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Agricultural Land-Use Effects on Soil Cation Exchange Capacity, Organic Carbon and Total Nitrogen in Soil Aggregate Sized Fractions in Ile-Ife, Nigeria

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Abstract
The study determined the distribution of organic carbon (OC), cation exchange capacity (CEC) and total nitrogen (TN) associated with soil aggregates across land use types in Ile-Ife, Nigeria. Six agricultural land-use types were considered which were undisturbed secondary forest, continuously cropped land, paddock, oil palm, cocoa and teak plantations at the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife, Nigeria. Soils samples were randomly collected from each land use at 0-15 and 15-30cm soil depths in three replicates. The samples were segregated into four aggregate classes; <63μm, 63-250μm, 250μm-1mm and 1-2mm respectively. The following analyses were carried out on the whole soil: particle size distribution, soil pH, CEC, OC and TN while CEC, OC and TN were carried out on different soil aggregate fractions. Data obtained were subjected to analysis of variance using SAS software and means were separated using Duncan's Multiple Range Test at $p \leq 0.05$. Results showed that OC, TN and CEC were more associated with smaller sized soil aggregates (<250μm) across all the land-use types, except under oil palm plantation, which had most of its SOC associated with 1-2mm sized soil aggregate. In the whole soil, continuously cultivated land had the least OC and TN while secondary forest surprisingly had the least CEC. The study revealed that aggregate size <250μm contributes the most to soil nutrient available. Therefore, conservative land-use practices (such as conservative tillage, mulching, manuring etc.) that protect the loss of soil micro-aggregates (<250μm) especially to erosion should be adopted for sustainable land-use.

Keywords: Organic carbon, Land- use, Soil aggregate and Soil nutrient.

Effets de l'utilisation des terres agricoles sur la capacité d'échange cationique du sol, le carbone biologique et l'azote total dans les fractions granulométriques du sol à Ile-Ife, Nigéria

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Résumé
L'avenir de l'agriculture biologique au Nigeria dépend dans une large mesure de la demande de produits biologiques par les consommateurs. Cependant, les consommateurs peuvent ne pas

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exiger des produits dont ils ne sont pas au courant ou sur lesquels ils disposent d'informations limitées. Dans cette étude, l'évaluation de la notoriété des produits alimentaires biologiques a été réalisée. La procédure d'échantillonnage à plusieurs degrés a été utilisée pour sélectionner 120 répondants utilisés dans l'étude. Des données primaires ont été collectées sur la connaissance par les répondants des aliments biologiques et des caractéristiques socio-économiques qui ont été analysées à l'aide de statistiques descriptives (fréquence, pourcentage, moyenne et type d'écart) et d'une analyse de score composite. Les résultats ont montré que 55% des répondants étaient des femmes avec un âge moyen et une taille de ménage de 49 ± 12 ans et 4 ± 1 personne, respectivement. Moins de 50% des répondants savaient que les aliments biologiques sont plus naturels avec un goût de qualité (43,3%) et sans conservateurs (49,2%), leur production est respectueuse de l'environnement (43,3%) et leur consommation favorise une vie saine (35,8%). Le niveau de sensibilisation des répondants était élevé avec environ 39,2% et 50% des répondants ayant des niveaux de sensibilisation élevés et modérés, respectivement. Les résultats de la désagrégation du niveau de connaissance selon certaines caractéristiques ont révélé que le niveau de sensibilisation était plus élevé chez les femmes (40,9%), les jeunes (50,0%), ayant fait des études secondaires (46,9%) et à revenu élevé (48,6%). L'étude a donc recommandé que plus d'éclaircissements et d'éducation sur les attributs et l'importance des produits alimentaires biologiques, en particulier parmi les hommes sans instruction, à faible revenu et les membres plus âgés de notre société.

Mots clés: produits chimiques synthétiques, aliments biologiques, consommateurs, organisme génétiquement modifié.

