8	1000100	7.2	38.6
Next 10	1.7	92.5	1200000	8.7	47.3

Next 10	2.5	95	2100300	15.2	62.5
Next 10	1.7	96.7	1600200	11.6	74.1
Next 10	3.3	100	3600079	25.9	100
Total	100		13852379	100	

Source: Field Survey 2014

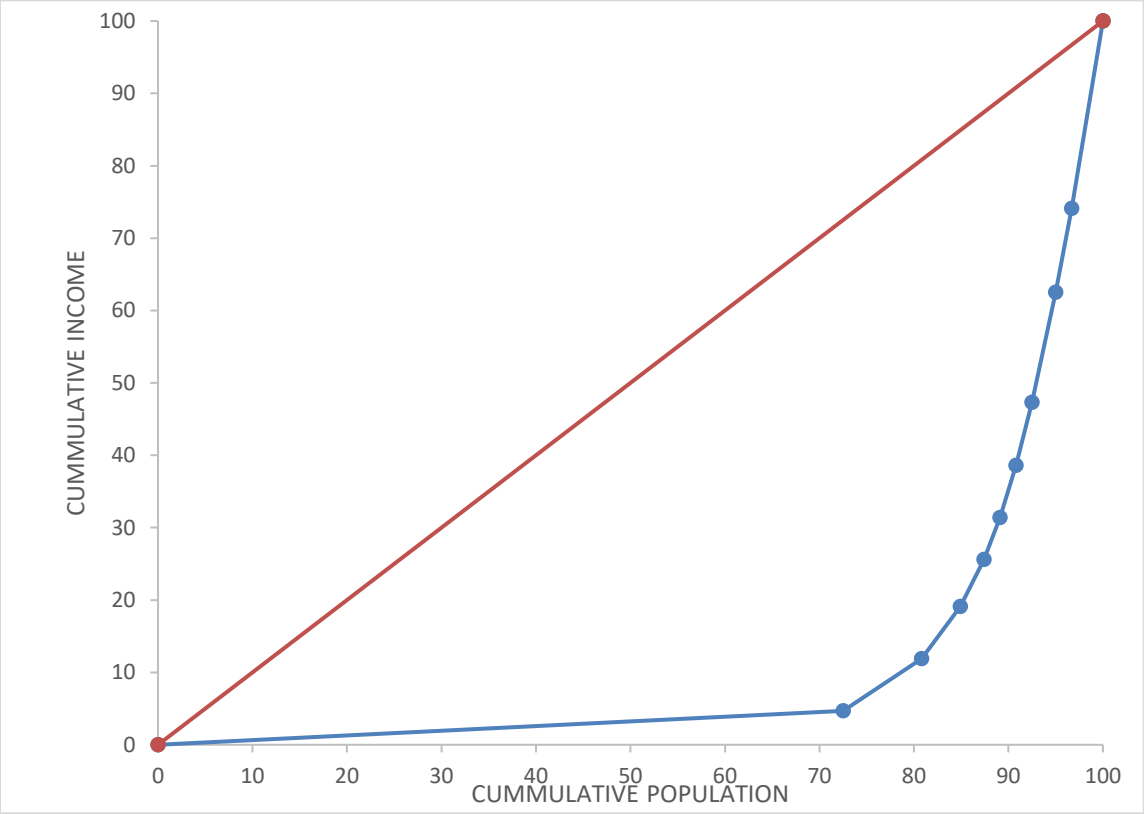

Figure 3: Lorenz curve for off-farm income distribution of yam farmers.

Table 5 shows that the distribution of off-farm income was unequally distributed among the respondents with a Gini coefficient of 0.611. This indicates that there is a high level of inequality in off-farm income distribution among the yam famers. This result corroborates the findings of Jude *et al. (*2013) who found a very high Gini coefficient of 0.987 in their study area.

Total income distribution

In estimating the total income distribution of the households Table .7 presented the result. It could be observed that 20% of the households earned annual income that fell within ₦200, 001 to ₦300, 000 brackets on annual income basis. This was followed closely by 19.1% of the total sampled households which received between ₦600, 001 and ₦700, 000 on annual basis. This result is in agreement with Waqar *et al.* (2011) who found that 33% of the respondents in their study area earned annual income of ₦ 200,001- ₦ 300, 000. This finding is in agreement with Waqar *et al.* (2011) who found that 53% of respondents in their study area earned annual income of 200,001-300,000.

Table 7: Computation of Gini coefficient for the households' total income of yam farmers

Income(₦)	Numbers of farmers (freq)	% of farmers in income group (X)	Cum frequency	Cum % of farmers in income group	Total income	% of their income	Cum % of income (Y)	XY
≤ 100000	3	2.5	3	2.5	182400	0.31	0.31	0.0000775
100001 – 200000	23	19.1	26	21.6	3428800	5.75	6.06	0.0116
200001 – 300000	24	20	50	41.6	6230017	10.46	16.51	0.0330
300001 – 400000	28	15	68	56.6	6655850	11.17	27.69	0.0415
400001 – 500000	14	11.5	82	68.3	575800	0.97	28.66	0.0335
500001 – 600000	6	5	88	73.3	3219581	5.40	34.06	0.0170
600001 – 700000	2	1.7	90	75	1277401	12.14	36.2	0.0062
700001 – 800000	8	6.7	98	81.7	7479711	12.55	48.75	0.0326
800001 – 900000	8	6.7	106	88.4	6769830	11.36	60.11	0.0402
> 900000	14	11.6	120	100	23768314	39.88	100	0.1049
Total	**120**	**100**			**59587704**	**100**		**0.320575**

Gini Coefficient = 1 – 0.320575 = 0.679425
Source: Field Survey (2014)

Lorenz curve for total income

Table 8 shows that the income was distributed unequally among sampled households with Gini Coefficient of 0.321. The lowest 42 percent of population owned just 17 percent of the total income whereas highest 25 percent households owned 64 percent of total income. These findings corroborated the findings of Waqar *et al.* (2011), who found a Gini coefficient value of 0.69 and 0.75 for the asset of household in their study on the empirical analysis of household income in rural Pakistan, evidences from Tehsil Samundri Pakistan. The result also further revealed that the lowest 25percent population owned just 5 percent of the total income whereas highest 26 percent household owned 65 percent of total income.

