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EVALUATION OF *Gliricidia sepium* LEAF MULCH ON OIL PALM (*Elaeis guineensis Jacq.*) SEEDLING PERFORMANCE UNDER SOME SILVICULTURAL TREATMENT.

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ABSTRACT

The study was conducted in 2017 to evaluate the performance of one variety (Tenera) of oil palm (*Elaeis guineensis Jacq.*) using the leaf mulch of *Gliricidia sepium* at the nursery site of Crop Production Department, Kogi State University Anyigba. Leaf mulch of *Gliricidia sepium* was air dried during the dry season, grinded, and weighed at different rates; 0 g (control), 20 g, 40 g, 60 g, 80 g, 100 g and was applied as mulch to each treatment which was replicated nine times. The layout of the experiment was Completely Randomized Design (CRD). The result of the study showed that *Gliricidia sepium* leaf mulch does not have significant effect on the different growth parameters. Plant height, number of leaves, stem girth and leaf area were not increased significantly within the period (1-5 months) of the study period except in a very few instance. The results showed that oil palm (*Elaeis guineensis Jacq.*) seedling were not responsive to *Gliricidia sepium* leaf mulch except for plants that received 100 g of the treatment for leaf area and this was observed at the fifth month after planting.

Keywords: Evaluation, *Gliricidia sepium*, oil palm, silvicultural treatment, Kogi State

INTRODUCTION

Oil palm (*Elaeis guineensis Jacq.*) is a tropical tree crop which is mainly grown for its industrial production of vegetative oil. It is a typical estate crop, grown and harvested over large uniform areas (3,000 to 5,000 ha) around a central oil mill to allow rapid industrial handling after harvesting. Palm trees can also be observed in village gardens where they provide oil for local consumption, but in that case both yield and oil quality are much lower (NIFOR, 2009). Oil palm is a typical crop of the rainy tropical lowlands. The tree requires a deep soil, a relatively stable high temperature and continuous moisture throughout the year. Soil fertility is less important than physical soil properties (Pandey *et al.,* 2006). According to Obahiagbon (2012) dry periods of more than 2-3 months do not specifically damage vegetative growth, but affect seriously the production and quality of the fruit bunches. Oil palm yield is not only determined by vegetative growth and production, but also in a way at which pests and diseases can be controlled or eradicated. Because industrial oil palm plantations need the clearance of large areas they often require the expropriation (surrender of claim) of land and the cutting of extensive (pristine) forest areas. Hence, the development of such plantations is usually associated with land tenure conflicts and problems of local land ownership on one hand and ecological problems, viz. biodiversity loss, on the other hand.

The closely related American oil palm *(Elaeis oleifera)* and a more distantly related palm, *Attalea maripa*, are also used to produce palm oil. Human use of oil palm may date as far back as 5,000 years in West Africa; in the late 1800s archaeologists discovered palm

oil in a tomb at Abydos dating back to 3,000 BCE (Kiple and Conee, 2000). It is thought that Arab traders brought the oil palm to Egypt (Obahiagbon, 2012). Oil palm cultivars in the strict sense do not occur, as the oil palm is monoecious and crosspollinated, individual palms are usually very heterozygous; and vegetatively propagated clonal material cannot be made. The current classification of cultivars is mainly based on fruit structure and yield or commercial value (Achieng *et al*., 2010).

• *Macrocaria*: shell (endocarp) is 6-8 mm thick; is an extreme form of *Dura*, which is still widely spread in Sierra Leone and western Nigeria; without any commercial value;

• *Dura*: shell is 2-8 mm thick, comprising 25-55% of weight of fruit, medium mesocarp content of 35-55% by weight, but up to 65% in Deli palms; less productive but hardy variety, well adapted to village gardens;

• *Pisifera*: shell-less, with small pea-like kernels in fertile fruits; of little commercial value, because of its high abortion ratio, but important for cross-breeding commercial palms; and

• *Tenera:* shell is 0.5-3 mm thick; comprising 1-32% of weight of fruit; medium to high mesocarp content of 60-95%, but occasionally as low as 55%; this variety is the result of a hybridization of *Dura* and *Pisifera*, and has a high commercial value.

In Nigeria, the ideal climatic condition is not readily obtainable due to a marked variation in dry season with reduced amount of rainfall in some part of the country. In addition, heavy cloud usually overhangs the atmosphere thus reduce the sunshine hours and incoming radiation which the crops get during the rainy season. The oil palm, however, can still be cultivated successfully provided the rainfall is in excess of evapo- transpiration. Soils, which have high water storage capacities, can support the crop. The oil palm can grow fairly well in areas of Nigeria, which have low rainfall and good soil (NIFOR, 2009). Over the years, crop (food and tree) growers have limited themselves mainly to the use of either Nitrogen Phosphorus and Potassium (NPK) fertilizer, Ammonium Sulphate etc as inorganic fertilizers or the use of cow dung, poultry droppings etc as organic fertilizers in a bid to boost productivity. Not much attention has been given to the use of green manure (applied as mulch) in increasing crop productivity.

The importance of oil palm (*Elaeis guineensis*) cannot be overstressed. It is the source of palm oil which serves as the main cooking oil in most countries where it is produced (FAO, 2005; Owolarafe *et al*., 2007). Just like other fats, palm oil is a good source of energy, provides carotenoid (Pro-Vitamin A) and Vitamin E. Hence, the reason for using green manure such as *Gliricidia sepium* leaf mulch to boost productivity of oil palm (*Elaeis guineensis Jacq.*) in the study.

MATERIALS AND METHOD

Study Area: The pot experiment was conducted under a light tolerance shade in front of the green house at the Faculty of Agriculture, Kogi State University, Anyigba. The location is at (Longitude $7^{\circ}43^{'}$ E and Latitude $7^{\circ}6^{'}$ N) which falls within the southern Guinea Savanna Zones of Nigeria (Amhakhian *et al*., 2012). The daily temperature range is about 25°C- 35°C. Relative humidity is moderately high and varies from an average of 65-80% (Sale *et al*., 2015). Kogi State has a bimodal rainfall with the peak pattern occurring in July and September. The mean rainfall ranges from 1560 mm at Kabba in West to 1808 mm at Anyigba in the East (Sale *et al*., 2015).

Oil Palm (*Elaeis guineensis Jacq.)* sprouted nut of tenera variety was obtained from the Nigerian Institute for Oil Palm Research (NIFOR), Benin City on the 4th of October, 2017 and rich fertile soil was collected from within Anyigba, Dekina local government Area of Kogi State. The soil was sun dried and sieved, using 2 mm mesh-sieve. Fresh leaves of *Gliricidia sepium* leaves were harvested from its mother tree from the nursery site of Crop Production Department, Faculty of Agriculture. It was air dried in the screen house for four

days and grinded and weighed to get different rates of 20 g, 40 g, 60 g, 80 g, and 100 g respectively.

The design of the experiment was Completely Randomized Design (CRD) with 6 levels of the treatment replicated nine times giving a total number of 54 pots.

All the data collected were subjected to analysis of variance (ANOVA) and significant means was separated using least significant difference at 5% level of probability (LSD 0.05) and was correlated.

RESULTS

The plant height response of the sprouted nut of the Tenera variety of *Elaeis guineensis* to the various rates of *Gliricidia sepium* leaf mulch is presented in (Table 1). The application of *Gliricidia sepium* leaf mulch had significant effect on the plant height only at the second months after planting. It also reveals that *Gliricidia sepium* leaf mulch application of 20 g/pot had the highest plant height (3.20) in the 2nd month after planting (Table 1).

Table 1: Effect of various rates of *Gliricidia sepium* leaf mulch on sprouted seed-nut of oil palm on plant height.

Rates (g)	1MAP	2MAP	3MAP	4MAP	5MAP
Control	1.52	3.20a	4.05	4.60	4.80
20	1.98	2.82c	3.72	4.80	4.80
40	2.28	2.90b	4.06	4.70	6.10
60	1.84	2.66d	3.39	4.20	4.90
80	1.94	2.70d	3.61	4.30	5.20
100	1.84	2.86c	3.83	4.80	5.40
Significance	NS	*	NS	NS	NS
LSD	-	0.07	-	-	-
C.V (%)	30.00	12.61	14.61	14.84	21.07

[*]Means followed by the same letter (s) within the same column are not significantly different from each other at 5% level of probability

The number of leaves response of the sprouted nut of the Tenera variety of *Elaies guneensis* to the various rates of *Gliricidia sepium* leaf mulch is presented in (Table 2).The application of *Gliricidia sepium* leaf mulch does not have any significant (p > 0.05) effect on the number of leaves at 1, 2, 3, 4, and 5 months after planting (MAP).

Table 2: Effect of various rates of *Gliricidia sepium* leaf mulch on sprouted seed-nut of oil palm on number of leaves.

Rates (g)	1MAP	2MAP	3MAP	4MAP	5MAP
Control	1.70	2.67	3.00	3.90	5.30
20	1.40	2.67	3.30	3.90	5.60
40	1.40	2.56	3.00	4.00	5.40
60	1.60	2.56	3.30	3.70	5.80
80	1.60	2.33	2.90	3.70	5.20
100	1.40	2.56	2.90	3.90	5.60
Significance	NS	NS	NS	NS	NS
LSD	-	-	-	-	-
C.V (%)	41.60	19.92	18.70	17.70	12.24

The stem girth response of the sprouted nut Tenera variety of *Elaeis guineensis* to various rates of *Gliricidia sepium* leaf mulch is presented in (Table 3).The application of *Gliricidia sepium* leaf mulch did not have any significant (p > 0.05) effect on the plant height at 1, 2, 3, 4, and 5 months after planting (MAP).

Table 3: Effect of various rates of *Gliricidia sepium* leaf mulch on sprouted seed-nut of oil palm on stem girth.

Rates (g)	1MAP	2MAP	3MAP	4MAP	5MAP
Control	0.59	0.88	0.99	1.10	1.20
20	0.59	0.84	0.99	1.00	1.30
40	0.62	0.84	0.99	1.00	1.40
60	0.61	0.83	0.93	1.00	1.30
80	0.61	0.83	0.91	1.00	1.30
100	0.62	0.80	0.91	1.00	1.40
Significance	NS	NS	NS	NS	NS
LSD	-	-	-	-	-
C.V (%)	10.40	7.30	10.42	11.82	10.40

The leaf Area response of the sprouted nut *Tenera* variety of *Elaies guineensis* to various rates of *Gliricidia sepium* leaf mulch is presented in (Table 4).The application of *Gliricidia sepium* leaf mulch had significant effect on the leaf area only at 5 months after planting (MAP). It also reveals that *Gliricidia sepium* leaf mulch application of 20 g/pot had the highest Leaf Area (75.7) in the 5th month after planting.

Table 4: Effect of various rates of *Gliricidia sepium* leaf mulch on sprouted seed-nut of oil palm on Leaf Area

Rates (g)	2MAP	3MAP	4MAP	5MAP
Control	36.11	54.10	58.00	70.90[b]
20	37.80	53.80	59.60	65.30[b]
40	34.12	51.40	64.50	75.70[a]
60	34.80	47.40	50.60	66.80[b]
80	33.06	41.50	49.40	64.40[b]
100	28.49	45.70	51.70	67.20[b]
Significance	NS	NS	NS	*
LSD	-	-	-	0.97
C.V (%)	33.90	27.96	29.84	2.70

DISCUSSION

Effect of *Gliricidia sepium* leaf mulch on the seedling performance of oil palm *(Elaeis guineensis Jacq.).*

From the result obtained from the study it was obvious that *Elaeis guineensis* at the seedling stage between 1- 5 months after planting (MAP), was not influenced by *Gliricidia sepium* leaf mulch at varying rates. The application of *Gliricidia* leaf mulch at 0 g per pot gave the highest plant height (3.20) while the application of *Gliricidia sepium* leaf mulch at 100 g per pot gave the highest leaf area (75.70) for the 2 and 5 MAP respectively. The mechanism behind this insignificance may need to be studied as it is reported that *Gliricidia sepium* leaf contains between 3.2 and 4.2% N (Sumberg, 1994) and fixes atmospheric Nitrogen although only 13 kg N/ha per year (Duhoux and Dommergues, 2004).

Dan *et al., (*2017) observed significant (P<0.05) effect of *Gliricidia sepium* leaf mulch on vegetative growth of Maize. Plots treated with 120 kg /ha mulch rate recorded the tallest plants followed by 90 kg/ha mulch rate, while the shortest plants were obtained in the control treatments (0 kg/ ha) in both months.

Plant heights were not significantly different at 30 kg/ha and 60 kg/ha mulch rates for both months, but were significantly different (P<0.05) when compared to control

treatment. As the rates of *Gliricidia sepium* leaf mulch increases plant heights maximized, this could be attributed to rapid decomposition of the *G. sepium* leaves required for plant growth. Similar result was reported by (Khurshid *et al.,* 2006) that maize crop grew taller under greater *G. sepium* leaf mulch levels. Furthermore, (Shah *et al.,* 2009 and Achieng *et al.,* 2010) confirms that *Gliricidia sepium* significantly increased the height of plants.

Plots treated with 120 kg/ha of *Gliricidia sepium* leaves mulch produced maximum number of leaves followed by 90 kg/ha mulch rate, and was significantly different (P<0.05) from those other treatments at all sampling periods. The significant increase of leaf number in the mulched plots over unmulched could imply that the mulch plots constituted higher mineral nutrients from decomposed mulched materials (Dan *et al.,* 2017). At 1 MAP, there were no significant difference between the application rates of 30 kg/ha and 60 kg/ha mulch rates on number of leaves per plant. The control plots however obtained significantly (P<0.05) the lowest number of leaves per plant in both months (Dan *et al.,* 2017).

This result agrees with the findings of (Namakha *et al.,* 2008 and Mahmood *et al.,* 2001) who reported that optimum rates of *Gliricidia sepium* leaf mulch will supply nitrogen and increase assimilation rate and building blocks of plant (Uwah *et al.,* 2011) similarly reported that the use of *G. sepium* mulches promotes vigorous foliage.

Stem girths observed at 30 and 60 kg/ha, and 90 and 120 kg/ha mulch rates were not significantly different at all sampling periods, though it shows variation in increased stem girth development of maize in both months. The highest stem girth was recorded with 120 kg/ha mulch rate while control plots produced the least at all sampling periods. This could be attributed to better nutrient uptake and development of the plants. This result agrees with (Xue *et al.,* 2013) who found that *G. sepium* leaves mulch significantly improved plant growth in terms of leaf area, number of leaves per plant and stem diameter.

CONCLUSION

It can be deduced from the study carried out that application of *Gliricidia sepium* leaf mulch does not have significant effect on the seedling performance of oil palm (*Elaeis guineensis Jacq.)* within the period of 1- 5 months after planting (MAP) as revealed in the growth parameters: height, number of leaves, stem girth and leaf area.

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EVALUATION OF THE SUITABILITY OF ELEPHANT GRASS
(*Pennisetum purpureum*) FOR PAPER MAKING

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ABSTRACT

The suitability of elephant grass *(Pennisetum purpureum)* for paper production was evaluated. The dry grasses obtained were reduced to particles. The particles were washed and steeped in a mixture of 30 g/l NaOH and 21 g/l Na_2SO_3 at 30ºC for 6 hours. The impregnated particles were refined in a single stage and semi-bleached to 37.6% brightness using 0.57% H_2O_2 on Bone Dry (BD) pulp. The bleached prepared stock were formed into paper hand sheets. The result showed that the paper made from *P. purpureum* had a tear index of 4.83 $mNm^2\,g^{-1}$ and a percentage stretch of 2.21. The results showed that *P. purpureum* could be used in making a wide variety of paper grades.

Keywords: Elephant grass, chemi mechanical paper, paper making, paper strength.

INTRODUCTION

Pennisetum purpureum are found randomly within the tropics. According to Umoren, Udoh and Akpabio (2004), *P. purpereum* is a tall perennial grass, a native to high rainfall areas in tropical Africa. If well maintained, especially by the application of nitrogen, *P. purpureum* could be very productive (Kazmi and Akpan, 2011) and provides bulky forage from repeated cuts throughout the year (Reed, Capper and Neate, 2008). Research on its cultivation and silvicultural management in Nigeria had also been reported (Webster and Wilson, 2009). *P. purpureum* is currently being used as fodder grass due to its high carbohydrate and fat content of 44.99%, average crude fibre content of 33% and crude protein content of about 7.0% (Webster and Wilson, 2009). According to Odeyemi (2007), the dry grasses are also used for fencing and thatch house building in remote areas of the grasslands in Nigeria.

Paper and allied products could be made virtually from any fibrous plant (Langer and Hill, 2002). The suitability and adaptability of any of these fibrous raw materials for paper making depend on a number of factors namely; its availability in sufficient quantity, beatability, fibre geometry and intrinsic strength, percentage pulp yield, physical and chemical characteristics of the raw material to mention but a few (Britt, 2007). The choice of *P. purpureum* for paper making is to enhance the use of agricultural fibrous wastes. The grass is naturally abundant in the tropics. The fibre length on *P. purpureum* is 0.85 mm (Utuk, 2005). Even though its fibre length is short, *P. purpureum* provides an alternative source of stock for paper making, requiring long fibre kraft pulp as a carrier.

Paper making is the art of producing a sheet material used for writing, printing, wrapping etc. usually made by draining cellulose fibres from a suspension in water (Usoro and Utuk, 2017). Paper could be made from pulp using mechanical pulping processes, chemical pulping processes or chemi- mechanical pulping processes. Chemi-mechanical pulping process, according to McGovern (2007), is a two-stage process using; (i) chemical energy with and without heat energy; and (ii) mechanical energy to cause separation of the fibres of ligno-cellulosic materials. Chemi-Mechanical Paper (CMP) is paper obtained from chemi-mechanical pulp. The pulping process involves steeping of the hips/particles in a

chemical solution to soften the fibres. Steeping is the process of soaking fibrous chips/particles in a chemical solution at specified conditions to enhance defiberation.

Several studies had been carried out on the useability of the available fibrous ligno-cellulosic materials in relation to their potentials for paper making, Reed, Capper and Neate (2008). For instance, Akpabio (2017) researched on the use of plantain (*Musa paradisiaca*) and banana *(Musa sapientum)* plants for paper making. When *Musa paradisiac* pulp was blended with *Gmelina arborea* pulp, a tear index of 4.05 $mNm^2 g^{-1}$, tensile index of 20.25 $Nm g^{-1}$ and a stretch of 1.21% were obtained. Odeyemi (2007) found out that the stem and the leaf petiole of raphia palm (*Raphia hookeri*) had fibre lengths of 2.41 mm and 1.71 mm respectively with a pulp yield of 55.28%. Utuk (2005), used *Raphia hookeri* to make Chemi-Mechanical Paper (CMP) of remarkable strength (having a tear index of 13.33 $mNm^2 g^{-1}$, tensile index of 43.49 $Nm g^{-1}$ and percentage stretch of 1.83) due to its moderate fibre length. Akpabio, Essien and Eka (2007) carried out extensive studies on Nypa fruitcans (Nypa palm). The study showed a pulp yield of 34.56%. The choice of *P. purpureum* was to explore the suitability of the grass for paper making as an alternative to any other short fibre source such as *Gmelina arborea*

MATERIALS AND METHODS

Green *P. purpureum* were obtained from the field in University of Uyo, Uyo, Akwa Ibom State. The state is located in the South-south geo-political zone of Nigeria between latitudes 4°30' and 5°33' North and longitudes 7°30' and 8°25' East (Utuk, 2005). The grasses were air dried to 33% moisture content. The air dried grasses were reduced to particles with the aid of hand operated crusher. The resultant particles were boiled in water for 45 mins and then pressed in cramps for 10 mins prior to steeping in a mixture of 30g/l NaOH and 21 g/l Na_2SO_3 at 30°C for 6 hours. The steeped particles were refined with the aid of a manually operated pocket disc refiner in a single stage to a freeness of 84 CSF and a pulp yield of 53.43%. The pulp was semi-bleached to 37.6% brightness using 0.57% H_2O_2 on BD pulp. A small fraction of the refined, brightened pulp was analysed for lengths and percentage weighted distribution using procedure of Technical Association of Pulp and Paper Industries (TAPPI, 2008). The remaining fraction was used for handsheet formation.

The sheets formed were tested for the various properties in accordance with TAPPI, 2008 standards. The results obtained were compared with that of *Gmelina arborea* Chemi-Mechanical Paper (CMP).

RESULTS AND DISCUSSION

The drying of green *P. purpureum* aided in partial oxidation of its colouring matter and the reduction in moisture which made the raw material to be easily fed into "Akwa Jet Chopper" – a machine designed for particle production. Boiling of the *P. purpureum* particles in water enhanced the removal of residual chlorophyll and the water soluble components of the grass. This was in line with findings of Umoren, Udoh and Akpabio (2004) who found out that there would be considerable cost savings in the amount of chemical consumption if boiling is done before steeping.

Table 1: Weighted distribution and fibre lengths of unscreened unrefined and unwashed pulp of *P. purpureum*

Fibre length Range (mm)	Number of fibres	Weighted distribution (%)
0.00 – 0.50	27,178	57.14
0.51 – 1.00	2,855	27.15
1.01 – 1.50	481	8.30
1.51 – 2.50	62	1.97
2.51 – 3.00	33	1.26
3.01 – 3.60	27	1.25

Table 1 shows the weighted distribution and fibre lengths of unscreened, unrefined and unwashed *P. purpureum* pulp. 57.14% weighted distribution were of fibre lengths below 0.5mm which constituted the dirts, specks, grits and unacceptable particles which had to be screened prior to sheet formation. The oversized fibre bundles of lengths ranging from 2.51mm to 3.6mm, totally 4.48% by weighted distribution was also screened to enhance the strength properties to the resulting paper.