Introduction

Profitable agriculture needs proper management of land and soil resources on a sustainable basis. Soil physical and chemical properties often decline with conversion of forest to arable farm. Mostly, frequent cropping reduces soil aggregate stability, causes loss of soil organic carbon and total nitrogen, increased compaction and bulk density (Chisci and Zanchi, 1981; Paul *et* al., 2017; Akinde *et al.*, 2020). Hence, soil management practices should be geared towards understanding how soil quality can be maintained and enhanced (Weil and Islam, 2000). Soil management practice is an essential factor in sustaining soil quality which depends on the knowledge of soil response to land-use practices over time (Gelaw *et al.,* 2013). Agricultural land-use is when a typical land is devoted to crop production, rearing of livestock and fish farming to produce food for human. For the land to bring out its best produce, soil structure, its aggregate, water movement and nutrient availability within the soil are essential within the soil.

Soil structure refers to the arrangement of soil particles and voids spaces in them. It influences retention and transmission of fluids in the soil including aeration and infiltration. It can also be termed as shape and size arrangement as well as packing of particles into identifiable units called aggregates or peds. Soil aggregate is a discreet unit of soil particles bound to one another as separate from adjacent particles. The space between the aggregates provides pore spaces for exchange of air and water retention. Good soil aggregation is usually most desirable for plant growth especially in the critical stage of germination and seedling establishment. Oades and Water (1991) and Schmidt *et al*., (2011) proposed that micro aggregates are within the size range of less than (<) 20-250μm. Snyder and Vazquez (2005) also reported that in micro-aggregate of 63-250μm in diameter, bonding is generally strong enough that the aggregates are stable to slaking upon direct immersion of air-dry soil into water. Differentiation of soils by aggregate size distribution have been used to evaluate impacts of land-use (Jastrow, 1996). Land-use and management affect soil aggregation and aggregate stability (Cerda, 2000). At the microscopic level, clay and organic matter act as bridges between the sand and silt particles, producing micro-aggregates in the soil

(Mclaren and Cameron, 1996). Aggregate size distribution is another major physical characteristic of the soil that strongly affects soil and its resistance to erosion and degradation. It is also considered to be an indicator of soil structure (Pachepsky and Rawls, 2003). It is therefore important to maintain soil aggregate so as to prevent soil loss; and protect soil efficiency and productivity.

Soil organic carbon (SOC), cation exchange capacity and total nitrogen contents play a crucial role in sustaining soil quality, crop production and environmental quality (Bauer and Black 1994; Robinson *et al.*, 1994) due to their effects on soil physical, chemical, and biological properties (Sainju and Kalisz, 1990). Organic carbon (OC) content of soil aggregates influence aeration and water movement while the SOC content of bulk soil affects water-holding capacity (Symeonakis *et al*., 2007). The presence of SOC in different aggregate sizes is imperative for soil quality assessments (Curtin and Mullen, 2010; Li *et al.,* 2016).

The lower the aggregate size of the soil, the higher the CEC because the smaller sized particles, clay, contributes most to the exchange site (Arnaud *et al.*, 2018). Soil exhibits CEC mainly because clay particles and soil organic carbon in the soil tends to be negatively charged. The major source of CEC in the mineral fractions comes from clay. Improper land-use system has adverse effects on the soils. Severe soil deterioration reduces organic matter and clay contents in soil which often leads to loss of soil capacity to hold and release nutrients (Arnaud *et al.,* 2018). It may also cause important changes in soil physical and chemical characteristics which can affect soil quality. As far as we know, information on how soil aggregate and associated CEC, SOC and TN changes with changes in agricultural land-use in humid tropical area of Sub-Saharan Africa is rare. Hence, our quest for sustainable soil use for smart food production towards food sufficiency for our ever increasing global human population in areas with similar climate and land-use worldwide.

Therefore, there is the need to assess how land-use affects soil aggregate size distribution, soil CEC, SOC and TN within soil aggregate size fractions. The main objectives of this study was to determine the effect of agricultural land-use on CEC, SOC and TN within soil aggregate size fractions.