Table 8: Total Income distribution among sampled households

Households (Numbers)	Population (%)	Cumulated population (%)	Income (%)	Cumulated income (%)
Lowest 10	2.5	2.5	0.31	0.31
Next 10	19.1	21.6	5.75	6.06
Next 10	20	41.6	10.46	16.52
Next 10	15	56.6	11.17	27.69
Next 10	11.5	68.3	0.97	28.66
Next 10	5	73.3	5.40	34.06
Next 10	1.7	75	12.14	36.2
Next 10	6.7	81.7	12.55	48.75
Next 10	6.7	88.4	11.36	60.11
Next 10	11.6	100	39.88	100

Gini Coefficient = 0.320575
Source: Field Survey (2014)

Gini coefficient of total income

The Gini coefficient is 0.320575 and it reflects the level of inequality in income distribution. This is in concord to Gini coefficient of income distribution of 0.33 for food crop farmers 0.40 for livestock farmers and 0.39 for crop livestock farmers found by Ogunniyi *et al.* (2011). The result can also be compared with the findings of Ayinde *et al.* (2012) who found the Gini coefficient of 0.43 and 0.33 as against 0.69 and 0.67 for agricultural and non-agricultural incomes in rural and urban areas respectively.

Conclusion

It is discovered from the findings that over 42% of the yam farmers in the study area were not educated. This in turn reduces the farm productivity of the farmers. The study also revealed that the yam farmers do not have access to credit facilities and other incentives such as fertilizer, seeds among others that would enhance their productivity. It is also discovered that farm household who only depend on farm income suffer low-income generation.

Recommendations

1. Yam farmers should be encouraged to undergo literacy education which in turn will help in boosting their yam activities and income growth.
2. Government at all level should provide credit facilities and other incentives such as fertilizer, seeds among others to the yam farmers as this will enhance their yam productivity.
3. Farm households should not depend only on farm income as this may reduce their income generation.

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COMPARATIVE ANALYSIS OF USERS AND NON-USERS OF TECHNOSERVE FACILITIES IN COCOA PRODUCTION IN EKITI STATE NIGERIA

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Abstract

The study examined the socio-economic characteristics of users and non-users of Technical Support Services (TECHNOSERVE) facilities among cocoa farmers; estimated the costs and returns of the users and non-users of TECHNOSERVE facilities and also the effects of TECHNOSERVE facility on cocoa production among users in the study area. These were with a view to assess the contribution of Technoserve – BOA (Bank of Agriculture) facilities in production and marketing of cocoa in Ekiti State, Nigeria. The study area was Ekiti State and a multi-stage sampling technique was employed in selecting the respondents. The sampling techniques enables the study to select 240 respondents in the final enumeration used for data analysis. Descriptive statistics, budgeting technique and multiple regression analysis were used to analyze the data. The result of descriptive statistics revealed that the mean age of users and non-users farmers were 44±9.78 and 48±12.70 years respectively, most (i.e. 94% of users and 85% of non-users) of the respondents were male, majority (95%) of the cocoa farmers were married, while majority of both the users and non-users had household size between 6 and 10. Most of the respondents (62% users and 49% non-users) had secondary education while 63% of the users and 77% of the non-users had farming as their primary occupation. The mean year of experience of users was 18.74±11.06 while non-users had 22.43±12.43 years of experience; the mean value of land allocated to cocoa production by users was 6.08±3.71 while that of non-users was 6.55±3.89. Budgetary analysis result showed that, the mean value of total variable cost and total fixed cost of both users and non-users were ₦140,348.63, ₦40,252.85 and ₦95,978.33, ₦33,233.86 respectively. Mean value of the total revenue for both users and non-users were ₦276,562.77 and ₦171,619.47 while their Net Farm Income were ₦95,961.29 and ₦42,407.28 respectively. The gross margin equals ₦136,214.14 for users and ₦75,641.14 for non- users. This indicates that the enterprise is more profitable with the use of Technoserve facilities. The result from the regression model shows that all the independent variables had positive relationship with net income of the respondents except quantity of insecticide used by the respondents while quantity of fungicide, number of seedlings and quantity of herbicide used were in conformity with a priori expectation. This study observed that the enterprise is comparatively more productive for the users of Technoserve facilities. Farmers in the study area could improve their net income through the use of Technoserve facilities.

Keywords: Proportional analysis, Techno serve services, Cocoa production, Ekiti state

IJAFS 2018 (12), 8:1249-1264
Accepted for publication
September 2018

Introduction

In West Africa, agriculture has continued to play a dominant role in the provision of food, raw materials for industries, employment for the majority of the populace, and foreign exchange used in financing development activities. Permanent crops otherwise known as perennial tree crops are long term crops that occupy the field planted for a long period of time and largely harvested every year and do not have to be replanted for several years after each harvest. In the last 40 years, permanent crops, notably cocoa, coffee, oil palm, and rubber, have dominated the export agriculture (Nkamleu *et al*., 2010).

Perennial tree crop systems in Africa are important for national macroeconomic balances and rural livelihoods. Among the perennial tree crops, cocoa (*Theobroma cacao L.*) is of particular interest for West and Central Africa from where approximately 70% of the world supply of cocoa originates and for the global chocolate industry (Nkamleu and Kielland, 2006). Cocoa is grown on about 7.2 million hectares with major concentrations in West Africa, South East Asia and Latin America. Cocoa is one of the most widely produced agricultural cash crops in the West African countries. It is a vital source of foreign exchange, investment, and economic growth. The cocoa proportion of the agro forest ecology in Cameroon, Nigeria, Ghana and Cote d'Ivoire account for over 2 million Metric tons which represents 70% of world supplies. Cocoa production raises over $2 billion in foreign exchange for the sub region and taxation of the sector generates significant government revenues. With average country yields between 300 kg and 400kg per hectare (ha), approximately 7 million hectares of land is devoted to cocoa production in these countries farmed by approximately 2 million households (Vos *et al.*, 2002).