Table 2: Weighted distribution and fibre lengths of screened refined and washed pulp of *P. purpureum*

Fibre length Range (mm)	Number of fibres	Weighted distribution (%)
0.51 – 1.00	2,855	98.45
1.01 – 1.50	481	1.29
1.51 – 2.50	62	0.17
2.51 – 3.00	33	0.09

Table 2 shows the weighted distribution and fibre lengths of screened, refined and washed *P. purpureum* pulp. *98.45%* of the fibres were of lengths 0.5mm – 1.00mm. This is in congruence with the work of Utuk (2017) who found out that *P. purpureum* is a short fibre, having a length of 0.85 mm.

Table 3: Consistency and freeness of unblended *P. purpureum* and *Gmelina arborea* stock at 23°C temperature and 6.85 pH

Species	Consistency	Freeness
P. purpureum	4.1	84
*Gmelina arborea**	4.1	107

*Source: Nigeria Newsprint Manufacturing Company (NNMC), (2005).

P. purpureum stock was beaten to a freeness of 84 Canadian Standard Freeness (CSF) whereas *G. arborea* stock had a freeness of 107 CSF after being refined at a consistency of 4.1% as shown in Table 3. The freeness of pulp is the extent of work done on the fibres during beating/refining. Beating of the pulp increases the strength of paper. This is because the strength of paper depends on the increased bonding area of the pulp due to external fibrillation of the fibre walls. Secondly, increase in flexibility increases the bonding area and hence the strength of the paper (Britt, 2007). Pulp freeness is an indication to the extent of bonding of the fibrillated fibres and hence, the strength of the resulting paper/the holding capacity of the paper.

Table 4: Consistency and freeness of blended kraft and *P. purpureum* pulp; kraft and *Gmelina arborea* pulp at 28°C temperature and 6.85 pH; 1:14 v/v

Species	Consistency	Freeness
P. purpureum	4.1	14
*Gmelina arborea**	4.1	18

*Source: NNMC (2005).

Table 4 shows the freeness of the blended stock of kraft: *P. purpureum* pulp and kraft: *G. arborea* pulp at 28°C, 6.85 pH, 4.1% consistency; 1:14 v/v of stock. The freeness of *P. purpureum* with Kraft pulp was 14 CSF while that of *G. arborea* with kraft pulp was 18 CSF.

Table 5: Paper Quality Testing

Qualities	Units	*P. purpureum* CMP	*G. arborea** CMP
OD grammage	gsm	55.30	55.30
Moisture content	%	13.10	6.00
Tear strength	mN	267	220
Tear index	mNm^2g^{-1}	4.83	4.58
Tensile strength	KNm^{-1}	1.15	1.94
Tensile index	Nmg^{-1}	20.80	41.70
Stretch	%	2.21	1.86

*Source: NNMC (2005).

Table 5 shows the qualities of papers made from *P. purpureum* and those of *G. arborea*. The tear strength of *P. purpureum* CMP (267mN) was higher than that of *G. arborea* CMP (220mN). The corresponding tear index of *P. purpureum* CMP (4.83 mNm^2g^1) was higher than that of *G. arborea* CMP (4.58 mNm^2g^{-1}). The percentage stretch of *P. purpureum* CMP (2.21) was higher than that of *G. arborea* (1.86) and it is an acceptable TAPPI (2008) standard for grasses. When compared to the findings of Akpabio (2017), with a tear index of 4.05 mNm^2 g^{-1}, tensile index of 20.25 Nm g^{-1} and a stretch of 1.21% for *Musa paradisiaca*: *G. arborea* CMP, *P. purpureum* CMP recorded a higher tear index of 4.83 mNm^2 g^{-1}, tensile index of 20.80 Nm g^{-1} and a stretch of 2.21%. This implies that *P. purpureum* is suitable for use as a fibrous raw material in the production of Chemi-Mechanical Paper (CMP) which could be used for newsprint, wrapping and writing grades of paper.

CONCLUSION

P. purpureum is a cheap source for Chemi-Mechanical Paper (CMP) as the raw material is readily available in the tropics. *P. purpureum* pulp forms a good stock with kraft pulp for making a wide range of paper products where its strength and percentage stretch could be utilized. Based on the findings of this study, *P. purpureum* CMP could be used as writing, printing and wrapping grades of paper due to its high tear index of 4.83 mNm^2 g^{-1}, tensile index of 20.80 Nm g^{-1} and a stretch of 2.21%. The use of *P. purpureum* fortified with bleached raphia pulp for corrugating medium in paper boards should be investigated.

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INTEGRATED FARMING: GROWING OF FRUIT TREES AND REARING OF RUMINANTS

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ABSTRACT

A large number of people in the tropics have trees and shrubs growing around their compounds mostly to provide shade during sunny afternoons as well as providing sustainable supply of fresh fruits. A less number of the people also keep livestock as well. Ensuring constant good harvest from the fruit trees is a challenge because the soil fertility starts dwindling after much harvest of fruits without replenishing the plant nutrients extracted from the soil. In addition, feeding of ruminants kept in their homestead is a big challenge as purchase of concentrate feeds to boost the production of these ruminants is mostly beyond their financial capability. The use of inorganic fertilizers to replenish the plant nutrients is associated with a number of environmental hazards such as soil acidity because the physical and chemical properties of the soil are sometimes adversely affected. It is also to be noted that most of the people involved in this integrated farming are resource poor peasant farmers. This paper looked at the existing practice and possible adjustments that can be put in place and considered some of the ways forward.

Keywords: Integrated compound farming, fruit trees, confined ruminants

INTRODUCTION

Small ruminants such as sheep and goats are reared around homesteads mainly by subsistence farmers who also have one or more fruit trees such as plantain and banana as well as cashew, citrus and mango growing around their houses Integrated farming of this nature ensures regular supply of animal protein from sheep and goat rearing while the fruit trees supply carbohydrates from plantain or banana. Mangoes and cashew in addition to oranges will ensure regular supply of minerals and vitamins both for home consumption and for sales. Moyo *et al*. (2010) noted that for most of the 2.6 billion people who depend on smallholder farming systems, livestock production is an important way of diversifying income sources and maintaining soil fertility. Adequate feeding of the ruminants and sufficient nutrition of the fruit trees are difficult to achieve at the same time. Adequate provision of feed for ruminants that are reared in homestead is a challenge because if they are left to roam around the community, they are likely to destroy neighbours' crops and flowers found around their houses; the animals are therefore restricted to avert such destructive tendencies (Figure 1), the resource poor farmers may not have sufficient finance to purchase feeds or source for enough browse plants to meet the dietary needs of the restrained animals. Concentrate diets could ameliorate problems relating to small ruminants feeding but this would be at a cost which is out of the reach of subsistence farmers. Use of inorganic fertilizer after soil test could reduce the challenges of fruit trees' nutrition in homestead but the category of farmers involved in this practice may not have the financial power to back it up. Objectives of this paper include offering ideas regarding how to provide a cost effective nutrition for both ruminants and fruit trees grown in homestead.

Existing practices of rearing small ruminants and growing fruit trees

Sheep and goats in southern Nigeria are reared mainly by subsistence farmers, who practice mixed cropping. They periodically restrain their animals at the commencement of the rainy season when crops are planted to prevent the animals from destroying the crops. In most

urban, semi-urban and organized rural communities in southern Nigeria, small ruminants may only be reared in confinement to prevent the ruminants from feeding on crops grown around households as well as preventing their faeces from causing nuisance and bad smell in the environment. Many households in Africa do not attach sufficient importance to the plants that grow in their environment (Gurib-Fakim, 2009), hence, fodder plants may be growing luxuriantly in the vicinity of their compounds yet they may trek long distance to fetch twigs of browse plants which they have knowledge of. In some other cases, browse plants may not be found around their compounds at all.

Figure 1 Goats in confinement within a compound in Asaba

Small ruminants in most organized urban and semi-urban communities may only be reared in confinement; therefore, sourcing of browse plants becomes inevitable in order to keep ruminants (Figure 2). Clash of interest arises when a farmer who is in search of browse plants gets into the compound of another person who may have planted such species for an entirely different reason. Quarrels bordering on trespassing may ensue. As dry season approaches, such clash of interest heightens, more so, if the owner of the browse plants wants the twigs as fodder for his own ruminants or for mulching fruit trees growing in his compound. It is suggested that production of confined ruminants may go on along with the growing of fruit trees in compounds by giving priority in the use of twigs from browse plants to feeding the small ruminants, when there is additional supply, then such is used for

mulching of fruit trees. Fodders around the homestead are hardly sufficient for ruminants kept in confinement, except the animals in captivity are very few. The animal dung generated by ruminants after feeding on fodder is commonly seen as a waste material, and a burden as it cannot be recycled as such it is heaped in dumpsites or thrown over the animal fence used to confine the animals. However, some farmers are known to use such waste materials to improve soil around fruit trees.

Possible adjustments in the contemporary integrated farming
Raising pasture broadleaf and grass plants around households are seen by people as encouraging weeds proliferation around homes. People expect that such plants should be kept in check. However, planting browse shrubs and trees around homes should be encouraged. Some portions in the home garden should be marked out for raising grasses such as guinea grass (*Panicum maximum*) plus leguminous perennials which have high nutritional values and are cherished by ruminants. In order to provide a suitable space for the raising of pasture plants for confined ruminants, shrub and tree species as well as the fruit trees may be arranged in rows while the alleys are planted with pasture species.

Figure 2 Goats relishing freshly browsed *Gliricidia sepium* obtained from Gliricidia used as live stakes for fencing in the goats

Ruminant farmers need not suffer because of lack of knowledge of integrating keeping of ruminants and the various shrubs and trees which could be valuable to them, the link between researchers, extension officers and the farmers should be strengthened, exploring the use of English and other languages of communication in local radio and television stations in addition to using print media. The research findings on the various shrubs and trees such as how the seedlings are raised or procured, established and maintained for optimal performance should be made known to the farmers. Spacing and land area required for specific number of plants will provide suitable guide on the number of animals that such browse plants could sustain. Animal dung generated by restricted ruminants rather than

being considered as a burden should be composted and used as a source of nutrients for shrubs and trees which provide fruits in compounds. Crops residues are generated by shrubs and trees grown in association with fruit trees through regular weeding of the homestead while; animal manure is generated by ruminants fed with fodders and left-over foodstuffs from households. The crop remnants, animal manure, leftover foodstuffs and biodegradable, urban waste could be added to the animal dung for composting. The resulting compost is applied to improve soil fertility, thereby improving the soil environment in terms of releasing more plant nutrients to fruit trees and enhancing their yields. Mango and banana leaves (heap of banana plants as waste) together with Tridax plant are forages easily available in homesteads (Shiawoya and Musa 2003). They have been known to be relished by small ruminants and micro livestock like rabbits. Ruminant animals ought to be selected based on the ones that have the ability for high growth rate while feeding on the readily available browse plants and the wastes from the fruit trees in the home gardens. It may cost more and require more effort to acquire such species, as they are usually more productive and make better use of their feed and use resources more efficiently; at the end it may pay off. Eventually, the efforts and investments in that direction pay off. It is suggested that old poor performing animals be culled; this should also apply to all categories of animals. Animals that give poor growth performance relative to the amount of feed intake may be removed from the confinement and consumed either by direct consumption or by biased sales to only those we are sure want to consume them so that such low performance problem is not transferred to another farm. Selection should also be made for animals that are productive and prolific. Provision of extension services through well trained resource personnel will improve livestock production among homestead farmers.

Rewards of pruning trees and shrubs to crops and small ruminants
Pruning from shrubs and trees planted in compound garden could be used as mulch and placed around crop stands. Schonbeck (2010) reported that when a cover crop is killed by temperature extremes, mowing or rolling residues left on the soil surface as a mulch can continue to hinder weed growth for some time. By keeping the soil surface shaded and cool, and by reducing daily fluctuations in soil temperature, the organic mulch reduces the number of weed seeds that are triggered to germinate. Kang (1993) noted that the past work on hedgerow intercropping indicated that application of tree mulch was effective in controlling weeds. In this way Anegbeh *et al*. (2010) postulated that high labour input for weeding is avoided. Mulch from *Inga edulus* provided good ground cover, and results in better suppression of weed growth. Thick layer of the applied Inga mulch and leaf fall of the tree species prevented noxious weeds like *Axonopus compresus* SW. Beaux, *Cyperus esculentus* Linn and *Aspilia africana* (Pers) C.D. Adams from receiving enough sunlight to proliferate (Anegbeh *et al*., 2010). Pruning from shrubs and trees could check weed growth around fruit trees. In most cases, materials from trees and shrubs have more lignified materials hence are able to last longer on the soil surface before being converted into humus by biodegradable agents. Hutchinnson and McGiffen (2000) in agreement with the above statement added that warm moist weather combined with high soil biological activity accelerates decomposition of cover crop residues and their allelochemicals, thus shortening the weed control period. Straw low-N residues last longer than succulent, high-N residues. Pruning from *Gmelina arborea* is reported to be very useful for mulching crops (Obiazi and Ojeifo, 2000). Gmelina is rich in nitrogen, the nitrogen is vital for good growth and yield of crops.

Preference of tree and shrub species
Shrubs and trees species which could play the dual role of supplying fodder to ruminants and twigs for mulching fruit trees in compounds require identification. Nwoboshi (1982) stated that species like *Tectona grandis* and *Gmelina arborea* owe their popularity in

forestry to their capacity to establish and grow well in plantations. Obiazi and Ojeifo (2000) reported that pruning from Gmelina is useful for mulching and that it produces an appreciable amount of foliage and fodder for livestock. Sempebwa and Kagumaho (1992) noted that for most farmers the immediate benefit of fuel wood and fodder made planting *Leucaena leucocephala* and maintaining the hedgerows in banana worthwhile.

Continued use of Leucaena to mulch banana plot and as feed to cattle improved milk production. Diversification of nutritive fodder species which maintain their leaves during the dry season is crucial to sustainable management. Any undesirable effect a species might have when used as the only source of feed (such as abundance of tannins) would be offset by using many species at the same time such species could provide many other services essential to local community well-being (Mizrahi et al., 1998). It is known that most tree crops maintained in compounds bear fruits. Such fruits like pawpaw and plantain are also liked by birds. The attraction of birds into a compound is a source of good recreation where birds of varied plumage visit the fruits and, snap-shots of such birds is encouraged. Their songs will also liven up the environment too. Some of the suggestions of Obiazi (1995) for selection of trees and shrubs for stake procurement also hold for choice of trees and shrubs species for mulching and fodder. They include quick establishment and development and capacity of the stock to sustain itself on available plant nutrients on minimally improved soil after several removals.

RECOMMENDATIONS

Most tree and shrub species are eaten by small ruminants such as sheep and goats; such species may have high nutritional values, however, not much work has been done on their feeding values. Information on nutritional values of such edible species is required by farmers and extension agents in order to make proper choice of plant species to plant and use as browse plants. In cases where such plant species have been established, information on species nutritional values would guide farmers in sowing plants with high nutritional values. More studies are required on establishment techniques, optimal planting density, and pruning intensity for promising fodder species. Ruminants need regular feed intake both in the rainy and dry seasons. Observations on various plant species are required in the dry seasons to discern if they lose or retain their growth performance relative to what obtains in the rainy season. It will be very useful to conduct research to ascertain drought-tolerance levels of the promising species as well as their ability to tolerate zero-level fertilizer application, having in mind that the target of most of these studies is to model out a production package which is sustainable and adaptable by resource deficient farmers.

CONCLUSION

Appreciable amount of fodder for confined ruminants is supplied from planted shrubs and trees. In some instances any excess foliage is used to mulch fruit trees which repress weeds by providing excellent ground cover. If all the browse twigs are used for the ruminants, most of it still goes back to the fruit trees as farm yard manure; there is therefore no stiff competition between the fruit trees and the animals for what the browse plants are able to generate. Open spaces between fruit trees and browse plants may be used to raise pasture grasses and leguminous cover crops to supplement ruminant feedings. Composting of animal dung plus plant materials generated in the homestead results in organic matter; which when applied to fruit trees and shrubs, improves fruit quality and yields. Burden of ruminant dung disposal from the confined animals is minimized or completely reverted by composting it together with waste plant materials into organic material to fertilize the soil where fruit trees and shrubs are planted.

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YIELD AND YIELD COMPONENTS OF EXTRA-EARLY MAIZE (*Zea mays* L.) VARIETIES AS INFLUENCED BY RATE OF NITROGEN AND INTRA-ROW SPACING

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ABSTRACT

Two field trials were conducted during 2012 and 2012/2013 wet and dry seasons respectively, at the Institute for Agricultural Research (IAR) Farm, Samaru, in the northern Guinea savanna ecological zone of Nigeria, to assess the performance of two extra-early maize varieties (SAMMAZ-28 and SAMMAZ-29) as influenced by rate of nitrogen and intra-row spacing. Treatments were laid out in a Randomized Complete Block Design (RCBD) and replicated three times. Application of 90 kg N ha^{-1} gave significantly higher cob length, cob diameter, number of grains per cob and yield ha^{-1} than N levels at (0, 45 and 135 kg N ha^{-1}). Spacing of 20 cm produced significantly (P$\leq$0.05) higher grain yield, 100-grain weight and cob weight plant^{-1} than spacing at 15 cm, while varying spacing had no significant (P$\geq$0.05) effect on cob length, cob diameter and number of grains per cob. Application of 90 kg N ha^{-1} at the spacing of 25 cm produced 2486.06kg and 2280.1kg respectively compared to 45 kg N ha^{-1} with the spacing of 15 cm with the grain yield of 2038.35 kg and 2128.9kg respectively. Therefore, it is recommended that farmers in the northern guinea savanna ecological zone of Nigeria can adopt the two varieties for maximum yield.

Key words: Maize, nitrogen, spacing, yield

INTRODUCTION

Maize (*Zea mays* L.) was relatively a minor food crop in Africa by 1900 (Manyong *et al.,* 2003), but over the years, its widespread uses in human diet and animal feeds popularized it in Africa, especially in Nigeria (Ado *et al.,* 1999). Maize was the most widely adopted and the most important cereal in the world in 2009 with a production of 822.7 million metric tonnes followed by rice and wheat with 782.3million metric tonnes and 680.2 million metric tonnes respectively (FAO, 2012). United States of America was the largest producer of maize in 2009 accounting for 37.2% of the world's total, followed by China and Brazil that accounted for 20.1% and 7.1% respectively (FAO, 2012). Land area devoted to maize in Nigeria increased from 3.8 million hectares in 2008 to 5.2 million hectares in 2013 while, production increased from 7.5 million tonnes in 2008 to 10.4 million tonnes in 2013 (FAOSTAT, 2016). Fresh immature grain of maize is roasted or cooked and eaten directly (Delorit *et al.,* 1974) while the dried grain is used for the preparation of porridge after milling and boiling. It is also used for the production of livestock feeds and in industries, for the production of alcohol and non-alcoholic beverages, corn starch and production of bio-fuel (Fajemisin, 1991). Maize requires annual rainfall of 600–900mm (IITA, 2006); sandy loam and silt loam soils containing adequate organic matter and tolerates soil pH from 5.5 to 8.0 but the optimum range is 5.5–7.0. For good growth, maize requires a lot of sunshine and warmth. Ideal temperature for its growth ranges between 21-27°C (Wolkowski, 2001).

The use of chemical fertilizer as nitrogen source is appreciated by farmers but its high cost, poor distribution, and inadequate credit facilities have made the commodity

unavailable to resource-poor farmer, such that the rate of application of nitrogen by peasant farmers in Nigeria is as low as 5.5kg fertilizer per hectare (Camara and Heinemann, 2006). The commonly grown maize varieties in Nigeria are medium maturing (120 days) which are sown at the recommended spacing of 25 cm x 75cm of one plant per stand or 50 cm x 75cm of two plants per stand, and recommended fertilizer rate of 120:60:60 of N, P_2O_5 and K_2O (I.A.R., 2012). These recommendations may not hold for the new extra-early maturing (85 days) varieties with much smaller statures. It therefore becomes necessary to evaluate these new extra-early maturing varieties under different intra-row spacing and nitrogen levels. Extra-early maize varieties have been bred for marginal areas where rainfall pattern cannot support the medium and late maturing maize varieties. The ability of extra-early maize varieties to produce fresh consumable cobs in 75 days and dry grains in about 85 days offer unique opportunities for the inhabitants of the Sudan and northern Guinea savanna ecological zones of Nigeria (Ado *et al.,* 1999). Therefore the study was conducted to determine the response of extra-early maize varieties to rate of nitrogen and varying intra-row spacing.

MATERIALS AND METHOD

Treatments and Experimental Design

The treatments consist of four levels of nitrogen (0, 45, 90, and 135kgNha^{-1}) and three intra–row spacing (15, 20 and 25cm) using two extra–early maize varieties (SAMMAZ-28 and SAMMAZ-29) arranged in factorial combinations. The treatments were laid out in a Randomized Complete Block Design (RCBD) replicated three times. The gross and net plots were 20.25m^2 (4.5 m x 4.5 m) and 13.5m^2 (4.5 m x 3 m) of six and four ridges respectively.

Varietal Description

SAMMAZ-28 (99 TZEE-Y-STR) extra-early maturing variety (80-85 days) takes 50 days to mid silking, has a height of 170 cm, yellow-seeded kernels and a potential yield of 4.0 tha^{-1}for northern Guinea savanna ecological zone of Nigeria was used. It is also tolerant to *Striga hermonthica* and maize streak virus. SAMMAZ-29 (2000 TZEE-W-STR) extra-early maturing, takes 57 days to mid-silking under uninfested conditions with *Striga hermonthica.* The height is 170 cm, white-seeded and has a potential yield of 4.0 tha^{-1} for northern Guinea savanna ecological zone of Nigeria, tolerant to *Striga hermonthica*, maize streak virus and drought.