Materials and Methods

The study was carried out at the Teaching and Research Farm of the Obafemi Awolowo University, Ile-Ife. It is a region within the humid zone of Southwestern part of Nigeria. Ile-Ife lies between Latitudes 7° 32′ N and 7° 33′ N and Longitudes 4° 33′ E and 4° 35′ E and has different types of land-use. The area is about 200 metres above mean sea level. The climate is hot with distinct dry and rainy seasons. The area experiences approximately eight months (March-October) of annual rainfall that is bi-modal in distribution pattern with peaks in July and September. It has about four months (November-February) of dry season each year, though irregularity may occur in the rainfall distribution pattern over the years. The mean annual rainfall is about 1526.8mm (Akintola, 1986). Soil orders associated with this land-use types are Ultisol. Ultisols are strongly leached, acid forest soils with relatively low native fertility. They have a sub-surface horizon in which clays have accumulated, often with strong yellowish or reddish colours resulting from the presence of Fe oxides (USDA, 2014). They are derived from coarse-grained granite, gneisses and pegmatites which were identified as the bedrock of the soils of Iwo Association (Smyth and Montgomery, 1962). The six different land-use types considered in this study are: undisturbed secondary forest, continuously cropped land, paddock, oil palm (*Elaeis guineensis)*, cocoa (*Theobroma cocao*), and teak *(Tectona grandis*) plantations. These land-use were established about 35 years before this study except paddock and continuous cropped land-use which was established 20 years ago. Akinde *et al.,* (2020) gave detailed description of the land-use types including vegetal cover and management practices in each land-use.

Soil samples were randomly collected from different land-use types at two depths (0-15cm and 15-30cm) using sampling tube. Each land-use was divided into three replicates based on their

physiography (upper, middle, and lower slope). Collected soil samples were air dried, gently crushed and sieved through a 2mm mesh sieve. Exactly 2400g of soil was then placed on Endecott test sieve shaker (SER No: 6437) containing four sets of sieves to separate the soil into four different aggregate classes (<63μm, 63-250μm, 250μm - 1mm and 1-2mm).

On each aggregate class, particle size distribution was determined by the hydrometer method (Gee and Or, 2002). Soil pH in 0.01 M $CaCl_2$ was measured by WalkLAB electrode pH meter (Peech *et al.,* 1953). Cation exchange capacity (CEC) of the aggregate size classes under each land-use and the whole soil were determined using 1N ammonium acetate at pH 7 (Ross and Ketterings, 2011), Soil organic carbon (SOC) was determined colorimetrically following dichromate digestion method (Nelson and Sommers, 1996). Total nitrogen (TN) was determined by digestion procedure described (Bremmer, 1996). Due to inadequacy in the quantity of <63μm sized soil aggregate fraction, only CEC was determined on <63μm sized soil aggregate fraction. While all parameters (CEC inclusive) were determined on all other soil aggregate fractions and whole soil. All data were analysed using SAS software (9.2 version).

Analysis of variance was carried out and significant means were separated using Duncan's new multiple range test at 0.05 levels of probability.

Results and Discussion

The soil textural class of the different land-use types were found to be sandy loam except for that of paddock plantation at the 0-15cm soil depth, teak plantation at the 15-30cm soil depth soil and cocoa plantation soil at both 0-15 and 15-30 cm soil depths, which were sandy clay loam (Table 1).

This is an indication that paddock, teak and cocoa plantation contain an appreciable amount of clay.

The pH of the whole soil was not significantly different across the land-use types and highest values were observed under cocoa (6.0) and forest (5.9) at both 0-15cm and 15-30cm soil depths. Thus, the soil reaction range classified as slightly acidic under cocoa land-use whereas that of forest was moderately acidic (Brady and Weil, 2002; Adepetu, 1994). The higher values of pH under cocoa land-use could be resulting from higher organic matter content due to higher amounts of plant residues at the soil surface (Wang *et al.,* 2013). Rainfall leaches basic cations away from soil exchange sites and their position are taken over by Al^{3+} and H^+ which are acid forming and soil acidification is likely as a result of leaching.