Specifically, cocoa production is dominated by four countries; Côte d'Ivoire and Ghana produce approximately 41% and 17% of the world output respectively. The other two important producers are Cameroon and Nigeria, each contributing approximately five percent of the world cocoa production (Nkamleu *et al.*, 2010). The Nigerian cocoa economy has a rich history which is well documented in literature. The contributions of cocoa to the nation's economic development are vast and have been reported by many authors (Olayide, 1969; Folayan *et al.*, 2006). Cocoa has been the main agricultural export of Nigeria`s economy until the 1970's when the crude oil was discovered in the country in commercial quantity. It has remained a valuable crop and major foreign exchange earner among other agricultural commodity exports of the country (Ajayi, and Oyejide, 1974; ICCO, 2001).

Specifically, exports of cocoa beans represented close to 44% of total production in1997 and 50% in 2013. However, both the quantities exported and their values fluctuated throughout the period 1997-2013 (Table 1). Net trade ranges between a minimum of 128,065 exported tons in 1998 to a maximum of 267,700 tons in 2005, with an average 198,634 tons of exported cocoa beans for the period 1997-2013. Hence, Nigeria is currently a net exporter of cocoa beans (FAOSTAT, 2015). The beans are also used for primary processing of other cocoa derivate products, such as butter, paste, powder and cake together with chocolate, which are then also exported. Cocoa Butter is the second most exported cocoa product in Nigeria.

TABLE 1: Cocoa Beans Trade Flows, 1997-2013

Year	Production (tons)	Import Quantity (tons)	Export Quantity (tons)	Export Values (1000 USD)	Export as a Percentage (%) of Production
1997	318000	0	140000	172000	44
1998	370000	0	128065	193000	35
1999	225000	0	196377	295000	87
2000	338000	0	139000	210000	41
2001	340000	0	175272	210350	52
2002	362000	966	180723	252566	50
2003	385000	0	230560	437160	60
2004	412000	0	255000	312350	62
2005	441000	0	267700	427300	61
2006	485000	0	189500	306000	39
2007	360570	0	174900	285100	49
2008	367020	55	227303	491923	62
2009	363510	427	247000	599000	68
2010	399200	499	226634	659886	57
2011	391000	500	219000	635000	56
2012	383000	510	199800	460000	52
2013	367000	1	182900	420000	50

Source: FAOSTAT, 2015

Main trading partners importing cocoa beans from Nigeria are European Union Countries. Among all, The Netherlands holds the biggest share of quantity imported from Nigeria between 2005 and 2010, with an average of 30% of total quantity exported during those years. With 13% and 12% respectively of share Belgium and France follow the Netherlands, while the UK and USA both imported 5% of cocoa beans from Nigeria during the same time frame. Producer prices in Nigeria are determined by market conditions in both the internal and international markets (Traore, 2009). Apart from its contribution to the nation's economy, Cocoa is a plant-based food that contains carbohydrates, fats, proteins, natural minerals and some vitamins and like several other plant foods such as tea, red wine, fruits, vegetables and nuts cocoa contains a group of compounds which exhibit health benefits (Taubert *et al.,* 2007). Research conducted at Harvard Medical School showed that heavy consumers of cocoa had significantly lower rates of heart disease and cancer compared to those who consume less. Cocoa has a unique natural taste and colour and possesses a delicious aroma used in many food products for extra flavour and colour (ICCO, 2005).

In spite of its significance however, Folayan, *et al*., (2006), noted that cocoa production in Nigeria has witnessed a downward trend after 1971 season, when its export declined from 308,000 tons to 216,000 tons in 1976; 150,000 tons in 1986 and 110,000 tons in 1991 (Koekoek, 2003). And in spite of spirited effort to increase output as engendered by the Structural Adjustment Programme (SAP), output only increased to 205,000 tons in year 2000 (Oluwasola *et al.,* 2015). Cocoa output experienced a continuous increase from 2000 to 2006 (485,000 tons). Afterwards, cocoa output started experiencing fluctuation from 2007 through 2010. In 2011, the output was 391,000 tons which witness steady decrease to 367,000 tons in 2013 (FAOSTAT, 2015). Federal and State government of Nigeria have made it a matter of policy attention to diversify the present over dependence of the country's economy on oil, by focusing on tree crops such as cocoa and food

crops such as cassava productions, which is reflected in the set-up of the presidential initiatives on the production of these crops. The Federal Government's concern at diversifying the nation's export base has placed cocoa in the center-stage as the most important export tree crop (Nkang *et al.,* 2006). Since the early 1980s, dramatic changes in export commodity markets, and other shocks resulted in a drop in the price of cocoa and other raw material in the world market. Financing is important for an enterprising cocoa sector. Apart from purchasing inputs, credit is used by farmers to support their households during the off-season and hire or buy land to expand their farm holdings.