Cultural Practices

Land preparation

Each field was ploughed and harrowed to a fine tilt, ridged 75cm apart and then marked into plots and replications. Space of 0.5m between the plots and 1.5m between replicates were used as borders. The seeds were sown manually on 20th July, 2012 wet season and on 4th March, 2012/2013 dry season at the rate of 2 seeds per hole at intra-row spacing of 15, 20 and 25 cm according to treatment and later thinned to one plant per stand at two weeks after sowing (2WAS). Four levels of nitrogen, using urea (46%), at the rate of 0, 45, 90 and 135 kg N ha^{-1} were applied in two equal split doses. The first dose was applied at 2WAS, while the second dose was applied 6WAS, as per treatment. A basal application of P and K in the form of single superphosphate and muriate of potash at 26.4 kg P ha^{-1} and 49.8 kg K ha^{-1} respectively was made to meet phosphorous and potassium requirements of the crop. There was no incidence of Pests and diseases during the two trials.

Primextra Gold (Atrazine+ s-metolachlor) was applied pre-emergence at the rate of 2.5kga.i./ha and supplemented with hoe weeding at 6 WAS. Harvesting was done on 13th November, 2012 for wet season crop and on 27th July, 2012/2013 for dry season by

removing the cobs manually when the plant reached maturity. The cobs were threshed and winnowed to obtain the grain.

Crop Parameter

All cobs from each net plot were harvested, air-dried and weighed. Five cobs were randomly selected from each plot, the length of each cob was measured using meter rule and the mean length was taken. The diameters of the five randomly selected cobs from each net plot were measured using venier caliper. The mean diameter was calculated and recorded. The number of grains from the five cobs was counted and the total number of grains was divided by the total number of cobs to give the mean number of grains per cob. From each plot, 100 dried grains were randomly selected and weighed using a mettlar-balance and the value recorded. The harvested cobs from each net plot ($13.5m^2$) were threshed and cleaned; the grains were weighed for each treatment plot and expressed in kilogram per hectare by extrapolation.

Data Analysis

Data collected were subjected to analysis of variance as described by Snedecor and Cochran (1967). The treatment means were compared using Duncan Multiple Range Test (Duncan, 1955), at 5% level of probability.

RESULTS AND DISCUSSION

Influenced of Nitrogen Rate and Intra-row Spacing on Cob Length and Cob Diameter

Table 1 shows varietal differences, effect of nitrogen rate and spacing on cob length and cob diameter of two maize varieties at Samaru during 2012 and 2012/2013 wet and dry seasons. The result shows there were no significant differences between the two varieties in both seasons. Varying nitrogen rate had significant effect on cob length of the two maize varieties in both seasons. In 2012 wet season, increase in nitrogen rate from 0 to 45kgNha[-1] did not significantly (P≥0.05) affect cob length of maize, but further increase to 90 kg N ha^{-1} caused a significant increase and beyond which the increase was not significant. In 2012/2013 dry season 135 kg N ha^{-1} gave the longest cob, but was comparable to that treated with 90 kg N ha^{-1}. Spacing and its interaction with other factors had no significant effect on cob length of maize in both seasons.

The two varieties differed significantly (P≥0.05) in their cob diameter in 2012 wet season only as SAMMAZ-28 produced thicker cobs than SAMMAZ-29. Variation in N rate caused significant (p≤0.05) differences in cob diameter only in 2012 wet season. Application of 90 kg N ha^{-1}produced thicker cobs of maize than the other nitrogen rates, these was followed by 45 kg N ha^{-1} which was comparable to 0 and 135 kgNha[-1] in cob diameter. Varying spacing and its interactions with other parameters in both seasons had no significant effect on cob diameter of maize.

Table 1: Cob length and cob diameter of two maize varieties as influenced by nitrogen rate and intra-row spacing at Samaru during 2012 and 2012/2013 wet and dry seasons

Treatment	COB LENGTH		COB DIAMETER	
	wet	dry	wet	dry
VARIETY (V)				
SAMMAZ-28	9.97	13.97	7.01a	8.14
SAMMAZ-29	10.08	13.97	7.45b	8.49
SE±	0.394	0.203	0.084	1.47
NITROGEN (N) RATE (kg ha-[1])				
0	8.32b	13.03c	6.85b	7.22
45	9.04b	13.65bc	7.17b	6.65

90	10.73a	14.27ab	7.89a	6.95
135	12.01a	14.94a	7.02b	7.24
SE (±)	0.558	0.287	0.118	2.087
INTRA ROW SPACINGS (cm)				
15	9.97	13.69	7.23	9.12
20	10.17	14.03	7.27	8.94
25	9.93	14.21	7.19	6.88
SE (±)	0.483	0.248	0.102	1.807
INTERACTION				
N x V	NS	NS	NS	NS
N x S	NS	NS	NS	NS
S x V	NS	NS	NS	NS
N x S x V	NS	NS	NS	NS

Means followed by the same letter(s) within a column and treatment group do not differ significantly at 5 % level of probability according to Duncan's Multiple Range Test (DMRT); NS= not significant;

On the number of grains per cob (table 2), there were no significant differences (P≥0.05) in number of grains per cob of two maize varieties in 2012 wet season and 2012/2013 dry season. Varying nitrogen rate significantly (P≤0.05) affected the number of grains per cob of maize. In 2012 wet season, each increase in nitrogen from 0 to 90 kg N ha^{-1} significantly (P≤0.05) increased number of grains per cob, further increase to 135 kg N ha^{-1} did not significantly (P≥0.05) affect this parameter. In 2012/2013 dry season, number of grains per cob at 135 kg N ha^{-1} was highest but statistically similar to that at 45 and 90 kg N ha^{-1}. There was no significant effect of spacing on number grains per cob in both the seasons. Only the interactions between variety and spacing in 2012 significantly affected the number of grains per cob.

Cob Weight per Plant
The two varieties differed in their cob weight in 2012 wet season only as SAMMAZ-29 produced heavier cobs than SAMMAZ-28. Varying nitrogen rate significantly (P≤0.05) affected cob weight of maize in both seasons. Also, application of 135kgNha[-1] produced significantly (P≤0.05) heavier cobs per plant than the other nitrogen rates applied. A similar trend was also observed in 2012/2013 dry season where 135kgNha-[1] produced the heaviest cobs but was statistically at par with 45 and 90 kg N ha^{-1}.Varying spacing had significant effect on cob weight per plant of maize in 2012 only. Increase in spacing from 15 cm to 20 cm significantly increased cob weight per plant, but further increase to 25 cm did not significantly affect this parameter. However, interactions among treatments had no significant effect on cob weight per plant of maize in both seasons (Table 2).

Table 2: Number of grains per cob and Cob weight per plant of two maize varieties as influenced nitrogen rate intra-row spacing at Samaru during 2012 wet and 2012/2013 dry seasons.

Treatments	Number of grains per cob		Cob weight per plant(g)	
Variety(V)				
SAMMAZ-28	392.3	414.2	59.19b	123.18
SAMMAZ-29	392.9	617.0	69.86a	122.34
SE±	3.378	97.63	3.149	14.773
Nitrogen (N) rate (kgha[-1])				
0	323.6c	324.2b	46.32c	93.16b

45	365.8b	490.9ab	59.90b	108.47ab
90	442.5a	462.0ab	68.81b	121.19ab
135	438.6a	785.9a	83.08a	168.22a
SE±	4.777	138.07	4.453	20.892
Intra-row spacing (R)				
15 cm	390.1	401.4	56.29b	134.04
20 cm	388.8	570.9	68.97a	112.73
25 cm	398.9	574.6	68.24a	121.51
SE±	4.137	119.57	3.857	18.093
Interaction				
N X R	NS	NS	NS	NS
N X V	NS	NS	NS	NS
V X R	*	NS	NS	NS
N X V X R	NS	NS	NS	NS

Means followed by the same letter(s) within column and treatment group do not differ significantly at 5% level of probability according to Duncan Multiple Range Test (DMRT). NS= Not Significant. *=significant at 5% level of probability

Interactions between variety and spacing on number of grains per cob
Table 2.1 shows the interactions between variety and spacing on number of grains per cob of maize. The two varieties produced comparable number of grains per cob at 25 cm spacing, which were statistically ($p \leq 0.05$) higher than those obtained at the other spacing. However, least number of grains was produced by SAMMAZ-28 and 29 at 20cm and 15 cm spacing respectively. SAMMAZ-28 showed a significant decrease in number of grains per cob with increase in spacing from 15 cm to 20 cm, but with a further increase in spacing the number of grains was highest with SAMMAZ-29, however, each increase in intra-row spacing resulted in a significant ($P \leq 0.05$) increase in number of grains per cob. At 15 cm spacing SAMMAZ-28 produced more grains per cob than SAMMAZ-29, while the reverse was the case at 20 cm spacing; at 25 cm spacing there were no significant differences in number of grains per cob between the two maize varieties.

Table 2.1: Interaction between variety and intra-row spacing on number of grains per cob of two maize varieties at Samaru during 2012 wet season

Variety(V)	Intra-row spacing (R)		
	15 cm	20 cm	25 cm
SAMMAZ-28	392.75b	384.92c	399.42a
SAMMAZ-29	389.58c	393.83b	398.50a
SE±		5.908	

Means followed by the same letter(s) do not differ significantly at 5% level of probability according to Duncan Multiple Range Test (DMRT)

100-grain Weight
Varietal difference, effect of nitrogen rate and spacing on 100-grain weight and yield per hectare of two maize varieties are shown on Table 3. The varieties did not significantly ($P \geq 0.05$) differ in 100-grain weight in both seasons; however, variation in nitrogen rates significantly ($P \leq 0.05$) affected 100-grain weight of maize in both seasons. In 2012 wet season, increase in N rate from 0 to 45 kg N ha^{-1} did not cause a significant change in 100-grain weight, but a further increase to 90 kg N ha^{-1} did increase in 100-grain weight, the increase in N to 135 kg N ha^{-1} caused no further significant change. In 2012/2013 dry season

45 kg N ha^{-1} gave significantly higher 100-grain weight than the control, but it was comparable to 90 kg N ha^{-1} but both rates significantly lower than 135 kg N ha^{-1}. Varying intra-row spacing significantly (P≤0.05) influenced 100-grain weight in both seasons; increased intra- row spacing from 15 to 20 cm in 2012 significantly (p≤0.05) increased 100-grain weight, and further increase of spacing to 25 cm did not significantly (P≥0.05) affect this parameter. In 2012/2013, only change in spacing between 15 to 25 cm caused a significant increase in 100-grain weight. However, 100-grain weight at 25 cm spacing was comparable to that at 20 cm. Interactions among treatments had   no significant (P≥0.05) effect on 100-grain weight in both seasons.

Grain yield per Hectare

Table 3 shows the grain yield per hectare of two maize varieties as influenced by varietal differences, nitrogen rates and intra-row spacing at Samaru during 2012 wet season and 2012/2013 dry season. Varietal difference was not significant (P≥0.05) in each season and when averaged over both seasons.

Varying nitrogen rates significantly (P≤0.05) affected yield of maize in both seasons and the combined years. Each increase in nitrogen rate from 0 to 90 kgNha^{-1}significantly (P≤0.05) increased maize grain yield beyond which there was no significant effect on yield per hectare. When spacing was varied, it significantly (P≤0.05) affected maize yield such that in 2012 wet season, increase in spacing from 15 to 20 cm significantly (P≤0.05) increased yield per hectare, but further increase to 25 cm did not significantly affect maize yield per hectare. In 2012/2013 dry season, only change from 15 and 25 cm significantly (P≤0.05) increased maize grain yield as yield at 25 cm was comparable only to 20 cm. In the combined however, each increase in spacing caused a significant (p≤0.05) increase in maize grain yield. There were no significant interactions between factors on yield per hectare of maize in both seasons.

Table 3: 100-grain weight and yield per hectare of two maize varieties as influenced by nitrogen rate and intra-row spacing at Samaru during 2012 wet and 2012/2013 dry seasons.

Treatment	100-grain weight(g)		Yield in (kg/ha)		
	2012 w. season	2012/2013 d. season	2012 W. season	2012/2013 d. Season	combined
Variety (V)					
SAMMAZ-28	20.27	23.90	996.6	3315.1	2134.5
SAMMAZ-29	22.93	24.01	992.9	3276.1	96.299
SE ±	2.366	0.314	21.976	96.299	59.137
Nitrogen (N) rate (kgha^{-1})					
0	18.59c	21.66c	689.7c	2791.7c	1740.7c
45	20.58c	23.83b	905.3b	3171.4b	2038.35b
90	22.18ab	24.52b	1187.3a	3784.8a	2486.05a
135	25.07a	25.82a	1196.6a	3934.4a	2565.50a
SE ±	3.346	0.444	31.079	136.189	83.634
Intra-row spacing (R)					
15 cm	20.71b	23.39b	940.0b	3113.0b	2026.5c
20 cm	23.14a	23.85ab	1018.7a	3239.1ab	2128.9b
25 cm	20.96a	24.63a	1025.5a	3534.7a	2280.1a
SE ±	2.898	0.385	26.915	177.944	102.42
Interaction					
N x R	NS	NS	NS	NS	NS
N x V	NS	NS	NS	NS	NS
V x R	NS	NS	NS	NS	NS
N x R x V	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column and treatment group do not differ significantly at 5% level of probability according to Duncan Multiple Range Test (DMRT)
NS= not significantly

DISCUSSION

There were no significant ($P \geq 0.05$) differences in 100-grain weight, number of grains per cob, and yield ha^{-1} between the varieties. This finding confirmed the result obtained by Mani *et al.* (2002), who observed a non-significant increase in plant height and grain yield ha^{-1} between varieties. Yield component such as 100-grain weight, cob weight, number of grains per cob and grain yield ha^{-1} were all optimized at 90kgNha[-1]. Grain yield was observed to increase significantly with optimum nitrogen application and beyond that resulted in yield reduction, because excessive nitrogen encouraged vegetative growth at the expense of grain yield due to luxury consumption. This finding confirmed those of Hussaini *et al.* (2001), Mani (2004), Sharifai*et al.* (2004) and Namakka *et al.* (2009). Significant increase in 100-grain was observed with increase in nitrogen application up to 90kgNha[-1].This was because an increase nitrogen application positively enhanced chlorophyll content in plant thereby improving photosynthetic activities that promotes the final yield. Hussaini *et al.* (2001) reported similar response, attributing the significant increase in yield to favorable effect of nitrogen on cob length and cob diameter, which have direct bearing on the final grain yield. This increase in yield could be because of good dry matter production for grain filling.

Spacing has effect on the performance of crops especially maize. Inuwa (2001) reported that maize yield decreased when intra-row spacing was reduced beyond certain levels; primarily because of increase in inter plant competition for growth factors and reduction in the number of harvestable cobs. However, in the case of reduced spacing, intense inter plant competition for light, soil nutrients and soil moisture set in, thereby resulting in low crop performance. Also, the limited supplies of enough growth factors including soil nitrogen increases barrenness and reduced grain number per plant. Maize intra-row spacing for maximum economic yield varies from 18 to 45cm depending on planting date, water availability, soil fertility, maturity and varietal canopy architecture (Sangoi, 2001). The result of this study showed a non-significant response to varying intra-row spacing by a growth parameter as well as yield component such as cob length and number of grains per cob respectively. Increasing intra-row spacing from 15 to 20 cm significantly increased 100-grain weight and yield per hectare. This could be as a result of less competition due to optimum plant population. This result confirmed the report by Habib *et al.* (2002) that 1000-grain weight declined with increased plant population. However, the higher grain yield obtained at closer intra-row spacing (20 cm), could be attributed to higher number of plants and harvestable cobs at optimum spacing. This result is in conformity with the findings of Okan *et al.* (2004) who obtained high grain yield from closest intra-row spacing of 20 cm.

Also, the significant interactions between variety and spacing on number of grains per cob observed in 2012 wet season could be attributed to the presence of favorable moisture condition for growth and development which resulted in better leaf development and overall plant growth provided by the moderate fertilizer rate and spacing as well as optimum environmental conditions.

CONCLUSION

The results obtained showed that application of 90 kg N ha^{-1} at the spacing of 25 cm produced 2486.06kg and 2280.1kg for Sammaz-28 and Sammaz-29 respectively compared to 45 kg N ha^{-1} with the spacing of 15 cm with the grain yield of 2038.35 kg and 2128.9kg for Sammaz-28 and Sammaz-29 respectively. Therefore, both varieties of the maize could be recommended to farmers in the northern guinea savanna ecological zone of Nigeria for maximum yield.

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ASSESSMENT OF THE CONSERVATION STATUS OF *Gambeya albida* G. DON IN HOMEGARDENS OF NSIT IBOM LOCAL GOVERNMENT AREA, AKWA IBOM STATE, NIGERIA

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ABSTRACT

The study assessed the conservation status of *Gambeya albida* in homegardens of Nsit Ibom Local Government Area (LGA), Akwa Ibom State, Nigeria. Nsit Ibom LGA was stratified into two sampling blocks based on its existing clans. A total 150 households from thirty percent (30%) of the villages in the two clans were randomly selected for data collection. Data were collected using physical enumeration in quadrats and structured questionnaires. Descriptive statistics and other relevant inferential statistics were used in analyzing the data. Results showed that population density *Gambeya albida in* Mbiaso clan was 30 ha^{-1} against 31 ha^{-1} species recorded in Asang clan. The ages of the plant were not significantly different ($p \geq 0.05$) though ages ranged from 4-6 years were recorded. Conservation problems encountered in the study area included inadequate land, slow growth and large crown of the plant species. Inadequate land (69.50%) was significantly higher than all other problems at $p \leq 0.05$. For regeneration methods used by the farmers, artificial method (56.5%) was higher than natural method (18.5%) although not significantly different from each other. Forms of utilization differed significantly between the groups at $p \leq 0.05$; about 91.38% and 90.67% of farmers used *Gambeya albida* for income generation and food respectively. The result concluded that *Gambeya albida* was of great benefit to the people of Nsit Ibom LGA.

INTRODUCTION

Forests and woodlands harbour immense terrestrial and aquatic biodiversity and, especially in moist tropical regions, represent the most species-rich habitat type worldwide (Mace *et al*., 2005; Lindenmayer 2009; Gibson *et al*., 2011). Forests are critical habitats for biodiversity and they are also essential for the provision of a wide range of ecosystem services that are important to human well-being. There is increasing evidence that biodiversity contributes to forest ecosystem functioning and the provision of ecosystem services (Brockerhoff *et al.*, 2017). In some West African countries, forest fruit trees serve as alternative sources of food, especially during the dry season (between November to April) when food crops are planted and thus contribute to food security and increase the diversity of foods necessary to reduce monotony in the diet of rural people (Shiembo *et al.*, 1996). In addition, the edible parts (e.g. fruits and seeds) of these tree species could be processed into conventional products like jams, marmalade, alcohol, soaps, candles, jelly and chewing gums, table oil, margarine etc. (Shiembo *et al.*, 1996; Adisa, 2002).The edible products from these forest tree species are important for food security and have been noted to contain high level of vitamin C, minerals, sugar, proteins, etc., thus playing an important role in the nutritional balance of the people (FAO, 1989). Their barks, leaves, fruits, roots, seeds, etc could be used to cure a variety of sickness and diseases (FAO, 1998; Adewusi, 1997), thus contributing to the health care delivery. Also, they contribute significantly to rural poverty alleviation by providing employment and enhancing economic empowerment of rural dwellers through the collection, processing and marketing of their products such as fruits, seeds, leaves, and root. One of the forest fruit tree species that has been noted to have high

socio economic importance is *Gambeya albida*. The species is one of the indigenous fruit trees with enormous potential for plantation establishment. It is commonly called African Star apple. Star apple which is known locally in Efik language as "Udara" and botanically called *G. albida* (Linn) belongs to the family Sapotaceae. It has been reported to occur naturally in Nigeria, Uganda, Niger Republic, Cameroon and Cote d' ivore (Adewusi and Bada, 1997).

Botanical Description of *Gambeya albida*

G. albida is a small to medium buttressed tree species, up to 25-37m in height with a mature girth varying from 1.5 to 2m. Bole is usually fluted, frequently free of branches for 21m. Bark thin, pale brownish-green, slash exuding white, gummy latex (Orwa *et al*., 2009, Hong *et al*., 1995). Leaves are simple, dark green above, pale tawny below when young and silver-white below when mature, oblong-elliptic to elongate obviate elliptic, 12-30cm long, 3.8-10cm broad; apex shortly acuminate, base acuminate; primary lateral nerves widely spaced, 9-14 on each side of the midrib; secondary lateral nerves indistinct or invisible; petiole 1.7-4.2cm long (Orwa *et al*., 2009; Katende, 2000).

Flowers shortly pedicellate, in dense clusters in the leaf axils or from above the scars of fallen leaves; calyx 5-lobed, 3mm long, rusty pubescent outside, creamy white, the lobes equaling the tube in length (Orwa *et al*., 2009). Fruits almost spherical, slightly pointed at the tip, about 3.2cm in diameter, greenish-grey when immature, turning orange-red, yellow-brown or yellow, sometimes with speckles, 5 celled, with 5 brown seeds in yellowish, pleasantly acid pulp. Seeds 1-1.5 x 2cm, beanlike, shiny when ripe, compressed, with one sharp edge and a star-shaped arrangement in the fruit (Orwa *et al*., 2009 and Hong *et al.,* 1995).