Table 1: Texture and soil pH under different agricultural land-use

Land-use	0-15cm depth					15-30cm depth				
	Particle size			Texture	Soil	Particle size			Texture	Soil
	Sand	Silt	Clay	class	pH	Sand	Silt	Clay	class	pH
	←	(gkg^{-1})	→		($cacl_2$)	←	(gkg^{-1})	→		($cacl_2$)
Paddock	680	60	260	Scl	5.3ab	720	80	200	Sl	5.1b
Oil palm	730	90	180	Sl	4.7b	770	70	160	Sl	4.6b
Teak	700	110	190	Sl	5.5ab	720	70	210	Scl	5.2ab
Forest	740	100	160	Sl	5.9a	780	90	150	Sl	5.8a
Cocoa	660	100	240	Scl	6.0a	560	100	340	Scl	5.3a
Cont. crop	720	100	180	Sl	4.7b	740	60	200	Sl	4.9b

Means with the same letter on a column are not significantly different (P<0.05) according to Duncan's New Multiple Range Test.
Scl – Sandy, clay loam, Sl – Sandy loam

Distribution of cation exchange capacity, soil organic carbon and total nitrogen in the soil aggregate class fractions at 0-15 and 15-30cm soil depths

Soil organic carbon associated with 63μm-250μm sized soil aggregate fraction was significantly the greatest going by the Duncan New Multiple Range Tests (26.51 and 8.63g/kg in 0-15cm and 15-30cm soil depths respectively), while that of other aggregate size fraction were not different from each other (Table 2). This implies that smaller aggregate fraction stores SOC more compare to lager fraction, confirming the findings of Adesodun *et al.,* (2005) and Oyedele *et al.,* (2014). Akinde (2018) reported that 63μm-250μm sized aggregate fraction contributed more to SOC protection than both 250μm-1mm and 1mm-2mm aggregate size fraction. They found out that SOC associated with the smaller aggregate fraction were more stabilized against mineralization. Similarly, significantly more TN were associated with 63μm-250μm sized soil aggregate fraction (3.35 and 2.79g/kg in 0-15cm and 15-30cm soil depths respectively), while 1-2mm aggregate fraction was the least (Table 2).

This could be due to the fact that smaller sized aggregate contained more SOC. It has been established that most of the nitrogen in soil are of organic origin (Silva and Mendonca, 2007). This result corroborates the findings of Adesodun *et al.,* (2005) who observed a greater TN in smaller sized soil aggregate fraction. The CEC associated with the soil aggregate fractions was not significantly different from one another both at the surface and sub-surface soils, though <63μm sized soil aggregate fraction had the highest value at both depths (2.33 and 2.04cmol/kg 0-15cm and 15-30cm soil depths respectively) (Table 2). Higher value of CEC in <63μm sized soil aggregate fraction could be attributed to higher silt and clay fraction in this fraction (Igwe and Nkemakosi, 2007). Jiang *et al.* (2011) reported higher exchangeable cations in the in <63μm sized soil aggregate fraction indicating that this aggregate fraction has higher CEC.

Effects of land-use on CEC distribution within soil aggregates size fractions

The CEC distributions within the aggregate classes were significantly different across the land-use types (Figure 1). The CEC under CL and CCL ranked highest when compared to other land-use types while SFL was observed to be lowest among the land-use types and across all the aggregate size fractions. The unexpected trend the CEC followed in soil of SFL and CCL could prompt further research into the clay mineralogy and other factors that affects CEC. This was also recommended by Akinde *et al.,* (2020) who observed similar trend in the CEC of the land-use types. Forest soils have been reported to be characterized by high CEC and CCL with lower CEC (Wakene and Heluf, 2003).