Some of the problems attributed to the decline in cocoa production include labour shortages, low producer prices and lack of credit facility to support production practices (Asare, 2005). Nkang *et al.,* (2006) stated that access to bank loan by cocoa farmers was a big problem due to lack of collateral and the risky nature of agricultural production. As a result of the failure of the commercial and merchant banks to provide sufficient funding for the agricultural sector, the Nigerian Agricultural Bank Limited was established in 1973 by the Federal Government to deal exclusively with agricultural loans. The provision for the establishment of the bank was developed during the 1st national development plan period of 1962-1968 but was not implemented until the 2nd period which spanned between 1970 and 1974 (http://www.novapdf.com)

The establishment of this specialized bank was actualized following the acceptance of the recommendations made in Stoneham's report and subsequent inclusion in the 1970-1974 Development Plans. Based on the plan, the proposed agricultural cooperative bank which was meant to operate in all states of the federation will assist farmers in the area of cooperative farming and agricultural marketing cooperatives. The bank was meant to make funds available directly to cooperatives, credit-worthy individuals and Governments. As part of government effort to provide low-cost credit to small holder and commercial farmers, the Nigerian Agricultural and Cooperative Bank (NACB) was conceptualized to specifically enhance the development of the nation's agricultural sector. However, the bank was restructured in 2000 into a new one called 'Nigerian Agricultural Cooperative and Rural Development Bank (NACRDB) from the amalgam of the former Peoples Bank of Nigeria, the NACB, and the Family Economic Advancement Programme (FEAP). The new institution was mandated with the responsibility of accepting deposits from customers and offering loans and or advances whose interest rates are stratified according to the purpose for which they are obtained (Fakayode *et.al,* 2009).

A plan to reposition the Bank into an effective and sustainable national agricultural and rural development finance institution in 2010 led to a further name change to Bank of Agriculture Limited (BOA). The aim of BOA is to ensure effective delivery of agricultural and rural finance services on a sustainable basis to support the national economic development agenda, including food security, poverty reduction, employment generation, reduction in rural to urban migration, less dependency on imported food items, and increase in foreign exchange earnings (http://www.bankofagricultureng.com, 2015). However, researches had shown that use and delivery of BOA credit was affected by the constraints such as bureaucracy, delay in loan disbursement, administrative cost, among others. Reducing the bottle necks for the farmers will increase use of BOA credit, thus increasing agricultural production (Ugbajah, and Nenna 2014; Yesufu *et al.,* 2013)

Syngenta foundation for sustainable agriculture (2012) established that Public-Private Partnerships (PPPs) in agriculture as important mechanism to harness technology, resources, skills, expertise and market access to improve the livelihoods of resource-poor smallholders in developing countries. Public-Private Partnerships (PPPs) is a generic term for the relationships formed between the private sector and public bodies. Public-private partnerships have been a collaborative venture between the public and private sectors built on the expertise of each partner that best meets clearly defined goals through the appropriate allocation of resources,

risks and rewards" (Bettignies and Ross, 2004). These arrangements generally entail "reciprocal obligations and mutual accountability, voluntary or contractual relationships, the sharing of investment and reputational risks, and joint responsibility for design and execution" (World Economic Forum, 2005). The public and private sector realize that they need to work together in order to more effectively solve problems which would be more difficult, if not impossible, to be resolved by working alone. (Inter-American Development Bank, 2012).

Technoserve (TNS) is an international non- profit development organization, founded in 1968. Its mission is to help entrepreneurial men and women in poor rural areas of the developing world, to build business that create jobs, income and economic opportunity for the families, communities and countries. Technoserve was registered in Nigeria as non- profit organization in 2010, and has engaged in collaboration with key public and private sectors including cocoa, poultry, and feed grains. Technoserve works with groups and individual farmers to address market failure (constraints that prevent agricultural market system from operating efficiently), develops capacity (improves farmers productivity efficiency and competitiveness) , promotes market connection (coordination of market participants and connecting emerging businesses and farm to capital, market, network, suppliers and qualified labour) and improves the business environment (encouraging self-sustaining economic activity, by addressing the policies, information and incentives that help market function better).

In line with Agricultural Transformation Agenda of the Federal government, non-governmental organization such as Technoserve is in collaboration with Bank of Agriculture with the aim of increasing cocoa production and strengthen the economy of cocoa growing communities (http://www.technoserve.org, 2015). Technoserve developed a number of programs to address constraints in cocoa production, such as a program connecting cocoa farmers with access to input credit such as fertilizer and pesticides (herbicides, fungicides and insecticides) which have potential to double cocoa yield on smallholder plots. As a results of the fact that most Nigerian farmers do not have access to the credit to purchase these inputs, Nigerian cocoa producers are achieving only 30 percent of their potential yields. Hence, Technoserve acts as a facilitator in positioning cocoa farmers to secure credit from Bank of Agriculture. The inputs credit facilities from Technoserve given to cocoa farmers are fertilizer, pesticide (herbicide, insecticide, fungicide) and seedlings. These inputs are supplied to the cocoa farmers on credit. At the end of the cropping season, the farmers sell their produce to Technoserve receiving agents who register farmers with BOA by making payment for their produce into each cocoa farmers' account whereby BOA now make payment transfer in respect of input procured on credit to Technoserve, thereby making the farmers to be in position to access credit facilities from BOA. The collaboration is believed to provide solution to the identified problems of input credit among cocoa farmers.

Statement of Research Problem

Literatures have identified lack of adequate credit facilities and rural banking infrastructure as major problems for cocoa farmers as very limited proportion of farmers have access to formal credits (Institute of Development Studies, 2008). In addition, Onumah *et al.* (2014) and Pischke and Adam (1980) reported that inadequate credit facility was found to hinder productivity of cocoa farmers and have negative consequences for cocoa marketing. Fesenberg (2012) also found out that low income and productivity of cocoa farmers is as a result of poor access to quality input credit and technology and poor access to buyers and market information. Majority of cocoa farmers are not organized in cooperative, and infrastructure and hence input finance are inadequate (Fesenberg, 2012). Cocoa production has been on decline over the years and this is partly attributed to poor infrastructure together with credit and marketing (Denning *et al.,* 2009).