Distinctive Benefits of *G. albida* Fruits

 i.   Nutritional Values of *Gambeya albida*

G. albida fruits are an excellent source of vitamins and minerals such as iron, ascorbic acid, anacardic acid, crude protein, folate, carbohydrate, sodium, vitamin B6, zinc, magnesium, calcium, manganese, vitamin K, vitamin B1, vitamin C, crude fibre and potassium (Orijajogun *et al.,* 2013). *Gambeya albida* extracts contain cardiac glycosides, tannins, phenols, steroids, reducing sugar, phlobatannins, terpenoids, alkaloids, flavonoids and saponins (Orijajogun *et al.,* 2013).

ii. Regulation of Blood Sugar Level

Studies reveal that *Gambeya albida* (local cherry fruit) is essential for regulating the blood sugar level. Both the barks, leaves and roots of *Gambeya albida* can be used for preparing herbal medicines for regulating the blood sugar level (Emmanuel and Francis, 2010). *Gambeya albida* leaves can be infused and used for treating diabetes. The seeds cotyledon possesses anti-hyperglycemic properties thus can lower high blood sugar level (Egunyomi and Oladunjoye 2012).

iii. Antioxidizing Properties

Orijajogun *et al.,* (2013) investigated the free radical scavenging and phytochemical activities of the exocarp of *Gambeya albida* fruit extract. Their study shows that this fruit contains saponins, tannins, triterpeniods, alkaloids, volatile oil, steroids, resins and balsam. As a result, it can serve as a natural antioxidant booster for treating oxidative stress disorders where free radicals are present. Due to the antioxidant properties of *Gambeya albida*, it can scavenge for free radicals in the body thereby reducing lipid peroxidation and preventing cancer and heart diseases (Edem *et al*., 2011).

iv. Regulates the Blood Cholesterol Level

The seeds cotyledon of *Gambeya albida* plants possess hypolipidemic properties. The seeds cotyledons are normally used in folk medicine for preparing herbal medicines for lowering the blood cholesterol level (Amusa, *et al*., 2003).

v. Antimicrobial Properties

Gambeya albida contains eleagnine, which is the key compound behind the antimicrobial properties of this plant (Orijajogun *et al*., (2013). Orijajogun *et al*., (2013) also agreed that eleagnine is both antioxidizing, anti-nociceptive and anti-inflammatory in nature. The leaves of *Gambeya albida* plants can be squeezed and used as a soothing ointment or moisturizer for treating dry skin, skin eruption and skin itches (Amusa, *et al*., 2003).. The cotyledons from the seeds of *Gambeya albida* can also be used for treating dermatological infections as well as vaginal infections. Studies reveal that the leaves of *Gambeya albida* plants can be used for treating gastrointestinal diseases such as diarrhoea, stomachache and indigestion (Florence and Adiaha, 2015).

The leaves, roots and barks of *Gambeya albida* can be used for preparing herbal medicines that can be applied on wounds, cuts, sprains and bruises for quick healing. The roots and seeds extracts can be used for seizing bleeding from fresh cuts, injuries and wounds thereby preventing microbial growth on the wound while facilitating the healing process of the injury (Florence and Adiaha, 2015). The brown seeds of the *Gambeya albida* fruit can be used for making beads, local necklaces and decoration. The brown seeds can be knitted together and used as local musical instrument known as ichaka. The trees of *Gambeya albida* species are very hard and durable thus very good for construction purposes. The strong, heavy and durable woody tree can be cut and used for constructing rafters, fence posts and pillars (Ureigho and Ekeke, 2010).

vi. Socio-Economic Importance of *Gambeya albida*

The economic importance of *G. albida* has increased in recent years due to awareness of its nutritional, social, traditional and medicinal value (Onyekwelu and Stimm, 2006). Thus, the fruit plays an important role in household food security. Wild harvesting of these fruits from forests and semi domesticated trees growing on-farm and homesteads can substantially boost rural income and employment opportunities (Ruiz-Perez *et al*., 2004; Leakey *et al.,* 2005). Their commercial importance has led farmers to identify these local species as trees for domestication through agroforestry (Franzel *et al.,* 1996). Tree domestication is the application of genetic principles to increase the value of tree crops and also to enhance economic returns from the end product. Increasingly, agroforestry trees are being improved in quality and productivity through the process of market driven domestication, by inventory of the natural resource and sustainable production of agroforestry products based on strategies that consider the needs of farmers and their priorities for domestication (Simons and Leakey 2004; Leakey *et al.* 2005). However, the high economic values of *G. albidum* has led to intense exploitation of its fruit resulting in scarcity and a declining rate of its availability, causing the species to be classified as endangered or threatened (FORMECU, 1999). *Gambeya albida* may be a victim of unsustainable exploitation characterized by high consumption of the fruits and seeds, high rate of male to female sex ratio and little or no regeneration programs. This may have led to genetic erosion of the species.

viii. Cultural value of *Gambeya albida*

Some of the cultural values of *Gambeya albida* have been underscored by the following. The seed shell is used as rattles which adorn the ankles of traditional dancers. Bows and arrows which are indispensable traditional defense weapon are made from the light weight wood. The tree base is used as site for fertility rites in Anambra and Imo state of Nigeria (Ehiagbanare, 2007).

MATERIALS AND METHODS

Study Area

The study was carried out in Nsit Ibom Local Government Area of Akwa Ibom State, Nigeria. Nsit Ibom shares boundaries with Ibesikpo/Asutan, Etinan, Nsit Ubium and Uyo

LGAs. It is located between longitudes 4°53′N and latitude 7°54′E (Fig. 1). The vegetation of that is a lowland rainforest with a strong seasonal climate. It is characterized by two seasons, which are the rainy and dry seasons. The dry season starts from November to March or early April, with the driest and hottest period in March. The area also experiences the harmattan weather from December – February during which night temperatures are low (AKS, 1989). Annual rainfall decreases from North - South across the study area. Average daily temperature ranges from 14°C- 23°C. Nsit Ibom has a total population of 108,611 people according to 2006 national population census.

SOURCE: GIS LAB Department of Geography, University of Nigeria Nsukka
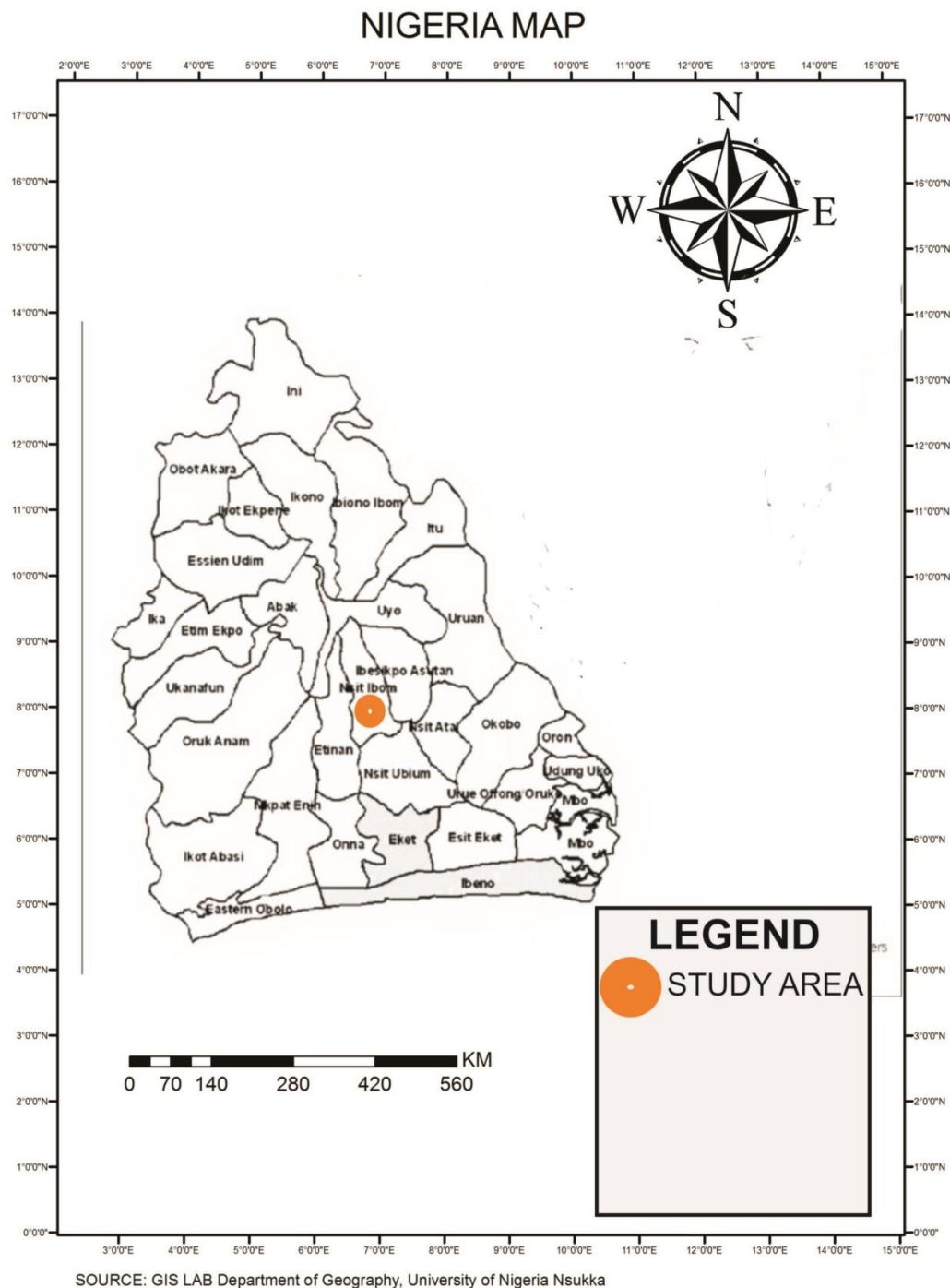
Figure 1: Map of Akwa Ibom State Showing Nsit Ibom LGA

Sampling Technique: Multistage sampling was adopted in the study. Nsit Ibom was stratified into two sampling blocks based on the two existing clans (Asang and Mbiaso). There are 17 villages in Mbiaso clan and 30 villages in Asang clan making it a total of 47 villages in Nsit Ibom L.G.A. Thirty percent (30%) of the villages in each of the clans were randomly selected giving a total of 15villages and 10 homegarden were further randomly selected from each of the sample villages giving a total of 150 homegardens in the Study Area

Data collection and analysis

Data were collected using structured questionnaire, oral interviews and field enumeration according to Udofia and Akpan (2016). Field enumeration was carried out from the sampled study area to determine population density of the tree species using quadrat of 20m×20m at each of the sample homegardens. *Gambeya albida* found were counted. The age and methods of planting were obtained through oral interview with the respondents/homegarden owners in line with Udofia and Akpan (2016) and Ferris-Kaan and Patterson (1992). The analytical method used for this study was descriptive statistics and Statistical Package for Social Sciences (SPSS) version 20.0.

RESULTS

Demographic characteristics of Respondents

Table 1 shows the demographic information of the respondents in the study area. Males and females respondents constituted 71.30% and 28.70% respectively. The age classes of the respondents were 30-40 years (19.30%), 41-60 years (54.00%) and 61 and above (46.70%). Majority of the respondents were Christians (92.00%), while traditional worshipers made up the remaining 8.00%. Educationally, 26.00% of the respondents had First School Leaving Certificate (FSLC), 44.67% had Senior School Certificate Examination (SSCE), 37.00% had Ordinary National Diploma (OND) while 4.70% obtained B.Sc. and other higher degrees. Occupationally, majority of the respondent (58.67%) were engaged in full time farming, 26.00% combined self-employed jobs with farming while 15.33% combined civil service jobs and farming. The results also indicated that 5.33% were single, 70.67% were married, and 12.00% were widows, while 12.00% were divorced. Furthermore, land ownership results reveals that 18.33% acquired their homegarden lands through outright purchase, and 78.00% inherited their homegarden from their parents while 2.67% rented the land for cultivation.

Table 1: Demographic information about respondents in Nsit Ibom LGA, Akwa Ibom State, Nigeria

Variable	Asang	Mbiaso	Total	%
Gender				
Male	62	45	107	71.30
Female	28	15	43	28.70
Total	90	60	150	100.00
Age				
30-40	15	14	29	19.33
41-60	36	45	81	54.00
61-above	39	31	70	46.70
Total	90	60	150	100.00
Religion				
Christianity	81	57	138	92.00

Traditional worship	9	3	12	8.00
Total	90	60	150	100.00
Education status	24	15	39	26.00
FSLC	42	25	67	44.67
SSCE	22	15	37	37.00
OND	2	5	7	4.67
B.Sc.-above	90	60	150	100.00
Total				
Occupation				
Farmer	50	38	88	58.67
Self employed	24	15	39	26.00
Civil servant	16	7	23	15.33
Total	90	60	150	100.00
Marital status				
Single	5	3	8	5.33
Married	64	42	106	70.67
Widow	12	6	18	12.00
Divorce	9	9	18	12.00
Total	90	60	150	100.00
Forms of ownership				
Bought	13	16	29	18.33
Inheritance	74	43	117	78.00
Hired/rent	3	1	4	2.67
Total	90	60	150	100.00

Source: Field data (2018)

Population density in Nsit Ibom LGA, Akwa Ibom State
Figs. 2 and 3 show the population density of *G. albida.* In Mbiaso clan in Nsit Ibom LGA., the species was found in greater number (16 ha^{-1}) in Mbiaso village followed by Edebom (14 ha^{-1}), Afaha Abia (12 ha^{-1}), Afia Nsit Udua Nko (12 ha^{-1}) while Afaha Offiong village was the least (8 ha^{-1}) in number found. In Asang clan, population density is presented in Fig. 3; the highest (16 ha^{-1}) found in Obontong village followed by Mbiokporo 1 (15 ha^{-1}), Ikot Idem (13 ha^{-1}). Afaha Nsit and Ikot Ntuen Nsit recorded the same number (12) of plant species. Obo Etuk, Afaha Nsit 1 and Obotim Nsit also recorded the same number of species and the least (9 ha^{-1}) was recorded in Ekpene Ikpan. In summary, Mbiaso clan recorded population density of 30 ha^{-1} while Asang clan recorded 31 ha^{-1}.
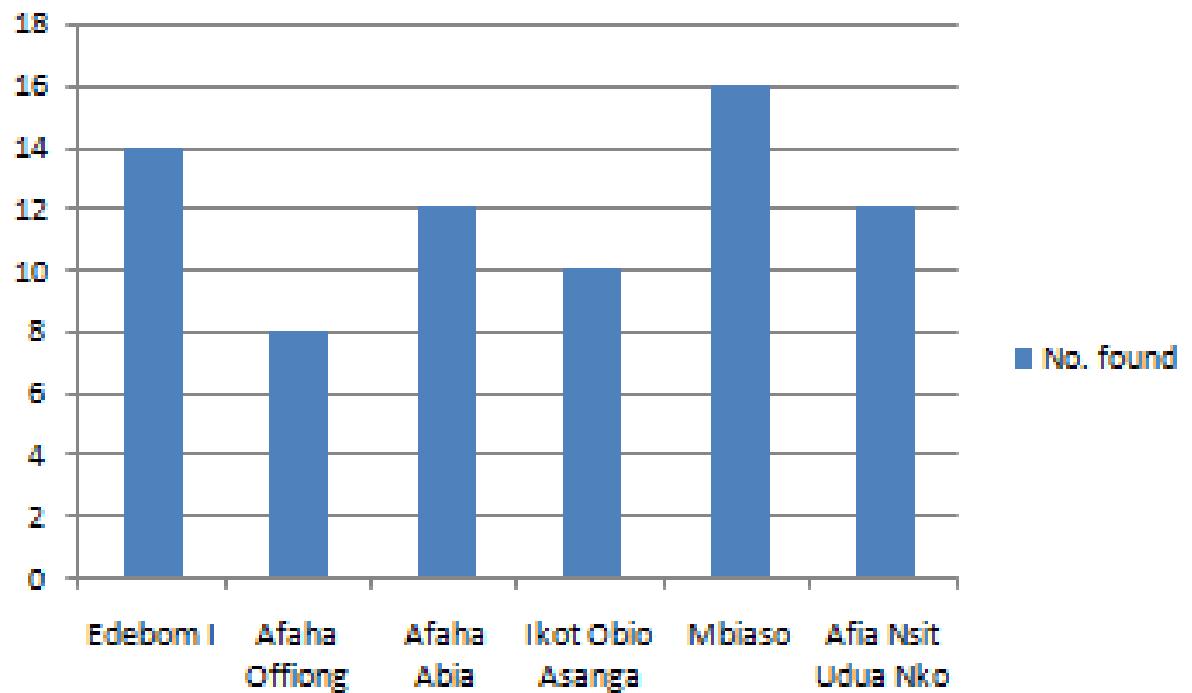
Fig. 2: Population density of *G. albida* in Mbiaso Clan

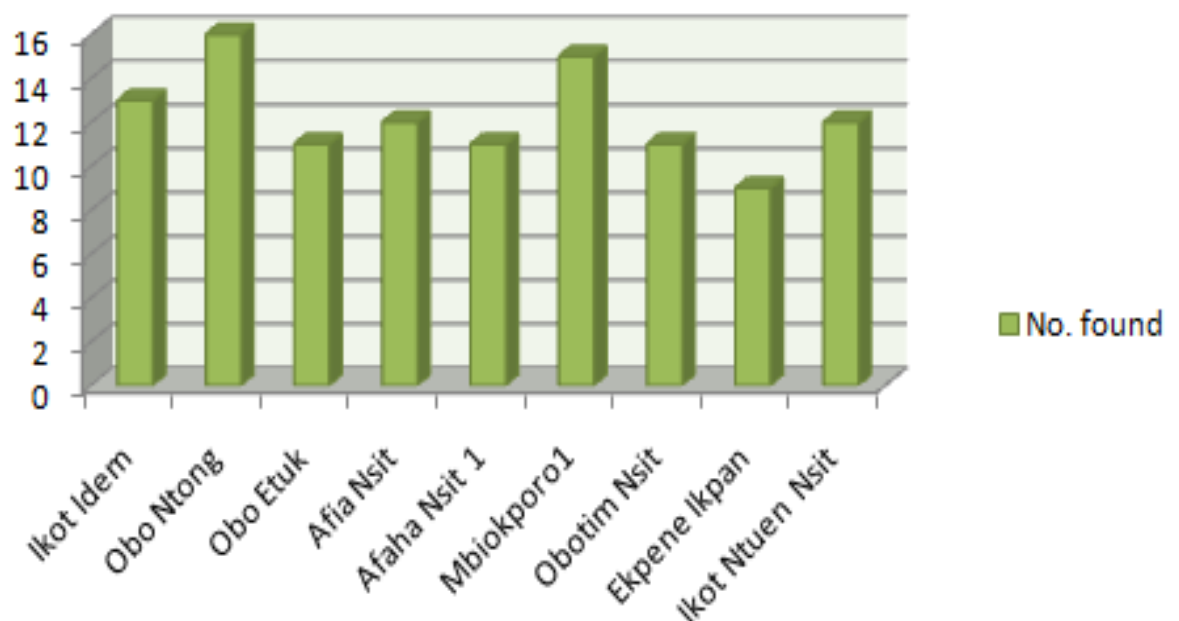

Fig. 3: Population density of *G. Albida* in in Asang Clan

Age of *Gambeya albida* in Homegarden in Nsit Ibom LGA

Table 2 shows the ages of *Gambeya albida* in the two clans. There was no significant difference ($p > 0.05$) between the age groups. However, those in the age group of $4 - 6$ years recorded the highest number of species (50.67%), age group $7 - 9$ years recorded 28% of

the population captured while age group 9 years and above recorded 6.67% of the population.

Table 2: Age class of *Gambeya albida* in Homegarden in Nsit Ibom LGA

Age (yrs)/Clans	Mbiaso	Asang	Total	%
4 – 6	29	47	76	50.67
7 – 9	15	27	42	28
>9	4	6	10	6.67

Problems of conservation of *Gambeya albida* in homegarden in Nsit Ibom LGA.
The result in Table 3 shows the problems encountered by the respondents towards the conservation of *Gambeya albida.* There was no significant difference (p> 0.05) between the mean groups. Among all the problems faced by the home garden farmers, inadequate land recorded the highest (92.67%) followed by lack of improved variety (82.67%). Inadequate seedlings recorded (50.67), large crown recorded (28%) and slow growth had (22.33%).

Table 3: Problems of conservation of *Gambeya albida* in homegarden.

Problems	Mbiaso	Asang	Total	%
Inadequate Land	58	81	139	92.67
Slow growth	13	22	35	22.33
Lack of improve variety	49	75	124	82.67
Inadequate seedlings	27	49	76	50.67
Large crown	11	31	42	28

Methods of regeneration of *Gambeya albida* in Nsit Ibom LGA.
The result in Table 4 showed that 150 farmers planted *G. albida* in their homegardens. About 75.33% of the population planted it artificially with a mean of 18.5, while 24.67% were from natural regeneration with a total mean of 56.5%. There was no significant difference (p> 0.05) between the methods of regeneration methods, although majority of the plant species under study was grown artificially in both Asang and Mbiaso clans.

Table 4: Methods of regeneration of *Gambeya albida*.

Methods	Mbiaso	Asang	Total	Mean	%
Natural	18	19	37	18.5[NS]	24.67
Artificial	42	71	113	56.5[NS]	75.33

Utilization of *Gambeya albida*.
Utilization of *G. albida as* recorded in Table 5 shows that this species has been utilized in many ways such as for food (68.0), income generation (68.5), medicine (35.5), aesthetics (9.5), and for shade (28). The means of all the forms of utilization differs significantly between the groups at p≤ 0.05 . However, 91.33 % of the population used this species to generate income and is higher significantly at p≤ 0.05 than other means of utilization. The result also revealed that 90.67 % used this product as food for consumption purposes followed by medicinal uses (47.33 %), shade (37.33 %) and the least of it utilization

purposes is for aesthetic value which recorded 12.67%. Among all the forms of utilization only mean of income generation is highly significant and higher than every other forms of utilization. This means that home garden farmer mostly used this product as one of their sources of income.

Table 5: Summary of utilization of *Gambeya albida* in Nsit Ibom LGA, Akwa Ibom State.