To resuscitate cocoa production and marketing; and hence, salvage the cocoa industry from further declining, some individuals and private organizations have been involved to complement the efforts of the governments. Government intervention programmes such as Structural Adjustment Programme (SAP), Agricultural Credit Guaranty Scheme (ACGS), Bank of Agriculture (BOA) and Nigerian Incentive Based Risk Sharing Agricultural Lending (NIRSAL) were aimed at increasing cocoa production and thereby strengthen the economies of cocoa farming communities in respect of input credit accessibility in line with the Federal Government Agricultural Transformation Agenda. In spite of the existence of these programmes, Nigerian cocoa farmers are achieving only 30% of their potential yields (http://www.technoserve.org, 2015). Bank of Agriculture (BOA) engages in collaborative scheme with Technoserve (TNS) in order to foster pooling together of resources and skills to help small holder cocoa producers access input credit from BOA's loans schemes. The collaboration between BOA and TNS which helps to educate, supervise and provide cocoa farmers and marketers with assistance in accessing credit and marketing of cocoa in poor rural areas of Ekiti State is yet to be assessed.

Therefore, this study examined the contribution of Technoserve– BOA service to the production of cocoa in Ekiti State. It assessed the willingness of farmers to use Technoserve–BOA services which has not been empirically researched. The major question therefore is; has the accessibility of input credit through Technoserve–BOA service by the farmers helped the production of cocoa? The broad objective is to comparatively analyze users and non-users of Technoserve facilities in the production and marketing of cocoa in Ekiti state.

Methodology

Ekiti State, located within latitude $7^0 15^1$ and $8^0\ 15^1$ North of the equator and longitude of $4^0\ 45^1$ and $5^0\ 45^1$ East of the Greenwich meridian, was created out of the old Ondo State in 1996 with its capital in Ado Ekiti in the south west geopolitical zone of Nigeria (Akinyemi *et al.*, 2013). The State enjoys tropical climate which has the wet and dry seasons. Mean annual temperature ranges between 21^{o}C to 28 ^{o}C and mean annual rainfall ranges between 1200mm to1800mm (Ugwuja *et al.*, 2011) while the mean relative humidity is over 75% (Ekiti State Government, 2008). The population of Ekiti State as reported by National Population Commission 'NPC' (2006) is 2,384,212 people with more than 80% of the population engaged in farming as main source of livelihood (Olaitan and Oladipo, 2002). The State has 16 administrative Local Government Areas (LGAs) divided into three (3) agricultural zones. It is suitable for livestock rearing, production of cash crops such as cocoa, coffee, kola nut and food crops such as yam, cassava, cocoyam, plantain and so on (Kuponiyi and Bamigboye, 2009). Since the climate in the study area support the minimum requirement for cocoa production, the people in the study area have taken advantage of it to produce and market cocoa products, making them require proper financing for optimal production.

Sampling Procedures

A multi-stage sampling technique was employed in selecting the respondents. The first stage involved stratified sampling techniques of the LGAs into those who use and those who do not use the facilities provided by Technoserve. The second stage involved purposive selection of Gbonyin LGA which was the only LGA in which Technoserve activities were operated. The third stage involved stratification of the LGAs without the activities of TNS based on intensity of cocoa production. The fourth stage involved the random selection of one LGA from the high producing LGAs. The fifth stage involved random selection of 120 respondents from each of the two LGAs making a total of 240 respondents.

Data Collection

Primary data was collected using a pretested questionnaire. Data collected include socio-economic characteristics of the respondents such as age, sex, marital status, family size and level of education; types and value of assets owned by the respondents such as farmland, cutlass, hoe, knapsack sprayer; the income of cocoa farmers and total expenditure on cocoa inputs used such seedlings, agro chemicals, fertilizer, etc. Data were also collected on revenue from marketing and production of cocoa. A total of 240 respondents were interviewed with the help of well-structured questionnaires to obtain information from the respondents.

Analytical Techniques

Descriptive statistics

These were used to describe the socio-economic characteristics of the respondents. This involved the calculation of percentages, frequency counts and mean values for parameters such as farmers' age, gender distribution, level of education, farm size, inputs and output level.

Budgeting techniques

These were used to compute the costs and returns of users and non-users of Technoserve service in the study area. The profitability of the two groups were determined and compared. Budgetary analysis (Gross Margin Analysis) was used by Henri-Ukoha *et al*. (2011) to analyze the Net Farm Income, Gross Margin and Benefit Cost Ratio. Budgeting technique used to assess the profitability of cocoa production is as given below:

TR = Price x Quantity
TC = TFC + TVC
GM = TR – TVC
NI = GM –TFC
Where:
GM = Gross margin
TR = Total revenue
TVC = Total variable cost
NI = Net Income
TC = Total cost
TFC = Total fixed cost

The performance and economic worth of the respondents were determined by the use of the following Profitability ratios:

1. Benefit Cost Ratio (BCR) = TR/TC
2. Expense Structure Ratio (ESR) = FC/VC
3. Rate of Return (ROR) = NR/TC
4. Gross ratio (GR) = TC/TR
5. Net Income (NI) = GM-TFC

Multiple regression analysis

Multiple regression analysis was used to establish relationships between economic variables and also used to analyze the input credit effect on net income of users of Technoserve. Regression analysis is an important econometric tool for predicting the values of the dependent variable. It measures the degree of association between two or more variables. The coefficient of determination which is denoted by R^2, shows the percentage of the total variation in the dependent variable explained by the independent variables in the model. Regression

coefficient tells us the amount of change that will be observed in the value of the dependent variable when the values of the independent variables alter. The model is specified as:

$Y_1 = f(X_1, X_2, X_3, X_4, U)$ …….. (1)
Where, Y_1 = Net Income (₦)
X_1 = Fungicide (kg)
X_2 = Seedlings (₦)
X_3 = Insecticide (litres)
X_4 = Herbicide (litres)
U = Error term

Measurement of variables
The data used in determining the net income of cocoa production among cocoa farmers in the study area were: labour, fungicides, seedlings, age of cocoa farmers, education, insecticide, farming experience and herbicide.
Net income: The net income of various farmers was measured by subtracting total cost of cocoa production from total revenue which was measured in Naira. The range was between ₦13,700.00 and ₦428,730.00
Fungicide: This was the total number of fungicides in kilogrammes used in the last cropping season. The range was between ₦330.00 and ₦800.00 per kilogramme
Seedlings: This was the number of seedlings planted by individual cocoa farmers**.**
Insecticide: The insecticide variable was measured by the quantity applied by the farmers in litres. The range was between 1liter and 80 liters
Herbicide: The herbicides variable was measured by the quantity applied by the farmers in litres. The range was between 1liter and 100 liters.

Results and Discussions
Socioeconomics Characteristics of the Respondents
The gender distribution of respondents, almost 95% of the respondents who used Technoserve facility were male, also most (85.0%) of the non-users of Technoserve facility were male. This implies that cocoa production in the study area is largely dominated by men. Women according to Doss (2002) are mostly into production of crops which are more for home consumption. For any agricultural enterprise, age of respondents is very crucial in that age of the farmer has an important bearing on his effectiveness (Adeyemo, 2011). Table 2 presents the distribution of respondents according to their ages. This result shows that the age distribution of respondents ranged between 20 and 92 years. The respondents that were between 31 and 50 years were in the majority (75.8%) among the users of Technoserve facility, while the non-users for the same age range was 57.5%. The mean ages of users and non-users were 44.27 and 48.31, respectively while their standard deviation was 9.75 and 12.70 for both users and non- users, respectively

This suggests that the respondents for both users and non-users of Technoserve facility were in their active and productive age and ready to take advantage of available opportunities. This is in contrary to the findings of Onumah *et al.* (2014) that the age of majority of cocoa farmers were above 60 years of age and also Vigneri (2007) also observed that the mean age of cocoa farmers in Ghana was 49, with a reason being that the young cocoa farmers migrate to cities in search of other jobs. The distribution of the respondents according to their marital status is shown in Table 2. About 95% of the cocoa farmers were married. Only 4.2% were single for both users and non- users of Technoserve facility. This indicates that married people dominated the enterprise which implies that family labour may be provided by family members and may provide contributions to management of farm operations. This is in line with Oluwasola *et al*. (2015), Adebiyi and Okunlola (2013)

that married farmers have family responsibilities as well as access to family labour. This should ensure continuity and stability in the enterprise. Education enables the farmers to be more rational when it comes to decision making (Agunbiade, 2015).

Among users of Technoserve facility about 2.5% did not go to school and 62.5% attended secondary school, while among non-users 21.7% did not go to school and 48.3% attended secondary school. This indicated that there is high level of illiteracy among non- users of Technoserve facility which may not allow them to adopt and use Technoserve facilities, while the level of education among the users may make them to be more rational in decision to use Technoserve facilities. The household size is an indication of the potential family labour available for farm operations. The distribution of respondents based on the household size reveals that the majority of the respondents among both users and non-users of Technoserve services had between 6 and 10 members of household, 62.5% for users and 59.2% for non- users. This suggests that family Labour could readily be available in the households under this study. This result agrees with the findings of Osinubi (2003) in a study of urban poverty in Nigeria that members of household were mostly between 6 and 10. The distribution of the respondents according to primary occupation varied, it showed that about 63% of the

Techno serve users and (77.5%) of non-users were primarily engaged in cocoa farming, while only12.5% and 7.5% respectively were artisans. This implies that farming is the major occupation of those in the study area. The distribution of respondents according to years of involvement in cocoa farming operations ranges between 3 and 50 years. Majority (55.9%) of the users had between 11 and 30 years of experience also 60% of non-users had the same years of experience. This suggests that years of involvement in cocoa farming operations is an indication that they have been in production for many years and are well experienced.

Table 2: Socioeconomic characteristics of the Respondents

	User		Non user	
	Frequency	**Percent**	**Frequency**	**Percent**
Gender				
Male	113	94.2	102	85
Female	7	5.8	18	15
Total	120	100	120	100
Age				
≤ 30.00	7	5.8	7	5.8
31.00 - 40.00	48	40	35	29.2
41.00 - 50.00	43	35.8	34	28.3
51.00 - 60.00	15	12.5	29	24.2
61.00 - 70.00	5	4.2	8	6.7
71.00 - 80.00	2	1.7	6	5
81.00- 90.00	0	0	1	0.8
Total	120	100	120	100
Marital Status				
Single	5	4.2	5	4.2
Married	114	95	114	95
Widowed	1	0.8	1	0.8

Total	120	100	120	100
Level of Education				
Did not go to school	3	2.5	25	20.8
Adult school	2	1.7	4	3.3
Primary school	18	15	21	17.5
Secondary school	75	62.5	59	49.2
Tertiary	22	18.3	11	9.2
Total	120	100	120	100
House Size				
≤ 5.00	33	27.5	36	30
6.00 - 10.00	75	62.5	71	59.2
11.00 - 15.00	11	9.2	10	8.3
16.00 - 20.00	1	0.8	2	1.7
≥ 21			1	0.8
Total	120	100	120	100
Primary Occupation				
Artisan	15	12.5	9	7.5
Civil servant	3	2.5	3	2.5
Driving	2	1.7	2	1.7
Farming	76	63.3	93	77.5
Timber contractor	5	4.2	1	0.8
Trading	19	15.8	12	10
Total	120	100	120	100
Experiemce				
≤ 10.00	41	34.2	26	21.7
11.00 - 20.00	41	34.2	45	37.5
21.00 - 30.00	26	21.7	27	22.5
31.00 - 40.00	7	5.8	11	9.2
41.00 - 50.00	5	4.2	9	7.5
≥ 50			2	1.7
Total	120	100	120	100

Source: Field Survey, 2015

Availability and Acquisition of Land for cocoa production

30.8% of the total cultivated land available that was less than or equal to 5.00Ha for users of Technoserve facility. Among the non-users, 26.7% had total cultivated land available that was less than or equal to 5.00Ha. The mean total cultivated land available was 10.66Ha and 10.20Ha for users and non-users respectively. This suggests that the land holding capacity by respondents is small which could be as a result of land fragmentation caused by land tenure system and in the study area. 55.0% of the respondents had 5.00Ha or less while 35.8% had between 6.00Ha and 10.00Ha of farm land allocated for cocoa production among users of Technoserve facility. Also among non-users majority (46.7%) had 5.00Ha or less of farm land set aside for cocoa production,

42.5% had between 6.00Ha and 10Ha. This suggests that farmers in this area are really facing the problem of land shortage because of land tenure system which is mostly through inheritance, characterized by fragmentation.