Uses	Mbiaso	Asang	Total	Mean	%
Food	55	81	136	68.0	90.67
Medicine	40	31	71	35.5	47.33
Aesthetics	12	7	19	9.5	12.67
Income generation	55	82	137	68.5	91.33
Shade	23	33	56	28	37.33

DISCUSSION

Various studies have been conducted on conservation of valuable tree species in homegardens (Udofia *et al.,* 2011; Udofia *et al*., 2012; Udofia and Akpan, 2016). Homegardens have also been found as an important agroforestry practice in the conservation of biodiversity. The study indicated that *G. albida* was more abundant in Asang clan (110 ha^{-1}) than in Mbiaso clan (72 ha^{-1}). The abundant presence of this species in the study area shows that it is of economic benefit to the farmers. Problems faced by these farmers for conservation of this species despite its economic benefits are mostly inadequate land and lack of improved variety. Udofia (2011) noted that agroforestry practices which *Gambeya albida* are intercrop has the potential to increase products and services to farmers and homegarden practices on a sustainable basis and that it also has the capacity to combine development with conservation functions harmoniously. Slow growth also affect the conservation and abundant of this species in the study area which may be as a result of lack of sufficient water especially in the dry season. This is in agreement with Galle and Feller (2007) observation that drought or in sufficient water in the soil is a severe limitation to plant growth, development and productivity particularly in semi-arid region. Ahmad *et al.,* (2009) also pointed out that young seedlings growth requires enough water in it growing stage and lack of it make it hard to grow and slow it survival rate and development. Rizzardi (2009) said that many environmental factors such as temperature, light, pH and soil moisture are known to affect seed germination, thereby affecting the growth of the plants.

Regeneration methods also contributed to the conservation problems of the species in the study area. Artificial method of regeneration was seen to be higher than the natural method. Though, both artificial and natural method of regeneration of this plant in the study area does not differ significantly from each other. This was in line with ICRAF (2007) who observed that *G. albida* have poor natural regeneration and one factor that inhibits germination among many others is dry condition. Survival of species in it natural habitat after regeneration could be affected by the high rate of ecological disturbances. Udofia *et al*., (2001) stated `that with increased human and livestock pressures, the practice of agroforestry has come under stress, resulting in reduced yields, lower soil fertility, ecological disturbance due to excess over-felling of vegetation and poor socio-economic returns to the local community. This will directly affect the abundance of the species in the communities. Orwa *et al*. (2009) pointed that, disturbance of the plant's habitat have great effect on regeneration of fruit trees with poor regeneration. Slow growth is one of the problems of conservation which can contribute to low species diversity. This was seen in the age group of the studied plant in the study area.

The respondents mentioned that availability of seeds affect the planting of this species. This goes in tandem with observation by (Page *et al,* 2009) that it is important to

use good quality seed because they produce strong healthy seedlings for plant growth and development.

Utilization of *G. albida* in this study area showed a great significant valuation as the plant generates income to the people. Income generation was highest and most preferred form of utilizing the species compared to other forms such as food, medicinal purpose and aesthetics value. This is in line with Onyekwelu and Stimm, (2006), who observed that *G. albida* is of nutritional, medicinal and social/traditional important. They plant also plays an important role in household food security. Income generation ability of this plant in Nsit Ibom LGA agrees with Ruiz-perez*et al.,* (2004) and Leakey *et al.,* (2005) who stated that harvest of this plant boost rural income and employment opportunities. Growing diverse plant species in homegarden is to enhance use-value of the species to households as income generation, food, nutritional supplements and medicine (Udofia *et al.*, 2012). The dynamics of homegardens as an important agroforestry practice must be well understood, such understanding in size and management of the garden becomes essential because the extent to which they supply the major part of a family's subsistence requirement differs considerably within the same geographical region, from a backyard farm grown with herbs and fruits to be the main determinants of the appearance, function and structure of homegarden (Christanty, 1990). Akpan-Ebe *et al.,* (2016), highlighted some uses of *G. albida* to include food source, pharmaceutical, cultural, timber and environmental uses. This also goes in line with FAO (1981; 2007) that people from wide range of socio-economical, geographical and cultural contexts harvest NTFPs for a number of purposes, including but not limited to: household subsistence, maintenance of cultural and familial traditions, spiritual fulfillment physical and emotional well-being as well as scientific learning and income. Evans (1992) also stated that homegardens generate several public goods, including biodiversity and cultural heritage. In the southeastern Nigeria, the most economically marginalized farmers manage homegardens with the highest level of public goods and derived the highest private benefits from them.

CONCLUSION AND RECOMMENDATION

Conservation of economically advantage tree species should be of topmost priority for homegarden farmers. This is due to the benefits it provides as it output. Based on the finding of this study, it could be concluded that population of *G. albida* varies among the two clans in the study area. This species hardly regenerate naturally, hence the farmers seldom adopt artificial regeneration method than natural regeneration method. However, despite the challenges faced by farmers, the species has huge economic benefits to the farmers. Finally, the study concludes that there were challenges to conservation of *G. albida* in the study area. Appropriate regeneration and conservation methods are therefore, recommended in order to sustain the benefits of the plant species.

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THE IMPACT OF HUMAN ENCROACHMENT ON LARGE MAMMAL OCCUPANCY IN A NATURAL ECOSYSTEM: A CASE STUDY OF OBA HILLS FOREST RESERVE, OSUN STATE, NIGERIA.

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ABSTRACT

Substantial decline in large mammal population has been recognised in the African ecosystem where increasing human resource demands continue to degrade natural habitats. Despite the importance of large mammal to ecosystems, many African protected landscapes lacks baseline information on mammalian diversity and abundance. This study aimed to produce the current fauna species composition and abundance of Oba Hills Forest Reserve (OHFR) using a multiple detection techniques that combines non-invasive camera trapping and line transect method to survey three of the five hills constituting an area of 52km^2 of OHFR. From the camera trap survey, 84 trap-nights yielded 47 captures in total. Hunters (humans) were photographed at two of the camera stations, while none of the six camera stations captured animals. Across the 72km of transects walked throughout the study site, besides herds of cattle, no species of animals was directly sighted. The presence of three species bushbuck (*Tragelaphus scriptus*), duiker (*Cephalophus sp.*) and red river hog (*Potamochoerus porcus*) as well as logging activities were indirectly confirmed in the reserve. The result suggests that the OHFR is a degraded site, hosting low species richness of large mammals that is comparable to other sites in Africa. Apparently, the future food security of the local people whose livelihood depends on the natural resources of OHFR is threatened with the dramatic drop in large mammal populations owed in part to human encroachment. For a sustainable livelihood and wildlife conservation, there is a need to improve the population of large mammal through enforcement of forest and wildlife laws as well as effective management of the wildlife resources in the reserve.

 Keywords: Protected landscape, large mammal, abundance, human encroachment, food security

INTRODUCTION

Humanity in its restless pursuance of food security and economic growth is changing the face of the earth. This transformation is increasing at a very rapid rate and as a consequences, many species of large mammals are being lost at a rate estimated to be 1,000 to 10,000 times higher than the natural replenishing rates (UNEP 2007). Globally, the biomass of wild large mammals has declined by 82%, and a million species are at risk of extinction (Watts 2019). The rate of disappearance of these species has been attributed to negative impact of man's activities such as farm encroachment and overexploitation through illegal logging, grazing and hunting on the ecosystem (Dunham *et al*., 2007; Craul *et al*., 2009; Irwin *et al*., 2010). The continued loss of wildlife will greatly affect human society as well as ecosystem and their valuable services provided such as provisioning, (production of food and water); regulating, (control of climate and disease); supporting (nutrient cycles and oxygen production); and cultural (spiritual and recreational benefits). Considering all the products and services provided by these large mammals as well as the difficulty in their replacement, there would be a great consequences to be faced if their natural habitat are not well monitored and conserved.

In ecology, there is a distinctive link between species and their habitats. Through the process of evolution, some species adapt and persist within a restricted range of

environmental parameters but many are vulnerable to environmental change (Bellard *et al*., 2012). Variation in species commonness and/or rarity depends on the environmental change caused by human impact. Species rarity is centred on geographical range (where species are numerous but confined to a small geographical range), habitat specificity (where species may be geographically widespread but confined to a specialized habitat) and population size (where species occur in small populations) (Harcourt and Parks, 2002). However, the rarest species are those with a combination of small geographical range, low population size, high habitat specificity and disturbance (Pullin, 2002).

Hence, there is a need for effective wildlife conservation with priorities not only focused on large mammal occupancy and/or variation in abundance/ rarity of species, but on the level of threat (Forboseh *et al*., 2007). However, to disentangle the factors underlying large mammal occupancy, there is a need to identify the type and degree of threat at local level in other to enhance management strategies in minimizing if not totally eradicating the threat (Adams *et al*., 2004). To this end, this study aimed to examine the impact of human encroachment on large mammal occupancy of Oba Hills Forest and Reserve (OHFR).

MATERIALS AND METHODS

Study area

This study was conducted in Oba Hill Forest Reserve (OHFR) in Osun State, south-Western Nigeria (Figure 1). OHFR is a small enclave that covers an area of about $52km^2$ surrounded by five hills with a wide valley running in between. It lies roughly between latitudes 7^0 33 and 7^0 5 N, and longitudes 4^0 2 and 4^0 18 E with an elevation of 253 meters above sea level (asl) (NCF 2013). Basically, OHFR is a mix of agricultural plots, Teak plantations, woodland habitats and fragments of degraded riparian forests. The climatic condition is characterized with marked wet and dry season. The wet (rainy) season is from April to October while the dry season is from November to March (NCF, 2013). The reserve is surrounded by considerable number of villages (Akinleye, Owu-Ile, Ife-Odan, Isero, Olori, Familopa, Togunde Olota, Obameoro, Olala, etc.) (NCF, 2013). The villagers are mostly Yoruba indigenes and immigrant from neighbouring countries. The primary occupation of the local people in OHFR is agricultural farming (NCF, 2013). The reserve was a home to wild animals such as ungulates, rodents and warthogs etc.
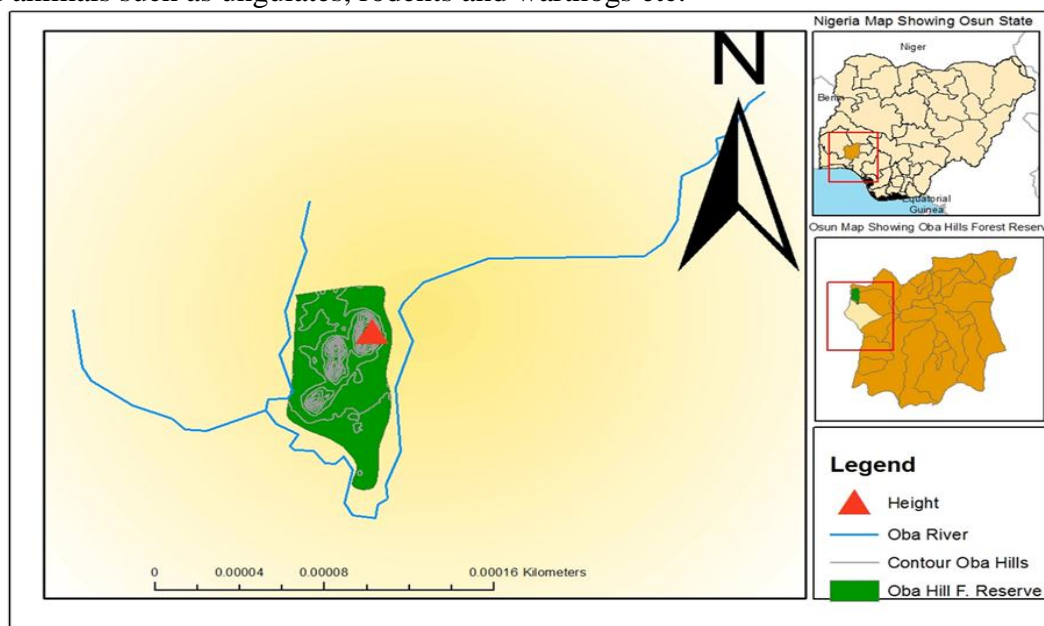
Figure 1 showing the land cover map of Oba Hills Forest Reserve and its location in Nigeria.

Data collection and analysis
Multiple detection techniques that combines camera trapping and line transect methods were employed in this study (Akinsorotan, 2017). Due to logistic reasons, three of the five hills across the reserve that were easily accessible were purposively selected for camera trapping and line transect survey. The study was conducted from March to May, 2018

i.   Camera trapping survey
In this study, two location points (sampling sites) were randomly selected in each of the three axis (Akinyele, Olododo and Owu-Ile), given a total of six sites for the camera trapping survey in OHFR. During the survey, areas that lack trees, were rocky or excessively steep were repositioned no more than 100m from the original location selected for the survey (Akinsorotan, 2017). Each location consists of one passive infra – red camera trap (Bushnell trophy cam) positioned in each selected point without a prior knowledge of species abundance or composition. Each camera was attached to a tree with a strap at a height of 30–40cm from the ground (Plate 1) and positioned at an optimum angle of less than 40° for sensor detection of different species (Kays *et al*., 2008, Hobbs and Brehme, 2017). No bait was used to enhance multiple detection of species.

       Each site was visited once in a month (this was done to prevent theft and reduce the rate of vandalization on the camera traps). The 5-day sampling period described by Mackenzie *et al*. (2002) was increased to 14 day sampling period with an assumption that it was insufficient to detect animal in the study area (Li *et al*., 2010). Each camera was operated for 14 days amounting to a total sampling effort of 84 trap nights. At the end of sampling period, memory cards were recovered and images were identified and verified the researcher.

Plate1. Setting of camera trap in OHFR

Species lists were compiled for animal captured by the camera. All photo captures taken per sampling period per camera was considered as an event.

ii.   Line transect method

A random design was used to lay six transects of 1 Km length in three axis of the reserve (Thomas *et al*., 2010). All the six transects were also laid independently of animal locations (along existing tracks and trails), to aid accessibility. The line transect survey was conducted at the same time as the camera trap survey.

Each transect was surveyed twice (fortnightly), for a period of three months (i.e. twelve repeats) across the forest reserve. Large mammal enumeration was conducted during the morning (06:30-11:30) and evening (15:00- 18:00) (Peres 1999) across the three axis between March and May 2018. Surveys were conducted on dry days only as mammals are less active when it rains (Peres 1999). Animal censuses were conducted by the researcher and a forest guard who are proficient in animal detection and species identification. Transects were walked slowly at 1.0 - 1.2km/hr for animals detection. During the transect survey, a standardized data sheet was used for collecting transect length (measured with a GPS Garmin 64), sighting angle between animal and line transect (measured with a standard Silva compass), sighting distance between observer and animal, time, animal signs/activities (indirect sightings) and the number and species of any animals sighted.

Lists of animals directly and/or indirectly sighted were compiled. Estimates of the animal encounter rate (n/L) for each species sighted was calculated using the formula:

Encounter Rate = Number of sightings
                             Total distance walked

Note: Number of sightings is the total number of sightings achieved for each species throughout the survey period.

RESULTS

i. Large Mammal Composition and Occupancy

A total of 84 trap-nights yielded 47 independent photo captures of individual species. A by-catch of Hunters were photographed at two of the camera stations (Plate 2), while none of the six camera stations captured animals.

Plate 2 Photo capture of hunter in OHFR during the 2018 camera trapping survey

ii. Large Mammal Encounter Rate

Across the 72km of transects walked throughout the study site, besides herds of cattle, no species of animals was directly sighted. The presence of three species of wildlife namely; bushbuck (*Tragelaphus scriptus),* duiker *(Cephalophus sp.)* and red river hog *(Potamochoerus porcus)* as well as logging activities were indirectly confirmed in the reserve (Table 3).

Table 3 Summary of animal species and illegal activity indirectly sighted in OHFR

Axis	No. of transects surveyed	No. of repeat surveys per transect	No. of bushbuck	No. of duiker	No. of red river hog	No. of illegal logging activity	No. of farms
Akinleye	2	4	10	13	16	3	3
Olododo	2	4	6	9	2	5	4
Owu-Ile	2	4	8	5	0	2	2
Total	6	12	24	27	18	10	9

The encounter rate (ER) for species of animal indirectly sighted was low for the three species sighted. Across the reserve, the ER was highest for duiker (0.38individual /km) followed by bushbuck (0.33individual/km) and red river hog (0.25 individual/km) respectively.

DISCUSSION

The findings of this study revealed that the OHFR lacks the ability to ensure a balanced and sustainable ecosystem by maintaining viable population of large mammals. Overall, camera detection and indirect sightings of mammals was low, with the three species; bushbuck, duiker and red river hog having low encounter rate across the study sites. Wild animals provides key ecosystem services and their absence is indicative of an unhealthy forest (). One possible explanation for the non-detection and low encounter rate of large mammals in this study is human encroachment across the study sites. The result further support the past finding that encounter rate and population of large mammals are low in protected areas (Rao *et al.*, 2010; Caro 2011) and human encroachment was identified as the major cause of the decline (Rao *et al.*, 2010; Caro 2011).

The study found evidence of human encroachment in the form of bushmeat hunting, livestock grazing, timber logging and crop farming. Human encroachment threatens the well-being of ecological and human communities (Díaz, *et al.*, 2006, Brook, Sodhi and Bradshaw 2008, Butchart, *et al.*, 2010). Bushmeat hunting has been identified as the major threats to local wildlife (Ripple *et al.*, 2016) which has reflected an economically inefficient use of wildlife in their natural habitat and to the tourism industry. The massive collapse in mammal population size and geographical ranges around the world is supported by the findings of this study and thus, this underlining decline suggests the need for an effective conservation measures in other to ensure that the ecological and economical services these species provide are not irrevocably lost.

Bushmeat hunting in OHFR for human consumption, medicinal products, pet trade or ornamental use therefore has a likelihood of local extinction of these hunted species, food insecurity, emergent disease risks and land-use changes (Nasi *et al.*, 2008). Several medium – sized and large mammals such as bushbuck (*Tragelaphus scriptus*), blue duiker (*Cephalophus monicola*), red river hog (*Potamochoerus porcus*) and patas monkey (*Erythrocebus patas*) which were documented during the period OHFR was gazetted have been found to decrease (Mr. Gbemileke: Pers. Comm. Akinyele farm/village 8th June 2018)

which reflect the skills that hunters always concentrate in areas where games is most abundant and the low relative abundance presently show the critical decline in their population size.

CONCLUSION

OHFR lacks viable population of large mammals, indicating an unhealthy forest. There is a considerable level of threat to the reserve as illegal logging, hunting and farming activities is taking their toll on reducing the large mammal population in the reserve. The use of natural resource by local people continue to be a major threat to conservation in OHFR, reducing the capacity of these hunted species to solve food insecurity (even in the future) as well as cutting short ecosystem services. There is a need for the Government and the conservation authorities to address human encroachment on protected landscape by employing conservation education awareness among the rural people neighbouring protected landscapes. Conservation strategies that address and/or change the behaviour of local people around OHFR in ways that benefits conservation such as community – based conservation activities should also be employed. Such strategy will link the resource and the community as the local communities will be involved in decision making. In addition, the study recommends the need for strict enforcement of laws for those whose flout the conservation rules.

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CORRELATES OF REVENUE AND TOURIST FLOW IN OLD OYO NATIONAL PARK, NIGERIA

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ABSTRACT

This study assessed the correlates of tourists' inflow in Old Oyo National Park. Data was obtained from administrative records of the park for the period of 2001 - 2015 and analyzed using descriptive statistics, correlation and least square regression. The results obtained indicated irregular trends in annual park expenditure, tourists' inflows and generated revenues in the park. The park had an annual mean of ₦119,876,868.70, ₦3,938,951.00±2828132 and 1440.35±1557.42 for expenditure, revenue and tourist inflow. United States of America had the highest number (90) of foreign tourists to the park, while revenue from offence fees (₦2,700,2050.00) constituted the major revenue source for the park. The study recommends adequate funding for the park to upgrade its infrastructure and management of the park to endear it to tourist in order to boost its revenue generation potentials.

Keywords: Tourism, conservation, revenue generation, protected area, Nigeria

INTRODUCTION

National parks possess unique attributes vital for the development of tourism in any country (Lawan, 2001; Okpoko and Ali, 2012). These attributes include its contribution to tourism in the area of preservation, conservation and propagation of important natural and cultural heritage for posterity (WTO, 1992, Yunis, 2003). National parks are tourist destinations where scenic features can be appreciated, hence, their development is vital for ecotourism and tourism development in general (Okpoko and Ali, 2012). Apart from its conservation function of tourism, national parks also have the potential to sustain the economy (Ajibade*et al*., 2013). According to Archer (1991), employment opportunities are created when tourist spend their money. This seeps in to the local economy, thus increasing the incomes of the locals. The increased incomes also result in increased expenditure for them, thus resulting in a chain reaction in the economy (Okpoko and Ali, 2012).

In Nigeria, there are seven National Parks with each possessing a unique attribute that makes it different from the other (Jacob, 2017). If well developed, these parks can be exploited for domestic and international tourism (Aremu, 2001) as seen in national parks of East and South Africa which are well developed and earn huge revenues in vital foreign exchange (Ayodele, 2002; Ajibade*et al*., 2013). Notwithstanding the challenges faced by these parks, they still serve as tourist destinations for interested ecotourist. According to Oladele (2000), wildlife resources in the country draws foreign tourist into the country. The tourists are attracted by nature's deposits that may not be available in their own countries. It also offers a promising recreational or leisure opportunities all year round where tourists have to pay to enjoy. This study therefore examines the relationship and tourist inflow and revenue generation in Old Oyo National Park for future development in the country's tourist industry.

MATERIALS AND METHODOLOGY
Study Area
Old Oyo National Park (OONP) is located between North latitudes 8° 10' and 9° 05', and East longitudes 3° 35' and 4° 21' and centered on North latitude 8° 36' 00 and East longitude 3° 57' 05'' (Jacob et al., 2018a). The Park covers a land area of approximately 2,512 km^2 making it the fourth largest national park in Nigeria. Politically, it lies in Oyo State in the Southwest of Nigeria and borders Kwara State in the Northeast. In Oyo State, it is surrounded by ten (10) Local Government Areas in Oyo State namely: Atisbo (Tede/Ago-Are), Atiba (Oyo), Irepo (Kisi), Oorelope (Igboho) Saki East (Ago-Amodu), Iseyin (Iseyin), Orire (Ikoyi), Itesiwaju (Otu), Olorunsogo (Igbeti), Saki West (Saki) and Kaima Local Government Area in Kwara State (Oladeji*et al.,* 2012). The park has an average rainfall of 1,100 mm per year (Aremu, 2007). The vegetation is southern Guinea Savannah with four sub-types consisting of dense woodland and forest outliers in the South-eastern part, mixed open savannah woodland in the central part; out crop vegetation in the northeast and riparian grassland and fringing woodland occupying the forest plains and valleys along the Ogun River. The park boasts of numerous fauna and wildlife species (Nigerian Park Service, 2010).