This is in accordance with Economic Commission for Africa (2004) that fragmentation of land holdings had developed among small holder farmers because of inheritance rules. Different methods of land acquisition exist for agricultural land. There is a salient connection between land acquisition and cash crop mode of land acquisition has implication of security of tenure. Table 3 presents the method of land acquisition and this reveals that 53% of the users of Technoserve facility farmers acquired their farm land by inheritance, 28.3% acquired land through purchase while 13.3% were through lease. Among non-users, 37.5%, 36.7%, 20.8% were through inheritance, purchase and lease, respectively. This connotes that majority of the farmers acquired their land by inheritance which also help to decrease the total cost of production.

Table 3: Availability and Acquisition of Land for cocoa production

	User		Non user	
	Frequency	**Percent**	**Frequency**	**Percent**
Total Farmland (Ha)				
≤ 5.00	37	30.8	32	26.7
6.00 - 10.00	34	28.3	49	40.8
11.00 - 15.00	27	22.5	23	19.2
16.00 - 20.00	11	9.2	6	5
21.00 - 25.00	4	3.3	7	5.8
26.00 - 30.00	7	5.8	2	1.7
≥ 30	0	0.0	1	0.8
Total	**120**	**100**	**120**	**100**
Land Allocated to Cocoa				
≤ 5.00	66	55	56	46.7
6.00 - 10.00	43	35.8	51	42.5
11.00 - 15.00	10	8.3	10	8.3
≥ 21.00	1	0.8	3	2.5
Total	**120**	**100**	**120**	**100**
Method of land acquisition				
Inheritance	64	53.3	45	37.5
Purchase	34	28.3	44	36.7
Lease	16	13.3	25	20.8
family land	1	0.8	1	0.8
inheritance and purchase	3	2.5	3	2.5
purchase and lease	2	1.7	1	0.8
Inheritance and lease			1	0.8
Total	**120**	**100**	**120**	**100**

Source: Field survey, 2018

Budgeting Techniques of Comparative Analysis of Users and Non-Users of Technoserve Facilities in Cocoa Production

The result of costs, returns and profitability of cocoa farm enterprise by users and non- users of Technoserve services is presented in Table 4. It was found that for users of Technoserve facility, variable inputs constitute about 77.71% of the total cost of production. Also, it was found that for non-users about 74.30% of the total cost of production was on variable inputs. Cost of Labour accounted for 41.90% for users of Technoserve services, while cost of Labour for non-users accounted for 40.82%. This suggests that a relative amount of money spent on hired Labour, was almost the same for both users of Technoserve services and non-users. The cost of fungicide made up 13.14% for users, and 8.26% for non-users. Cost of herbicide account for 4.61% of the total cost of production for users and 2.14% for non- users.

The mean value of total variable cost and total fixed cost were ₦140,348.63 and ₦40,252.85, respectively for users and for non-users. Mean value of the total revenue was ₦276,562.77 while the Net Farm Income (₦95,961.29) which was measured by subtracting total cost from total revenue for users and the mean total revenue for non-users was ₦ 171,619.47 and net farm income of (₦42,407.28). This indicates that the enterprise is more profitable with the use of Technoserve facility. Subtracting total variable cost from total revenue, the gross margin equals ₦136,214.14 for users and ₦75,641.14 for non- users.

A profitability measure which is also an attempt to estimate the future outcome of a plan in both qualitative and financial terms. Profitability ratios included in this study are profit margin which gives a value of 34.70% for users indicating that for every ₦1.00 generated from the enterprise a net income of ₦0.34 is earned, while for non-users the profit margin value of 24.71% will generate net income of ₦0.24 for every ₦1.00 spent; the value of per capital outlay gives 0.53 for users which implies that from every ₦1.00 invested into the enterprise, a net income of ₦0.53 was realizable and for non-users ₦0.33 was realizable. Operating Cash Expenses Ratio whose value is 0.51 and 0.56 for users and non-users respectively shows that from every ₦1.00 generated from the enterprise, ₦0.51 and ₦0.56 was invested, respectively as running cost into the enterprise. This suggests that users had low running cost. Also, Benefit-Cost Ratio of 1.53 for users and 1.33 for non-users implying that for every ₦1.00 investment on cocoa production ₦1.53 and ₦1.33, respectively was realizable. This suggests that users realize more on their investment. All these ratios affirm that cocoa marketing was profitable with the use of Technoserve Services.

TABLE 4: Results of the Comparison of the Budgetary Analysis of Users and Non-Users of Techno serve Facilities in Cocoa Production in Ekiti State, Nigeria

S/N	Items	Users		Non-Users		
		Mean amount (₦)	%TC	Mean amount (₦)	%TC	T-Test
1	**REVENUE**					
I	Quantity of Cocoa (kg)	606.83		378.50		
II	Price per kg (₦)	455.75		453.42		
A	**Total Revenue (TR)**	**276,562.77**		**171619.47**		**9.51**
2	VARIABLE COST					
I	Cost of Herbicide	8,332.25	4.61	2768.33	2.14	
II	cost of fungicide	23,739.04	13.14	10678.75	8.26	
III	Cost of insecticide	8,430.67	4.67	4039.58	3.13	
IV	Cost of fertilizer	257.50	0.14	225.00	0.17	
V	Cost of transportation	2,3916.67	13.24	25516.67	19.75	
VI	Cost of Labour	75,672.50	41.90	52750.00	40.82	
B	**Total Variable Cost (TVC)**	**140,348.63**	77.71	**95978.33**	74.30	7.66