Data collection and Analysis
The study is a desktop research which involved the collection of secondary data from administrative records of OONP between the period of 2001 and 2015. It was used to collect information such as expenditure of the park, staff strength, record of arrest of poachers from the park and types of prosecution given to the offenders.

Descriptive statistics and least square regression were used for data analysis. Least square regression was used to calculate the trend in park expenditure and staff trend in the study area.

RESULTS AND DISCUSSIONS
Trend in park expenditure
Figures 1 shows the line and least square composite graphs of the annual expenditure trend for Old Oyo National Park. The result indicates that the mean annual expenditure in the park was ₦119,876,868.70 ($328,429.78). Trend in annual expenditure in the park shows that between 2001 – 2007 and 2013 – 2015, annual expenditure for the periods were below the mean annual expenditure, while between 2008 and 2012 its expenditure exceeded the mean annual expenditure. The highest amount of expenditure was in 2011 (₦294,381,845.8/$806,525.61). This was followed by expenditures in 2010 and 2012 with ₦216,107,334.50 ($592,074.89) and ₦192,197,694.30 ($526,569.03) respectively. The least expenditure in the park was in 2002 (₦42,072,788 ($115,267.91)). The variation in annual expenditure trend for the park is statistically defined by the function $y = 6E+07 + 8E+06x + e$ (p > 0.05) with a coefficient of determination figure of 0.2112 or 21.12%. (Fig. 1). However, there existed a weak correlation between the expenditures in the park and years (r = 0.4596). This is an indication that spending in the park is not directly influenced by the previous year expenditure but by other external factors such as government resources, the geographic size of the protected areas and the degree of population pressure (Jacob *et al*., 2018a, b).

The further analysis indicates that the mean annual expenditure of the park per square kilometer for the study period was $130.74. This expenditure is far below the ideal recommended cost for effective management of the park (Jacob *et al*., 2018a). According to Ayivor*et al*. (2013) the ideal cost or expenditure for effective management of a protected area is estimated to be $250/km^2 for developed countries and $526/km² as the mean budget

for a developing country (James *et al*., 2001). The above result is in accordance with James *et al*. (2001) who reported that protected area budgets in developing countries especially in Africa are grossly inadequate. This therefore calls for more funding for the park for it to achieve its goal of biodiversity conservation.

1 USD$ = ₦365
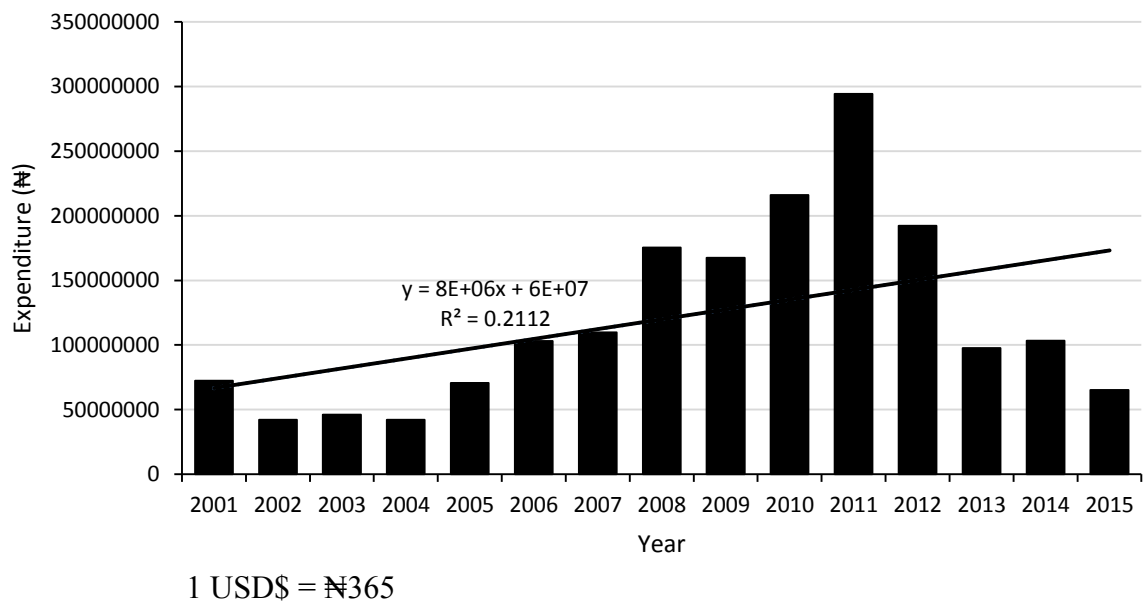
Figure 1: Trend in annual expenditure of Old Oyo National Park, Nigeria

Trend in tourist flow to Old Oyo National Park

The analysis of tourist flow between 2001 and 2015 showed no specific pattern of trend in the study area. The trend is inconsistent with increases and decreases with an annual mean of 1440.35±1557.42 (Figure 2). The highest number of tourist was recorded in 2013 with 4634 tourists, followed by 2015, 2014 2010 and 2011 with 3789, 3625, 2835 and 1305 tourists respectively, while the least number of tourists to the park (228) was recorded in 2006. This result is in accordance with the observation of Oladeji *et al*. (2012), Ajibade *et al*. (2013), Adejumo*et al*. (2014) who also recorded a large number of tourists in Nigerian National parks. However, the yearly number of tourist to the park was lower than those recorded for Kainji Lake National Park for the period of 2001 – 2009 (Adejumo*et al*., 2014). This could be attributed to the popularity of the later than Old Oyo National Park. Kainji Lake was the first National Park to be created in the country and is the second largest of all the national parks in the country.

The inconsistency in the number of tourists to the park is statistically defined by the function *y = 281.16x – 668.33 + e* (p > 0.05) with a strong coefficient of determination (R^2) of 0.569 or 56.9%. (Fig. 2). Also, there existed a very strong correlation between the number of tourist in the park and year (r = 0.746). This agrees with Ijeomah (2007) and Ogunjinmi and Ijeomah (2010) observations that there exists a strong correlation between number of tourist visiting and year. This could be attributed to the fact that it is sensitive to political crises whether real or imagined (Eltringham, 1984), as such it could be used as a measure of the political stability of a nation (Ijeomah, 2007).
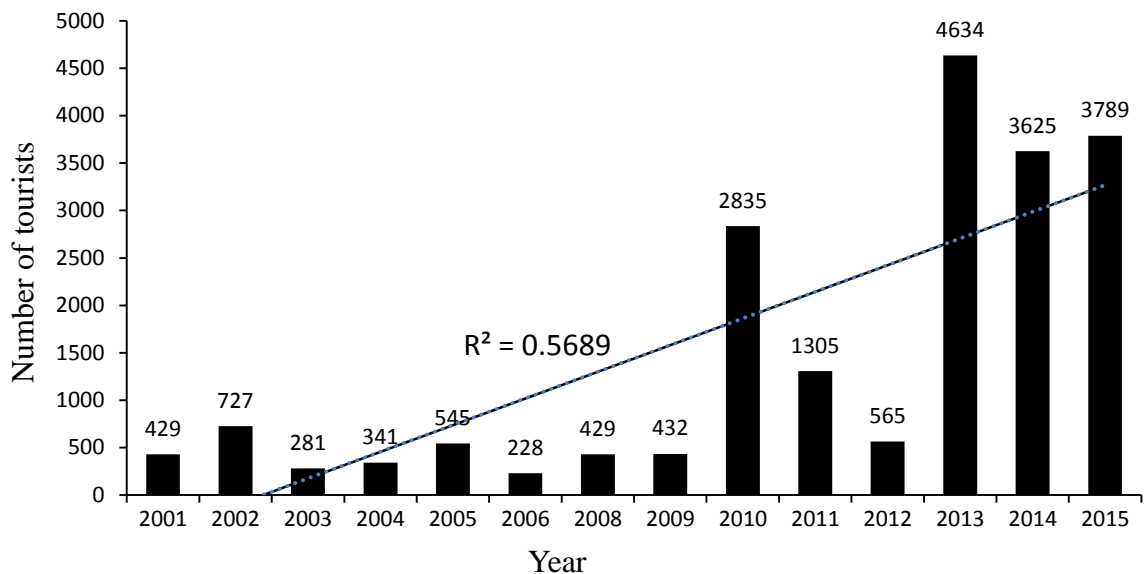
Figure 2: Trend in annual tourist visits to Old Oyo National Park, Nigeria

Trend in Tourist Flow between Locals and Foreigners

The annual trend in the number of local and foreign tourist to the study area did not follow any definite pattern (Figure 3). There were variations in number of tourists both local and foreign visiting the study area annually. Locally, the highest number of tourists to Old Oyo National park was 4630 in 2013. This was followed by 3785, 3617, 2824 and 1297 tourists in 2015, 2014, 2010 and 2011 respectively, while the least number of local tourist was in 2006 with 226 tourists. This variation in annual number of local tourists to the park could be defined statistically by the function $y = 45.11 - 3.795x + e$ (p > 0.05) with a coefficient of determination (R^2) figure of 0.3122. Also, the variation in annual number of foreign tourists to the park could be defined statistically by the function $y = -713.44 + 284.95x + e$ (p > 0.05) with a coefficient of determination (R^2) figure of 0.5791. The highest number of foreign tourist was in 2001 with 111 tourists. This was followed by 33, 20 and 11 tourists in 2002, 2004 and 2010 respectively, while in 2009, no foreign tourist was recorded in the park. Generally, throughout the study period (2001 – 2015), local tourists made up more than 94% of tourists to the park except for 2001 where the number of foreign tourist accounted for about 25.87% of tourists to the park. The variation in both the local and foreign tourist to the park could be attributed to the unstable political situation in the country (Ogunjinmi and Ijeomah, 2010). In their paper, a more detailed information regarding the trend of tourists and the impact of unstable political atmosphere (1996 – 2006) can be found. This situation has affected tourism development in the nation, thus robbing the nation of foreign earnings that could have been derived from the sector.
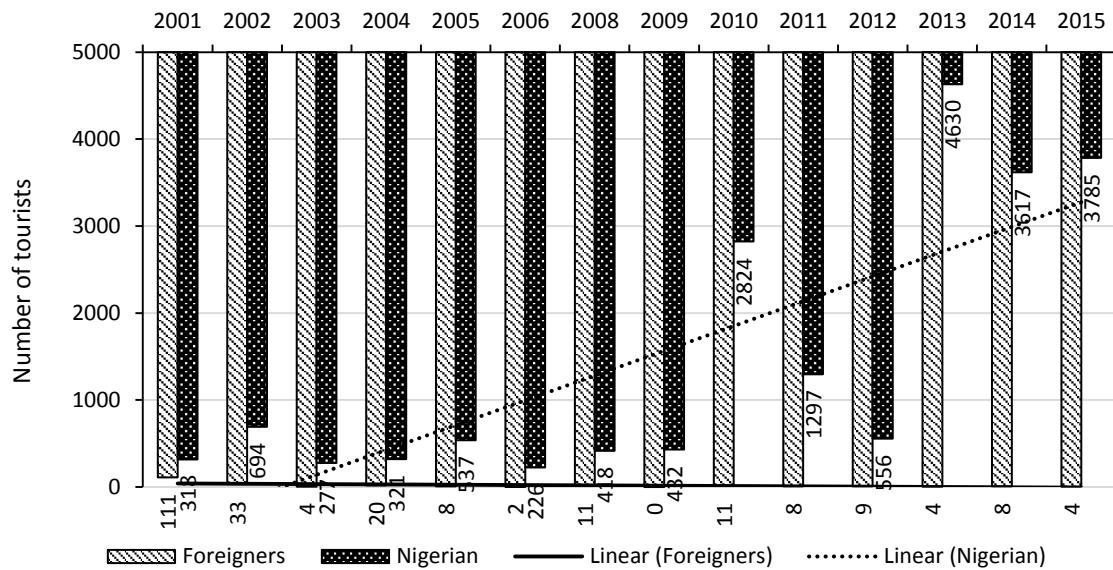
Figure 3: Comparison of Tourist Flow between Locals and Foreigners

Composition of foreign tourists to Old Oyo National Park
The result in Figure 4 shows the nationality of foreign tourists to Old Oyo National Park. Tourists from 24 nations visited the park within the period under review and United States of America (USA) had the highest number of tourists to the study area. This was followed by tourists from Ghana, Germany, Belgium and India with 46, 19, 15 and 11 tourists respectively. The countries with the least number of tourists to the park were Canada, Ethiopia, Finland, France, Holland, Poland, Singapore and South Africa with 1 (one) tourist each respectively. This result agrees with Adebanjo (2010) who reported that the Americans are among the top spending tourists in Nigeria.
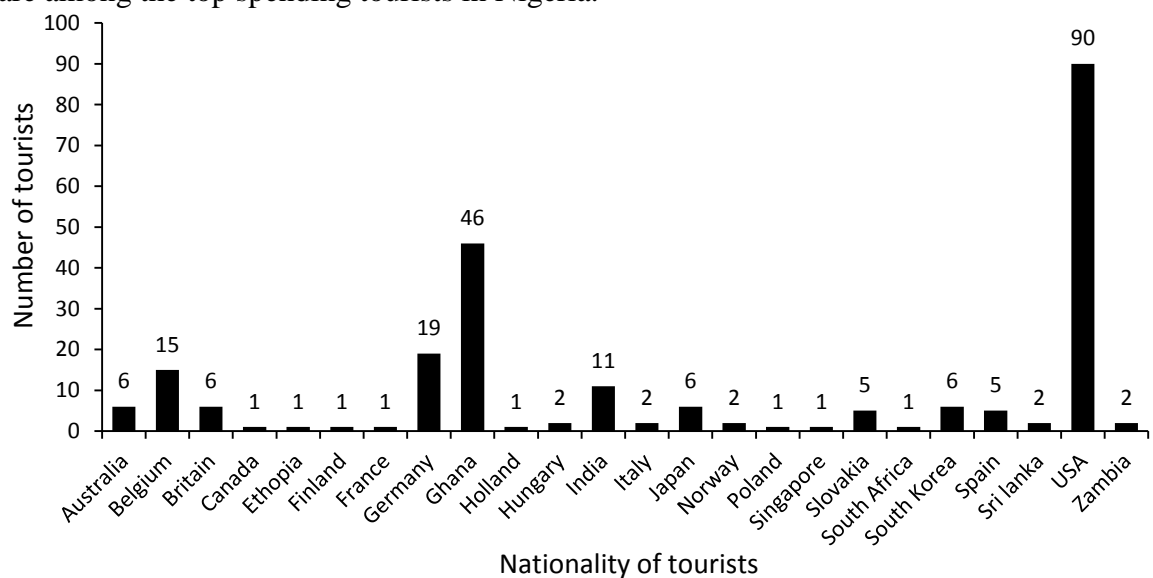
Figure 4: Composition of foreign tourists to Old Oyo National Park

Trend in park revenue in Old Oyo National Park

The result in Figure 5 shows the line and least square composite graphs of the annual revenue trend for Old Oyo National Park. The result indicates that the mean annual revenue for the park was ₦3,938,951.00±2828132. The highest revenue for the park was in 2012 (₦8,291,390.00) followed by 2011, 2015, 2013 and 2014 with ₦6,678,955.00, ₦6,592,069.00, ₦6,324,689.30 and ₦6,202,486.00 respectively. The least revenue was in 2003 with ₦238,825.05. This variation in revenue for the park is statistically defined by the function $y = -1E+09 - 581958x + e$ (p > 0.05) with a coefficient of determination figure of 0.8469 or 84.69%. Also, there existed a very strong correlation between the revenue generated in the park and year (r = 0.9203). This is an indication that revenue generation in the park was directly influenced by yearly activities in the park such as number of tourists, hiring of assets and rents from guest houses. This is in agreement with Ijeomah (2007), Ogunjinmi and Ijeomah (2010), Ajibade*et al*. (2013) and Adejumo*et al*. (2014).
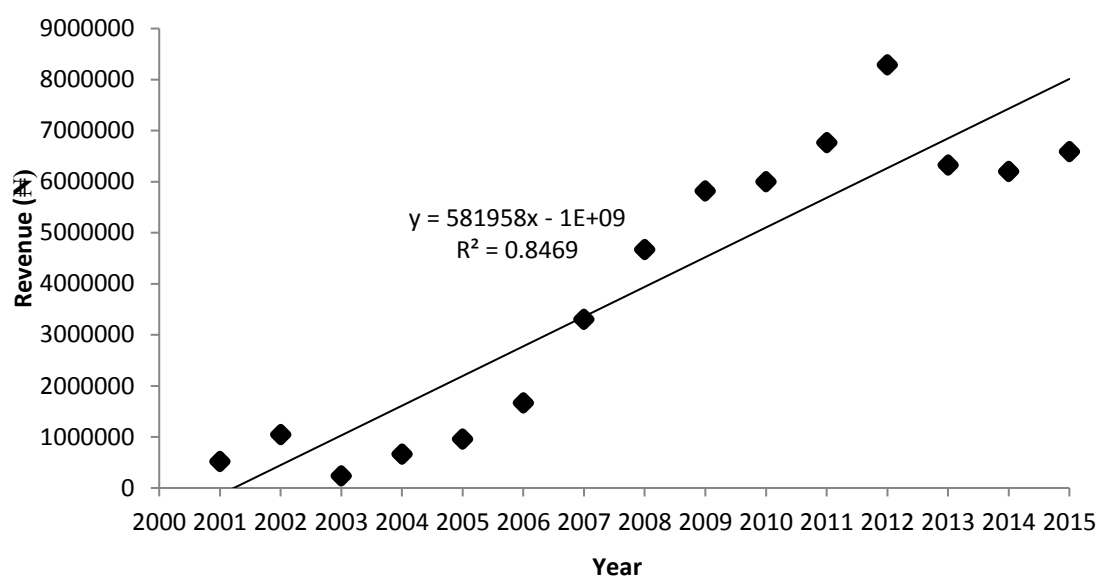
Figure 5: Trend in park revenue in Old Oyo National Park

Revenue composition of Old Oyo National park

The sources of income generated in the park are shown in Table 1. These include guest house for accommodation, catering services, hiring of assets, park entry fees among others. The highest income source (46.37%, ₦27,002,050.00) was from offence fees or charges obtained from illegal poachers in the park. This was followed by fees from hiring of park assets (31.63%, ₦18,415,710.00), accommodation (10.16%, ₦5,916,259.00) and park entry fees (4.49%, ₦4.49), while sales of confiscated animals (0.17%, ₦100, 030.00) accounted for the least revenue source in the study area. This is an indication that a great sum of the park revenue is not from tourist patronage. The huge revenue from offence fees could be attributed to the effectiveness of anti-poaching activities of the park in which offenders are charged to court and their offences compounded for them to make payment as compensation to the park (Jacob .*et. al*, 2018a, b). Also, hiring of park assets to the public especially the green parks in the headquarters to be used as reception venue for occasion and hiring of park vehicle also boosted the park revenue. The high patronage of the park could be attributed to the strategic location of the park office in the city, aesthetic, security and peaceful atmosphere in the park.

Table 1: Revenue composition of old Oyo National Park

Revenue source	Amount (₦)	Percentage (%)
Accommodation	5,916,259	10.16
Catering services	2,200,223	3.78
Park entry fees	2,612,107	4.49
Hiring of assets	18,415,710	31.63
Sales of confiscated item	207,900	0.36
Offence fees	27,002,050	46.37
Sales of confiscated animals	100,030	0.17
Other charges	1,773,710	3.04
Total	**58,227,988**	**100.00**

Correlates of tourist flow in Old Oyo National Park
Table 2 shows the correlation of tourists flow in the study area with park expenditure and revenue generation in the park. The result indicates a weak ($r = 0.2153$) correlation between tourists flow and park expenditure for the study period. This is an indication that the number of tourists visiting the park is not only dependent on the amount of money spent in the park for development but also dependent on other factors such as political stability in a region, insurgency and poor tourism marketing can also influence the flow of tourist to a park (Odunjinmi and Ijeomah, 2010; Jacob *et al.*, 2018a).

There was a strong positive ($r = 0.7251$) correlation between park revenue and tourist inflow in the study area. This implies that the revenue generated in the park is dependent on the number of tourist visiting the park. An increase in the number of tourist to the park will result in corresponding increase in revenue generated in the park. This is in accordance with Ogunjinmi and Ijeomah (2010). However, Adejumo *et al.* (2014) in their assessment of Kainji Lake National Park reported no correlation between revenue generation from ecotourism and tourists flow. This also affirms the observation of Ajibade *et al.* (2013) that the number of tourists in a particular year is not a major determinant of the income generated but the type of tourists and the purpose of the tourists.

Correlation between park expenditure and generated revenue showed a positive strong ($r = 0.6850$) relationship between them. This is an indication that an increase in expenditure in the park will result in a corresponding increase in generated revenue at 68.50%. This is in accordance with Ajibade *et al.* (2013) and Jacob *et al.* (2018b). According to Ajibade *et al.* (2013), the tourist inflow (revenue) in the country can only be improved by developing the national parks. This implies more expenditure for the park in terms of construction and improvement of its available infrastructure, improvement in its anti-poaching activities, enlightenment campaigns and provision of alternative livelihood activities for its support zone communities.

Table 2: Bivariate Correlation of Tourist flow in Old Oyo National Park from 2001 – 2015

	Expenditure	*Revenue*	*Tourist*
Expenditure	1		
Revenue	0.6850	1	
Tourist	0.2153	0.7251	1

CONCLUSION AND RECOMMENDATIONS
Old Oyo National Park has the potentials to attract inflow of tourists to the country as a means of revenue generation to the government. However, this is hampered by the poor funding of the park resulting in poor inflow of tourists to the park. The high rate of illegal

encroachment in the park has destroyed the aesthetic properties of the park, thus requiring the park to step-up its anti-poaching activities to curtail the rate of illegal encroachment in the park in order to safeguard it. Also, there is need for the management of the park to market its tourism potential on a platform that will attract more local and foreign tourists to it so as to generate more revenue for its development.

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LENDING PRACTICES OF MICROFINANCE BANKS AND ITS IMPLICATIONS FOR AGRICULTURAL LENDING

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ABSTRACT

The study assessed the lending practices of microfinance banks to agriculture with particular reference to Edo state, Nigeria. Key objectives included examining the characteristics of MFBs in the State; identifying their lending practices, agricultural loan products and loan portfolio allocated for agricultural lending; as well as the constraints associated with agricultural lending. Data were collected from 18 MfBs in the state, while data analysis was done using descriptive and inferential statistics. Major findings of the study revealed the average staff size of the MFBs was 381average and they have an operational existence of 15 years. Although, the MfBs employed both group (55.6%) and individual (44.6%) lending methods, the preferred lending method was the group method (100%). This preference was informed by guaranteed repayment (83.3%), low default rate (66.7%) and influence of peer pressure in repayment collection (38.9%) associated with the method. Chi-square test ($\chi^2 = 0.222$; p>0.050) suggests that there was no significant difference in the use of individual and group lending practices by the MFBs. However, t-test result (t = 7.96; p<0.050) revealed that the amount of loan disbursed under the group lending method (N85,595,960) was significantly higher than that disbursed under the individual lending method (N32,127,040). Major constraints faced by the bank in agricultural lending include lack of collateral, low educational status of farmers and uncertainty associated with the agricultural sector.

Key words: Lending practices, microfinance bank, agricultural lending

INTRODUCTION

Agricultural development in the country is constrained by several factors notable among which is lack of access to credit facilities. It is estimated that only 2.5 percent of total commercial banks loans and advances is directed at agriculture (CBN, 2008). Even where such credit is available, a major constraint has been the inadequacies of such credit. Many farmers need credit to purchase seeds and other inputs, as well as to harvest, process, market and transport their crops. While borrowing on the basis of anticipated crop production might seem logical where collateral assets are few, such loans expose the lender to production and price risk. Events like natural disaster, a decline in market prices, unexpectedly low yields, the lack of a buyer, or loss due to poor storage conditions are only some of the factors that can result in lower- than-expected revenues (IFAD, 2006). It is therefore obvious that agricultural lending can be notoriously risky if not practiced under lending practices that can mitigate these inherent risks.

According to Okojie *et al*., (2010), the lack of collateral and the cumbersome procedures for accessing credits from commercial banks limit rural farmers' access to credit. The complex mechanism of the commercial banking operations and processes also constitute a significant bottle neck to farmers in accessing credit (Agnet 2004). Microfinance Institutions have therefore risen up in the last few years to bridge the lending gap between the commercial banks and the rural and small-scale farmers.

However, despite the overwhelming reality of the significance of microfinance on agricultural productivity, many MFBs are still highly averse to agricultural lending because of the perceived high risk profile involved in its lending. Even when MFBs are willing to

lend, the lending practices to be adopted becomes a critical issue for consideration. Several literatures therefore argue widely on the reliability of different lending practices (Lehner, 2009).

Objectives of the Study

The main objective of the investigation is to assess the lending practices of MFBs and its implications for agricultural lending. The specific objectives are to:

  i.   Identify the lending practices of MFBs in agricultural lending in the study area;
  ii. Compare the volume of loan disbursed by the MfBunder each lending practice/methodology;
  iii. Examine the reasons for the preferred lending methodology by the MfBs;
  iv. Identify constraints associated with agricultural lending by MFBs.

Hypothesis of the study

The null hypotheses analyzed are stated below:

H$_1$: There is no significant difference in the lending practices used by the different microfinance banks.

H$_2$: The lending practices have no significant effect on the total loans disbursed by the MFBs.

MATERIALS AND METHODS

Study Area and Scope

The study was carried out in Edo State, Nigeria. The choice of study area was based on the presence of microfinance banks that are in operation in rural and urban setting. The State, which was created in 1991 out of the former Bendel State, has a land area of 19,794 square kilometers with an estimated population of 3,218,322 based on the 2006 national census estimate (census 2006). It has 18 local government areas distributed across three senatorial zones and is predominantly a rain forest region. The state is largely agrarian, producing crops such as cassava, groundnut, yam, cocoyam, rice, maize, plantain, rubber, cocoa, oil palm, pineapple, banana, orange and others. A large proportion of the population are engaged in farming, fishing, carving, and trading as well as the public civil service.

Sampling Procedure and Data Collection

The target population for the study was MFBs in the state. Given the small population of MFBs in the state, which was 20 (CBN, 2011) all of them were selected for the study. It excludes non-registered and self-help organizations that provide informal micro-credit services to its clients. The rationale for limiting the study population to only licensed MFBs was to ensure reliability and validity of data that was collected. This was because MFB secondary data on portfolio quality can be verified from their monthly report submitted to the regulatory authorities- CBN and NDIC.

Data Collection Method

Data for the study comprised of both secondary and primary data. Secondary data was collected on proportion of loan portfolio allocated to agricultural while primary data was collected using interview schedule. The interview sessions were held with the MFB's Managing Directors, Head of Operations, or their representatives. The instrument for data collection was the questionnaire. This was structured in such a way as to obtain responses to answer the objectives formulated for the study.

Data Analysis Techniques

Data collected were analyzed by the use of descriptive and inferential statistics. The descriptive statistics included frequency counts, percentages and mean scores. Inferential statistics used include chi-square, t-test and logit regression. Analysis of data was done using the Statistical Package for the Social Sciences (SPSS) version 20.

Logit Regression

The logit regression model was used to determine the MFB characteristics or factors influencing lending practices of MFBs. The Logit model is appropriate for assessing the relationship between several independents variables on a dichotomous or dummy dependent variable i.e. variable having only two options. The regression model predicted the logit, that is, the natural log of the odds of having made one or the other decision (i.e. lending option). That is,

$$\ln(ODDS) = \ln\left(\frac{\hat{Y}}{1-\hat{Y}}\right) = a + bX$$

Where:

Y = is the predicted probability of the event which is coded with 1 rather than with 0 (stop the research),

$1-\hat{Y}$ = is the predicted probability of the other decision,

a = constant term

b = coefficient term

X = is the predictor or independent variable,

The mathematical expression of the model is given as:

$P(Y_i/1 - Y_I) = a + b_1X_1 + b_2X_2 + b_3X_3 + b_nX_n + e$

Where

Y = Lending practices (group method = 1; individual method = 0)

X_1 = MFB length of establishment (years)

X_2 = Staff size (number of staff)

X_3 = Branch network (number of staff)

X_4 = Portfolio size (in naira)

RESULTS AND DISCUSSION

i. MFB's Year of Establishment and Staff Size

Results of Table 1 revealed that the average years of establishment were 15 years with a maximum range of 27 years. The findings suggest that the MFBs have some good experience in microfinance operations. Result of Table 2 reveals that the majority (44.8%) of the MFBs had a staff size of 101 to 200. The average staff strength was 381. Usually the staff strength of the MFBs would deepen their rural outreach i.e. number of clients served (Gonzalez-Vega, 2003).

Table 1: MFB's Year of Establishment

	Frequency	Percent	Mean	SD
1990 & below	4	22.3		
1991 to 1994	3	16.7		
1995 - 1999	5	27.9		
2000 - 2004	3	16.7		
2005 -2009	3	16.7		
Total	18	100	15	6.58

Source: Computed from field survey data, 2014

Table 2: MFB'S Staff Size

	Frequency	Percent	Mean	SD
100 & below	3	16.7		
101 – 200	8	44.8		
301 – 400	4	22.3		
>400	3	16.8		
Total	18	100	381	184.64

ii. MFBs' Sources of Funds

All the MFBs sourced capital from commercial banks (100%) and their clients (100%). The result agrees with the report of Microfinance Gateway (2010) who noted that commercial banks and clients constitute major sources of funds to MFBs usually on lending and savings respectively.

iii. Major Lending Methodology Used

The results in Table 3 indicate that 55.6% made use of group lending methods while 44.4% used individual lending method as their major lending practices. In terms of preference, the table revealed that all of them preferred the group lending method. This result is in consonance with the findings of Lehner (2009) who noted that microfinance institutions favoured group lending because of its higher repayment rate and social security.

Table 3: Lending Methodology Used

	Used		Preferred	
Methodology	Frequency	Percent	Frequency	Percent
Individual method	8	44.4	0	0
Group method	10	55.6	18	100
Total	18	100		

Table 4: Test of Difference in Lending Practices by MFBs (Chi-square)

lending methodology	Observed N	Expected N
Individual method	8	9
Group method	10	9
Total	18	

iv. Determinants of Lending Methodology Used by MFBs (Logit regression)

Based on the t values (Table 5), only staff size and branch network were significantly related to the probability of the MFBs using the group lending methodology. Staff size had a positive coefficient (b = 1.31) implying that MFBs with larger staff size were more likely to adopt the group lending method as against the individual lending method, which was more likely to be employed by MFBs with fewer staff. Kodongo and Kendi (2013) reported a positive relationship between MFB size (such as staff) and preference for group lending

method. The authors noted that individual lending is preferred by microfinance institutions whose goals are to reach out to the poor, to minimize transaction costs and to maintain market share (by pursuing low client dropouts), while MFIs prefer group lending if their goal is to expand in size or to lower delinquency and therefore increase their chance of financial sustainability and long-run survival. Similarly, the coefficient for branch network was positive (b = 0.131), implying that MFBs with more branches in the study area were more likely to embrace the group lending method while those with fewer branches were more likely to embrace the individual lending method.

Table 5: Determinants of Lending Methodology used by MFBs (Logit Regression)

Independent variables	Coefficient (b)	Std. Error	t	Prob. level
Constant	2.093	2.115	0.990	.
Years of experience	0.181	0.343	0.528	0.344
Staff size	1.31*	0.447	2.931	0.037
Branch network	0.131*	0.037	3.541	0.025

Significant at the 5% level (critical t = 2.131)
Goodness of fit test = (χ^2 = 13.332; df = 26; critical χ^2 = 38.885)
Pseudo R-Square = 0.613
-2 Log Likelihood text (χ^2 =15.63; df = 3; critical χ^2 = 7.815)

v. Target Clients of MFBs
From results shown in Figure 1 the major clients of the MFBs were traders (61.1%), farmers (50%) and artisans (38.9%). Micro-entrepreneurs and small and medium scale enterprises were not major targets given their percentage of 22.2% and 11.1% respectively. The result is in line with the findings or assertions of Mwenda and Muuka (2004).who noted that MFBs major clients are small business owners.
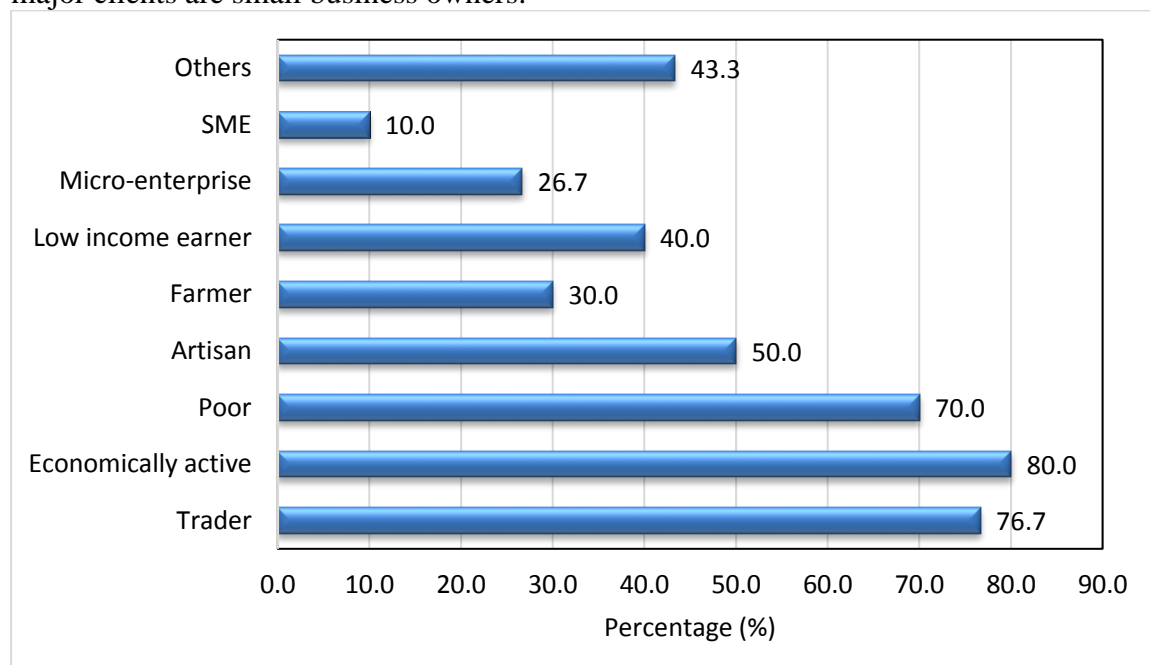

Figure 1: Distribution of target clients of MFBs by percentage

The results shown in Fig. 2 equally showed that MFBs in the State are not contributing effectively to growth of SMEs given their low percentage. Similar observation has been made by Ovia (2007) who noted that MFBs should be encouraged to target SMEs if that

sector is to experience significant growth and expansion. However, Madugu and Bzugu (2012).noted that an important constraint to MFBs intervention in the SME sector is because of the huge capital outlay required to undertake SME projects, which he noted that most MFBs are not financially capable of handling given their capital base.

vi. Reasons for Preferred Lending Method

Results in Figure 2 indicate that the main reasons for the preference of the group method were the guarantee of repayment (83.3%) and low default rate (66.7%). Other reasons include peer pressure associated with group lending practices (38.9%) and access to greater number of clients (22.2%). Similar reports have been given by Lehner (2009) and IFAD (2006) as per reasons why MFBs opt for group lending method as opposed to the individual lending method.
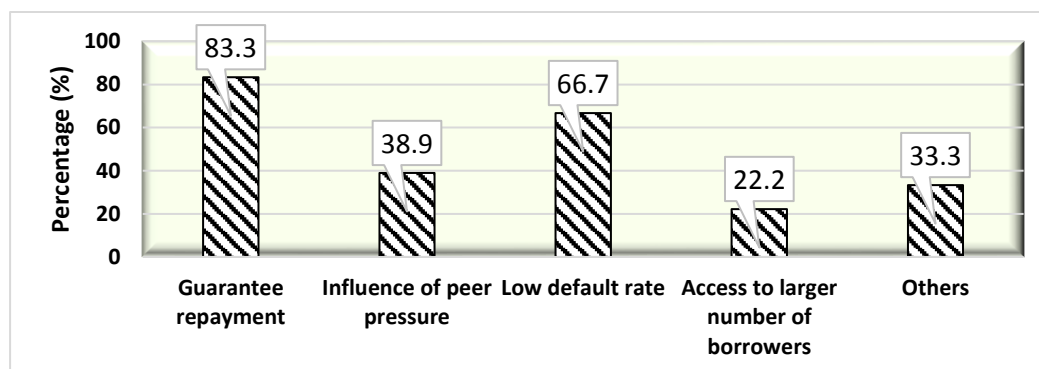
Figure 2: Reasons for MFB preference for group lending methodology (%)

RECOMMENDATIONS

Based on the findings of the study the following recommendations are made:

i. Instead of demanding for physical collateral before loan disbursement to farmers, MFBs can exploit social collateral usually associated with group loan lending practice. This entails the use of peer or group pressure to enhance repayment rate.

ii. To deal with the uncertainty characteristic of the agricultural sector, MFBs should link their farmer clients to insurance agencies whose premium rate should be easily affordable by the farmers.

iii. To make up for the farmers poor educational status, training programmes should be organized for them. Such training should focus on commercial systems of farming in order to encourage the farmers to improve their productivity and economic returns.

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PHYTOCHEMICALS COMPOSITION OF SOME PLANTS SPECIES

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ABSTRACT

In this study the phytochemicals and nutritive important of *Ixoracoccinea, Tectona grandis* and *Durantarepens* as anti-herbivory were determined. The plant samples were cleaned, oven-dried and milled for the phytochemicals analysis according to accepted standard procedures. The phytochemicals data obtained were subjected to analysis of variance (ANOVA). The results obtained indicated that alkaloids, tannins, saponins and cardiac glycosides were present in the extracts of *I. coccinea, T. grandis* and *D. repens*, while terpenoids and flavanoids were only present in *D. repens*. *I. coccinae* had the highest amount of hydrogen cyanide, tannin, phytate and oxalate (soluble and total) compared to the amount found in. *grandis and D. repens*. The presence of terpenoids and flavanoids in *D. repens* deter animals from grazing on it. Thus, it is recommended that *D. repens* plant be used for landscaping in areas prone to browsing by animals.

Keywords: *Durantarepens, Tectona grandis* and *Ixoracoccinae,* phytochemicals, Alkaloid

INTRODUCTION

Feeding animals is aimed at meeting their nutritional requirements for maintenance and production depending on the species, size and stages of development and production (Fiem *et al*., 2015; Johnson *et al*., 2016). The quality of feeds taken by animals to meet their nutritional requirement depends on palatability, digestibility and nutrient density of the feeds (Van, 2006). Most feeds are natural substances made up of organic matter from grasses, legumes; leaves of tress or plant in the form of browse plants (Yahya *et al*., 2000), with little composition of inorganic mater.

Browses are important nutrient provider for grazing ruminants in the arid and semi-arid environments where inadequate feeds are a major constraint for livestock production (Aganga and Tshwenyane, 2003). These forages form part of the complex interactions between plants and animals (Aganga and Tshwenyane, 2003). These interactions could help in balancing plant-animal-soil ecosystem to serve as a sustainable source of feeds for animals (Devendra, 1994). The availability of varieties of feeds and the selection process enables herbivores especially the goats to meet their feed preferences.

The preference of one plant species over another by animals could be attributed to the presence or absence of certain nutritional substance in the plant. Previous studies reported that plants have evolved a plethora of different chemical defenses covering nearly all classes of (secondary) metabolites that represent a major barrier to herbivory (Mithofer and Bolland, 2012). Some defense mechanisms exhibited by animals are constitutive, while others are induced after attack. Several compounds act directly on the herbivore, whereas others act indirectly via the attraction of some organisms from other trophic levels that in turn, protect the plant. According to Mithofer and Bolland, (2012) some chemical constituents in plants include alkaloids, cyanogenic glycosides, glusinolates, oxalates and terpenoids,while others are macromolecules which comprise latex or proteinase inhibitors Their modes of action include membrane disruption, inhibition of signal transduction process and metabolism, or disruption of the hormonal control of physiological processes. The recognition of herbivore challenge and the precise timing of plant activities as well as

the adaptative modulation of plant's metabolism is important inorder for metabolites and energy to be efficiently allocated for defense activities (Mithofer and Bolland, 2012).

The objective of this research was to evaluate the reason some ruminants fed extensively on *Ixoracoccinae* and *Tectona grandis* plants but fed less on *Durantarepens* plant. The phytochemicals of *Ixoracoccinae*, *Tectona grandis* and *Durantarepens* were determined to ascertain the natural compounds present in the plant species.

MATERIALS AND METHODS

Study Area

Ixoracoccinae, *Tectona grandis* and *Durantarepens* used in this study, were obtained from the Faculty of Agriculture, University of Uyo (latitude 4°30′Nand longitudes 7°31′Eand 8°20′E), Uyo in Akwa Ibom State, Nigeria.

Sample collection and preparation

Fresh leaves of *Ixora coccinae*, *Tectona grandis* and *Duranta repens* plants were collected from avenue plants in the Faculty of Agriculture, University of Uyo. The samples were washed with distilled water to remove impurities and dust particles and then oven-dried at 65°C, the oven-dried samples were transformed into chips and then milled. The milled samples were kept in air-tight plastic containers for phyto-chemicals analysis according to Ahmed *et al*. (2013). One gram of the milled samples was macerated in 50% aqueous ethanol according to the method used by Sofowora (1993). The liquid extract was recovered by filtration using cotton wool and glass funnel. The filtrate obtained was concentrated in a vacuous at 400ºC to yield semi-solid mass. The extract obtained was weighed and used for phytochemicals screening.