C	**Gross margin (TR-TVC)**	**136,214.14**		**75641.14**		9.67
D	FIXED COSTS					
I	Cost of Cutlass	7,654.17	4.24	4349.50	3.37	
II	Cost of Hoe	2,656.60	1.47	2641.39	2.04	
III	Cost of Knapsack Sprayer	3,334.31	1.85	2620.86	2.03	
IV	Cost of Wheel Barrow	1,264.38	0.70	1215.97	0.94	
V	Cost of harvesting hook	2,856.25	1.58	1468.75	1.14	
VI	Cost of file	2,587.50	1.43	1411.25	1.09	
VII	Cost of jute bag	557.08	0.31	407.68	0.32	
VIII	Cost of Basket	1,120.00	0.62	1007.92	0.78	
IX	Cost of Basin	1,221.46	0.68	1112.88	0.86	
X	Cost of head pan	456.94	0.25	1282.58	0.99	
XI	Land rent	12,166.67	6.74	13100.00	10.14	
XII	Cost of seedlings	4,377.50	2.42	2615.08	2.02	
D	**Total fixed cost**	**40,252.85**	22.29	**33233.86**	25.70	2.89
E	Total Cost (TC) = (TFC + TVC)	180,601.48	100.00	129212.19	100.00	6.99
F	Net Income (NI) = (GM - TFC)	95,961.29		42407.28		11.00
G	Profit Margin = F/A *100	34.70		24.71		
H	Return per Capital Outlay = F/E	0.53		0.33		
I	Operating Cash Expenses Ratio = B/A	0.51		0.56		
J	Benefit Cost Ratio = A/E	1.53		1.33		
K	Net Farm Income Ratio = F/C	0.73		0.58		

Source: Data Analysis, 2015

Costs and Profit per Unit of cocoa production of users and non-users of TECNOSERVE Facilities

Table 5 present both the cost and profit per unit of both users and non-users of TNS in the study area, the total variable cost of users (231.28) was found to be lower than that of the non-users (253.58) while profit per unit of users (158.14) was found to be higher than that of non-users (112.87), this implies that users of TNS incur less cost in their production process all because of the provision of reasonable credit and input by TNS at an appropriate time, this was not the case for non-users.

TABLE 5: Cost and Profit per Unit of cocoa production of users and non-users of TECNOSERVE Facilities

	Users	**Non-users**
TVC per Unit(₦)	231.28	253.58
Profit per Unit	158.14	112.87

Source: Data Analysis, 2015

Effects of Input Credit supplied by Technoserve on Net Income among Cocoa Technoserve **users**

Table 6 presents the results of multiple regression model. The lead equation was double-log. This was because of the high adjusted R-square, minimum standard errors and high number of independent variables that were significant. All the independent variables had positive relationship with net farm income of the respondents except quantity of insecticide used by the respondents while quantity of fungicide, number of seedlings, and quantity of herbicide used were in conformity with a priori expectation, quantity of insecticide was not.

The multiple regression table shows that the model fits the data reasonably. The adjusted R-square was 0.358. This suggests that 35.8% of the variability in the net farm income of the respondents is explained by variations in the specified explanatory variables considered. The results further shows that all the coefficients of the specified explanatory variables were significant at acceptable levels. Quantity of fungicide used by the cocoa farmers was positively related and statistically significant at 1%. This can be interpreted as additional increase

in the quantity of fungicide used in cocoa production will bring about 65.9% of the net farm income of the respondents. This is in accordance with the finding of Iya and Kwaghe (2007) that increase in the use of pesticide will increase output of cowpea which will invariably increase net farm income. Interestingly, quantity of herbicide used by the cocoa farmers was positively related and statistically significant at 10%. This indicates that as the quantity of herbicide used is increased by a liter, there is increase in the net farm income of the respondents by 12.8%. This result is in line with Grema and Gashua (2014) who confirmed that increase in quantity of herbicide could increase the output and net farm income of onion.

More also, amount of seedling planted by the farmers was positively related and statistically significant at 5%. This suggests that as the farmers are provided with more seedlings, there will be increment of 71% in the net income of the farmers. This result is in conformity with the finding of Onoja *et al*. (2012) that increase in seedlings can increase net farm income of the cocoa farmers. On the contrary, quantity of insecticide used was negatively related and statistically significant at 10%. This means that increase in the use of insecticide by one liter, this will result in 15.8% decrease in net farm income of the respondents. This finding is in agreement with Adesiyan (2015) that further increase in the use of insecticide might have a negative effect on output and net farm income of maize.

Table 6: Effects of Input Credit on Net Income among Cocoa Technoserve users

Variables	Linear		Exponential		Semi-log		Double-log	
	Coefficients	Std. Error	Coefficients	Std. Error	Coefficients	Std. Error	Coefficients	Std. Error
Constant	34023.71***	10962.366	10.709***	.099	-20229.257	36065.360	10.080***	.293
Herbicide	1725.60***	553.187	0.012**	.005	14830.236*	8568.457	.128*	.070
Insecticide	-570.92**	265.915	-0.004	.002	-22005.635***	7619.996	-.158**	.062
Fungicide	11799.76***	2697.881	0.127***	.024	70477.706***	17001.399	.659***	.138
Seedlings	0.91	0.822	1.101E-5	.000	6526.199	4288.410	.071**	.035
R-square	0.298		0.331	.099	0.312		0.388	
Adjusted R-square	0.273		0.308	.005	0.279		0.358	
F-value	12.18		14.22		9.30		13.00	
P-value	0.000		0.000		0.000		0.000	

Source: Data Analysis, 2015

*** ,** and * represent 1% , 5% and 10% significant level respectively

Conclusion

In conclusion the study showed that majority of the respondents' farmers in both users and non-users were over forty years of age with secondary educational level. Land holding capacity of the farmers is small and the mode of acquisition is mainly by inheritance. Positive value of net income and gross margin showed that the enterprise is comparatively more productive for the users of Techno serve facilities. Farmers in the study area could improve their market margin through the use of Technical Support Services (TECHNOSERVE).

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