Qualitative Phytochemical Tests

i. *Alkaloids Test:* About 0.5g was stirred with 5ml of 1% aqueous HCl on water-bath and then filtered. 1ml of the filtrate was measured into two test-tubes. In the first test-tube, few drops of Dragendoff's reagent were added and the occurrence of orange-red precipitate was taken as positive. In the second test-tube 1mlmayer's reagent was added and of buff-colored precipitate indicated the presence of Alkaloids (Sofowora, 1993).

ii. *Tannins test:* 0.5g of the sample was stirred with 10ml of distilled water and then filtered. Few drops of 1% Ferric Chloride solution were added to 2ml of the filtrate, the occurrence of a blue-black, green or blue-green precipitate indicated the present of tannins (Trease and Evans, 2002).

iii. *Anthraquinones test (Borntrager's test for free Anthraquinones):* 0.2g of the sample was shaken with 10ml of benzene and then filtered. 5ml of 10% ammonia solution was then added to the filtrate and shaken. The appearance of a pink, red or violet color in the ammoniacal (lower) phase indicated the present of free anthraquinones (Sofowora, 1993).

iv. Combined anthraquinones test: two separate samples 1g was boiled with 2 ml of 10 % hydrochloric acid for 5 minutes. The mixture was filtered while hot and the filtrate was allowed to cool. The cooled filtrate was partitioned against equal volume of chloroform and the chloroform layer was transferred into a clean dry test tube using a clean pipette. Equal volume of 10% ammonia solution was added into the chloroform layer, shaken and allowed to separate. The separated aqueous layer was observed for colour change; delicate rose pink colour indicated the present of anthraquinone (Sofowora, 1993).

v. *Cyanogenic glycosides test:* Also, 0.5g was measured into three test tubes labeled A, B and C. The samples in test-tubes A and B were mixed with 5 ml of water, and sodium picrate test paper was suspended in each of the three test-tubes. The test-tubes were stoppered immediately; test-tube B was placed in boiling water bath for five minutes while test-tubes A and C were kept at room temperature (Sofowora, 1993).

vi. Phlobotannins test: Extract of each plant sample was boiled with 1% aqueous hydrochloric acid. Red precipitate was evidence of phlobatinins presence (Sofowora, 1993).

vii. Liebermann-Buchard tests for steroids: 0.2g of sample was added to 2ml of acetic acid, the solution was cooled well in ice followed by addition of H_2SO_4. Color development from violet to blue or bluish-green indicated the present of a steroidal ring i.e. aglycone portion of cardiac glycoside (Sofowora, 1993).

viii. Terpenoids test: Two separate samples 0.5g each was dissolved in ethanol. In the first sample 1ml of extract was dissolved in ethanol. In the second sample 1ml of acetic anhydride was added followed by the addition of H_2SO_4. A change in colour from pink to violet indicated the present of terpenoids (Sofowora, 1993).

ix. Flavonoids test (Ferric chloride test):
0.5g sample was boiled with distilled water and then filtered. Few drops of 10% ferric chloride solution were added to 2ml filtrate. A green-blue or violet coloration indicated the present of a flavonoid (a phenolic hydroxyl group) (Trease and Evans, 2002).

Qualitative analysis of anti-nutrients
i. Tannin: Tannin was determined by the method of Trease and Evans, (1978). 1 ml of the methanolic extract was treated with 5 ml Folin Dennis reagent in a basic medium and allowed to stand for colour development. The absorbance of the reaction mixture of each sample was measured at 760 nm spectrophotometrically.

ii. Hydrogen Cyanide: 1g sample was dissolve in 50ml of distilled water in a corked flask and was allowed to stay overnight. The solution was filtered and the extract was used for cyanide determination. 1ml of the filtrate was corked in a test tube and 4ml of alkaline picrate was added and incubated in a water bath for 5minutes after color development, the absorbance was read in spectrophotometer at 49 nm with the blank.

iii. Oxalate: Total oxalate was determined according to Day and Underwood, (1986) procedure. One gram of the sample was added to 75 ml of 15 N H_2SO_4. The solution was stirred intermittently using magnetic stirrer for 1 h and then filtered filtered. 25 ml of the filtrate was collected and titrated against 0.1 N $KMnO_4$ solutions till a faint pink colour appeared that persisted for 30 second.

iv. Phytate: Phytate was determined using Reddy and Love, (1999) method. 4 g of the sample was soaked in 100 ml of 2% HCl for 5 hour and filtered. 25 ml of the filtrate was added to5 ml 0.3% ammonium thiocyanate solution. The mixture was then titrated with Iron (III) chloride solution until a brownish-yellow color that persisted for 5 minutes was obtained.

v. Saponin: Saponin was determined using the method of Birk *et al.* (1963). About 20 ml of 20% aqueous ethanol was added to 10 g of the sample and stirred using a magnetic stirrer for 12 h at 55°C. The solution was then filtered and the residue re-extracted with 200 ml 20% aqueous ethanol. The extract was reduced to 40 ml under vacuum and 20 ml diethyl ether added in a separating funnel and shaken vigorously. The aqueous layer was recovered and ether layer discarded. The pH of the aqueous solution was adjusted to 4.5 by adding NaOH, and the solution shaken with 60 ml n-butanol. The combined butanol extracts were washed twice with 10 ml of 5% aqueous NaCl and evaporated to dryness in a fume cupboard to give a crude saponin.

Statistical Analysis
Analysis of variance (ANOVA) were performed using SPSS Software version 15 and significant mean values were separated by least significant difference (LSD) at 0.05 level of probability

RESULTS AND DISCUSSION

i.   Qualitative screening of samples

The bioactive components of the phytochemicals screening of *Ixoracoccinae*, *Tectona grandis* and *Duranta repens*, are presented in Table 1. The results indicated that alkaloids (++), tannins (+++), saponins (+) and cardiac glycosides (+) were present in the extracts of the three plant species. Phlobotannins (+) was only present in *Duranta repens and Ixora coccinae,* combined anthraquinones (+) was only present in *Tectona grandis*, while free anthraquinones and cyanogenic glycosides were not present in any of the plant species.

Terponoids were absent in both *T. grandis* and *I. coccinae* but was present in *D. repens*. Previous studies on terpernoids according to Zho *et al*., (1992) and Van Etten *et al*., (2001), reported that terpenes composed of 5-C isopentanoid units, are toxins and feeding deterrents to many herbivores. Gershenzon and Croteau (1991) reported that terpenes are toxins and feeding deterrents to many herbivorous insects and mammals; thus they play important defensive roles in the plant kingdom. These works established the fact that the presence of terpenoids in *D. repens*may likely be the reasons animals do not extensively browse on it.

On the other hand, saponins was excessively present in *D. repens* (+++) when compared to *I. coccinae* and *T. grandis*. Acccording to Francis *et al*. (2002) and Podolak *et al*. (2010) the presence of saponins in high quantities in plants may have detrimental effects on ruminants that feed on them. Their reports asserted that excessive presence of saponins in *D. repens* may likely be one of the factors deterring herbivores from feeding the plant.

The present of flavonoids in *D. repens* and absent in *I.* coccinae, and *T. grandis* is the reason for the non-herbivory of the plant species. Coley and Kursar (1996) reported that foliar anthocyanin is responsible for plant resistance to herbivore. They further stressed that flavonoids plays important role in the protection of plants against plant feeding insects and herbivores. Furthermore, Harborne and Williams (2000) and Kimball and Provenza (2003) reported that flavonoids are one of many plant toxins that even in small concentrations may deter herbivory.

Table 1: Qualitative phytochemicals screening of samples

| Species | ALK | TAN | SAP | TERP | FLAV | Cardiac glycosides | | | FA | CA | CYA | PHL |
						SALK	KK	LM				
Ixora coccinae	++	+++	+	–	–	–	–	+	–	–	–	–
Tectona grandis	+++	+++	+	–	–	+	–	+	–	+	–	+
Durantarepens	+++	+++	+++	+	+	+	–	+	-	-	–	+

ALK - Alkaloids, TAN - Tannins, SAP - Saponins, TERP - Terpenoids, FLAV - Flavanoids, SALK - Salkwoski, KK - Keller Killiani, LM - Lierber Mann, FA - Free Anthraquinones, CA - Combined Anthraquinones, CYA - Cyanogenic glycoside, PHL - Phlobatannin

+++ = present in large amount, ++ = present in moderate amount, + = present in small amount, and - = Not present

ii.   Anti-nutritional properties of the samples

The hydrogen cyanide (HCN) levels in the plants ranged from 0.847 to 2.650% and were significantly different at 1% probability level (Table 2). *I. coccinae* had the highest HCN content (2.650%) followed by *D. repens* with (1.219%) and *T. grandis* with the least HCN content (0.847%). This result is in line with the result reported by Kumar and D'Mello (1995) and Siegler *et.al.* (1989) they asserted that many eatable plants are cyanogenic. However, the quantity of HCN produced by some plants were very low to pose major animal health problems. Smith (1992) reported that HCN levels below 50 mg / kg maybe harmless to farm animals.

The Oxalate content was categorized into two in this study; total and soluble oxalate. The total oxalate content ranged from 123.80 to 279.87% (Table 2), while soluble oxalate content ranged from 76.53 to 107.30%. *I. coccinae* had the highest soluble oxalate content (107.30%), followed by*D. Repens* (86.29%) while *T. grandis* had the least (76.53%). Total oxalate content was significantly different ($p < 0.01$) among the plant species. *I. coccinae* had the highest total oxalate content (279.87%) and *T.grandis* had the least (123.80%).

Tannin content indicated considerable difference in the nutritional quality among the three plant species considered in this study. Tannin level in *I. coccinae* (77.76%) was distinctly higher in comparison with tannin levels in *T. grandis* (13.00%) and *D. repens* (36.01%). Arthun *et al*. (1992) reported that tannin concentrations increased as the season progressed and attributed it to factors such as rainfall, temperature and humidity which may be peculiar to different locations (Singh, 1984; Oduguwa *et al*., 1998). Differences in season and stage at which these plant species were harvested could affect the nutritional properties of the sampled plants.

Phytate level in the *I.coccinae*, *T. grandis* and *D. repens* were significantly different ($p < 0.01$) and ranged from 2.45% to 0.93%. *I. coccinae* (2.45%) had the highest phytate content compared to *D. repens* (1.56%) and *T. grandis* (0.93%) respectively. This result is in accordance with Akinmutimi and Abasiekong (1997) who reported that the presence of phytate in a plant usually interferes with the utilization of mineral elements in the plant by forming compounds with anions and proteins, therefore making the plant less nutritional.

Table 2: Anti-nutritional properties of the samples

Plant species	HCN	Oxalate (Soluble)	Oxalate (Total)	Tannin	Phytate
Ixora coccinae	2.65±0.02**a**	107.30±3.44**a**	279.87±5.67**a**	77.76±0.22**a**	2.45±0.19**a**
Tectona grandis	0.84±0.03**b**	76.53±4.51**b**	123.80±5.96**b**	13.00±0.16**b**	0.93±0.07**b**
Duranta repens	1.22±0.03**c**	86.29±1.30**c**	183.08±1.30**c**	36.01±0.24**c**	1.56±0.19**c**

Means with the same subscript within columns are not significantly different from each other at $p < 0.01$

CONCLUSION

Plants protect themselves by producing some compounds called secondary metabolites which act as repellants or toxins to herbivores or insects and environmental stress, including reducing its digestibility by livestock. The present of terpenoids, flavonoids and saponins in *Duranta repens* served as anti-herbovory chemicals , thus making the plant not to be susceptible to animal attack with regards to *Ixora coccine*a and *Tectona grandis.* Furthermore, the presence of phytate in *D. repens* made it less nutritious to animals which graze on it. This study therefore recommends the use of *D. repens* as a suitable ornamental plant for landscaping in territories where there are livestock which browse and destroy plant materials used as ornamentals.

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EVALUATION OF THE DIFFERENT TYPES OF PESTICIDES USED IN GIWA AND SABO-GARI LOCAL GOVERNMENT AREAS OF KADUNA STATE

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ABSTRACT

The research was conducted in Sabo-gari and Giwa Local Government Areas of Kaduna state, to Evaluation the type of pesticides used in the study area for agricultural production. A combination of well-structured questionnaire and interview were used for data collection. A total number of 119 questionnaires were administered. Information on type of pesticide used, reason for choosing the pesticide, method of applying the pesticide and duration of post application storage, were collected. The data collected were subjected to descriptive statistics such as means, frequency and percentages. The survey reveals that majority (87.5%) of respondents were involved in selling of maize, sorghum and cowpea and the most used pesticide in the market is alumsinium phosphide marketed as phostoxin. Fifty three percent (53%) of respondents applied pesticides by fumigation and the choice of these pesticides was base on customary practices and thirty six point one percent (36.1%) of them stored their produce for less than a month before being disposed off to consumers. Banned pesticides are still in use in the visited markets and the use of banned pesticide should be prohibited and extension scheme on the use of pesticide on agricultural produce should be intensified by government. This will help to educate pesticide users on the use of pesticides and its health implications. Consumers are also implored to wash their food very well before consumption so as to remove pesticides that may be present on the seed coat or surface of food produce.

Keywords: Evaluation, consumers, pesticide, fumigation.

INTRODUCTION

Pesticide are toxic substance used in killing pest or a substance used for destroying insects or other organisms harmful to cultivated plants or to animal. Farmers use different types of pesticides such as organochlorines, organophosphorus, carbamate and pyrethroid insecticides, fungicides and herbicides against the possibility of a devastating crop loss from pests and diseases, as well as to increase agricultural productivity to provide adequate food supply for the increasing world population (Galloway, 2013). In recent time, there has been a rapid increase in the quantity and use of pesticides in the agricultural sector and this growth trend is expected to continue for the next decades due to several socio-economic and technological developments (Bempah, 2011). However, pesticides use has also been associated with several concerns, including the potential risks to human health from both occupational and non- occupational exposures, the death of farm animals and alteration of the habitant (Mansour, 2011). Many of these pesticides can cause moderate to severe respiratory and neurological damage or act as genotoxic, carcinogenic and mutagenic agents, endocrine disruption, etc., through routes that include consumption of dietary residues (Hayat, 2011).Many pesticides and their residues are also known to be contributory factors in several diseases such as cancer, heart diseases. The majority of these diseases mostly occur in developing countries, although far greater quantities of pesticides are used in the developed countries (Bhanti, 2014).

Agricultural production in Nigeria has been facing a lot a problems resulting in high crop losses due to the menace of pests and diseases. (Darko, 2014). Numerous indices can

be used to predict pesticide residues intake. The Maximum Residue Limit (MRL) is one of the indices for detecting the concentration of pesticide residue (mg/kg) on food commodities and animal feeds (FAO/WHO, 2004). Others include the Acceptable Daily Intake (ADI) which is the estimated amount of a substance in food that can be ingested daily over a lifetime without appreciable health risk to the consumer (Banik, 2012). The Estimated Daily Intake (EDI) of a pesticide residue in a given food is obtained by multiplying the residue level in the food by the amount of that food consumed (Choi, 2010). EDI of pesticide residues should be less than its established (Darko, 2014). The Hazard Risk Index (HRI) is applied to assess the potential health risk from consumption of pesticide residues containing foodstuff. (Solecki, 2014).

However, due to indiscriminate use of pesticides as a result of its easy availability, relatively cheap cost and ease of application, concerns about it has been raised (Chowdhury, 2012). Actually, pesticide residues in food and crops are as results of application of pesticides to agricultural field and to a lesser extent from pesticide residues contaminating the soil (Businelli, 2015). Moreover, most farmers do not wait for the withdrawal period after pesticide application due to high demand of farm products and low perception of the toxic effects of pesticide residues in food (Amoah, 2014). Thus, increased use of pesticides in agriculture has resulted in the occurrence of its residues in food commodities that has always been a matter of serious concern especially when these commodities are consumed fresh (Darko, 2014). Hence, the objectives of this study are to evaluate the different types of pesticides used and to determine the method of application of these pesticides by local market men and women in preserving selected agricultural produce (maize, cowpea, soya beans) in Sabon-gari and Giwa local Governments.

MATERIAL AND METHODS
Study Areas
The study was conducted in Sabon-gari and Giwa local governments of Kaduna state. Sabon-gari local Government area is situated between Latitude: 11.03818^0 N to 11.04218^0N and Longitude: 7.70454^0 E to 7.90454^0E. There are about 50 villages and 6 districts in Sabon Gari local government. The area is characterized by alternating dry and wet season with mean annual rain fall of 110mm.the rain duration is about five month beginning in May and ended in October. The mean daily minimum and maximum temperature are 19^0C and 37^0C, respectively. The condition is suitable for the crop grown in the area. Examples of such crop include cowpea, sorghum, maize, soya beans, millet, groundnut and vegetable.

Giwa local government is one of the 23 local government area in Kaduna state which was created out of IGABI local government local government area in September 15, 1991 by general I.B babangida administration. Giwa local government area is situated between latitude 11.20^0N to 11.42^0N and longitude 7.05^0E to 7.40^0E and bounded on the northern part of funtua and malunfashi local government as well as Faskari local government area of katsina state. It is situated north west of Zaria in the transition zones between northern Guinea savanna and Sudan savanna and in the east by Danja local government area of katsina and Kudan local government area.

There are about 41 village and 11 districts in Giwa local government. The area is characterized by alternating dry and wet season with means annual rainfall of 110mm. the rain fall duration lasted for about five month from may-September. The mean daily minimum and maximum temperature are 19^0C and 35^0C, respectively. Major crop cultivated in the area are sorghum, cowpea, maize, soya beans, millet, groundnut, vegetable and yam, tomatoes, pepper, onion, wheat, lettuce, carrot, garden egg, maize, amaranthus and sugarcane.

Sampling Techniques and Sample Size

The study was carried out in Sabon-gari and Giwa local government areas .Giwa market which is under Giwa district and their market day is always Thursday and Sunday and Sabon-gari market which is under Zaria district were purposively selected due to high availability of storage produce. Forty-four marketers were randomly selected from the Sabo market market and seventy five marketers were also selected randomly from Giwa market given a total sample size of 119 respondents.

Collection of Primary Data

Questionnaires were used to conduct oral interviews from market seller on the type of pesticide use, the mode of application, choice for choosing pesticide and length of storage after pesticide application.

Data Analysis

Data collection from the questionnaires were summarized using frequencies percentage and description statistics, with the aid of statistical package for social package for social sciences (SPSS version 15.0)

RESULTS

Sources of information

Table 1 shows the source of information of respondents. The table reveals that 21.8 % of the respondent sot their information from extension agents, 42.0 % from open market, 24.4 % from friends, 3.4 % from non- governmental organization and 1.7 % from agro service centers. From the table it can be deduce that most of the respondents got their information from open markets. This finding is consistent with Akarue and ofoegbu (2012) who reported that the major problem of rural farmer is lack of proper information.

Table 1: Sources of information of respondents

	Frequency	Percentage%
Non response	8	6.7
Extension agents	26	21.8
Open market	50	42.0
Friends	29	24.4
Nongovernmental Orgnisations	4	3.4
Agro-service centre's	2	1.7

Agricultural produce stored by farmers

Table 2 shows the common agricultural produce being stored by respondents. The result shows that 73.1 % of the respondents stored cowpea, 0.8 % respondent stored both cowpea and maize, 0.8 % respondents stored both cowpea and sorghum. 3.6 % of respondent stored maize, 0.8 % respondents stored maize and cowpea, 8.9 % respondent stored maize and sorghum, 4.7 % of the respondent stored millet, 1.6% stored both rice and cowpea, and 1.9 % stored sorghum. This agrees with findings of lawal (2012).

Table 2: Common agricultural produce been stored by the respondents

	Frequency	Percentage %
Cowpea	87.0	73.1
Cowpea and maize	1	0.8
Cowpea and sorghum	1	0.8
Maize	5	3.6
Maize and sorghum	6	8.9
Maize and millet	2	0.8
Millet	5	4.7

Rice and cowpea	6	1.6
Sorghum	6	1.9
Total	**119**	**100.0**

Pesticide application training

Table 3 shows respondents that receive pesticide application training. It shows that 54.6 % of the respondent had received pesticide training, while 31.9 % of the respondents did not receive pesticide training. Other studies revealed that illiterate application of pesticide led to pesticide residue in the study area.

Table 3: Respondents that receive pesticide application training

	Frequency	Percentage %
Non response	16	13.4
Yes	65	54.6

Pesticides used for storage

Table 4 shows the pesticide used by the respondents for storage. The table revealed that 48.7 % of the respondents use phostoxin for storage of their agricultural produce. This was followed by 24.4 % who used dichlorvos, 8.4% used lambdaccyhalothrin, 8.4 % use cypermethrin, 2.5 % used cold package material and 3.4 % who used dieldrin for storage. This agrees with the finding of Babangida (2013) who reported that most of consumed agricultural produce had been stored with dangerous chemical to increase their life shell.

Table 4: Pesticides used for storage by the respondents

	Frequency	Percentage%
Non response	1	0.8
Phostoxin	58	48.7
Chlovors (DD Force)	29	24.4
Lambdaccyhalotythrin	10	8.4
Cypermenthrin	10	8.4
Cold package material	3	2.5
Dieldrin	4	3.4
Profenofos	4	3.4
Total	**119**	**100.0**

Reasons why respondents choose the pesticide for agricultural produce.

The result in Table 5 shows that 6.7 % of the respondents did not respond to why they preferred a certain type of pesticide. However, 8.4 % of the respondents chose pesticide to use based on custom, about 61.3 % of respondents chose the selected pesticide based on its availability, 2.1 % respondents chose their preferred pesticide based on ease of application and 1.7 % do not apply pesticide.

Table 5: Reasons for choosing the pesticide used by respondents

	Frequency	Percentage%
Non response	8	6.7
Custom	10	8.4
Availabity	73	61.3
Ease of application	26	21.8
Not application	2	1.7

Duration of pesticide after application
Table 6 shows that 5.9 % of the respondent did not respond to the question, while 1.7 % of them stored their produce for less than one month after pesticide application, 20.2 % stored their product for 1 month after pesticide application, 36.1 % stored for 2 month after pesticide application,18.5 % stored their product for 3 month after pesticide application, 14.3 % stored it for 4-6 months after pesticide while the last proportion (3.4%) of respondent store for more than 9 months after application of pesticide.

Table 6: Duration of pesticide after application

	Frequency	Percentage%
Non response	7	5.9
Less than one month	2	1.7
1 month	24	20.2
2 month	43	36.1
3month	22	18.5
4-6 month	17	14.3
More than 9 month	4	3.4

Mode of application of pesticide
About 76 % of the respondents applied pesticide by fumigation, 40.0 % applied their pesticide by spraying and 3.0% respondent did not respond to the question.

Table 7: Mode of application of pesticide by respondents

	Frequency	Percentage%
Non response	3	2.5
Fumigation	76	44.0
Spraying	40	53.5

CONCLUSION

Most of the respondents deal in selling maize, cowpea and sorghum and the most common pesticides used were phostoxin and Dichlovors (DDVP). Majority of the respondents applied their pesticides on their Agricultural produce by fumigation. Furthermore, many of the respondents sold off their products not long after application of pesticides to their products without considering the withholding period as they are all concerned or after the supply of their produce to consumers based on demand.

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