The high CEC under cocoa land-use can be attributed to the relatively high clay and OC content of its soil and by extension its aggregates, being a sandy clay loamy soil at both depths. Oyebiyi *et*

Table 2: Distribution of cation exchange capacity, soil organic carbon and total nitrogen in the soil aggregate class fraction at 0-15 and 15-30cm soil depths

Soil depth	Soil Parameters	Soil Aggregate size fraction			
		<63μm	63μm-250μm	250μm-1mm	1mm-2mm
0-15cm	SOC (g/kg)	nd	26.51a	12.91b	6.91b
	TN (g/kg)	nd	3.35a	2.97b	2.67c
	CEC (cmol/kg)	2.33a	2.24a	2.16a	2.02a
15-30cm	SOC (g/kg)	nd	8.63a	6.29b	6.32b
	TN (g/kg)	nd	2.79a	2.40b	2.32b
	CEC (cmol/kg)	2.04a	1.84a	1.91a	1.88a

Means with the same letter in a row are not significantly different (P<0.05) according to Duncan's New Multiple Range Test.

nd= not determined, CEC= cation exchange capacity, SOC= soil organic carbon, TN= total nitrogen

al., (2018) reported that soil clay and OC are the major contributor to soil CEC. Tan (1998) reported that clay soils ordinarily carry an electronegative charge which gives rise to cation exchange reactions.

Effects of land-use on SOC distribution within soil aggregates size fractions

In soil OC (Figure 2), there were significant different across the land-use in each aggregate size classes except soil under oil palm which was significantly higher ($P < 0.05$) at 1mm- 2mm aggregate size fraction. This might be resulting from the fibrous and dense root system of oil palm. This result corroborates the findings of Akinde (2018), who considered similar land-use types, and found out that oilpalm plantation had most of its soil OC fractions concentrated in the 1mm-2mm sized soil aggregate fraction. Concentration of SOC is dependent on both the above ground and below ground biomass (plant root inclusive) (Zhang *et al.,* 2013). The fibrous rooting system of oil palm might have resulted in high amount of root fragments associated with 1mm-2mm sized soil aggregate fraction, hence, high soil OC contents within this soil aggregate fraction. Soil OC under TL was significantly greater than CCL in both 63μm-250μm and in 250μm-1mm. Likewise, other land-use except that of OL were statistically greater than CCL at 250μm-1mm. However, at both 63-250μm and 250μm-1mm aggregates size, there was a decreasing trend from other land-use types to CCL as could be observed from the chart (Figure 2). This could be due to land preparation activities which induce soil disturbance and expose soil OC to rapid decomposition (Oyedele *et al.*, 1999).

Effects of land-use on TN distribution within soil aggregates size fractions

Total nitrogen contents of the SFL, PL and the tree crops land-use types were not significantly different from one another within all the soil aggregate size fractions except for 250μm-1mm sized aggregate fraction where SFL had the significant highest (3.33g/kg) (Figure 3). CCL had the least TN content across the soil aggregate size fractions (2.04, 1.82 and 1.74g/kg in 63μm-250μm, 250μm-1mm and 1-2mm sized aggregate fraction respectively).

This result corroborates Tan *et al.,* (2007) who reported that forest soil contained considerably high amount of nitrogen. Forest is made up of numerous assemblage of plant species (including nitrogen fixing species) which may likely improve the soil nutrient (nitrogen inclusive). Deng *et al.,* (2016), and Deng and Shangguan (2016) reported that successional vegetation plays an essential role in improving soil nitrogen content.

Generally, the TN content in the soils of SFL, PL and the tree crops land use types could be attributed to their SOC content. Statistically, there was little to no variation in their soil OC content (Figure 2) and most of the nitrogen in soil has been reported to be of organic origin (Silva and Mendonca, 2007). In addition, animal wastes (faeces and urine) contains high amount of nitrogen (McNaughton *et al.,* 1997), which would have contributed to the TN content of paddock soil. The least TN content in the soil of continuously cropped land could be attributed to its low soil OC content (Figure 2). It could also be due to the fact the land is continuously cultivated with maize (*Zea mays*) (Akinde *et al.,* 2020). It has been established that maize requires high amount of nitrogen (Galindo *et al.*, 2019). It might also be due to volatilization of nitrogen resulting from increased oxidation of nitrogenous compounds in the soil. This may have been triggered by high exposure of the soil to air and increased temperature by frequent tillage operations. Also, the ability of nitrogen to be mobile in the soil might have possibly resulted into nitrogen losses by leaching. Oguike and Mbagwu (2009) reported similar result, they stated that continuous cultivation of soils caused a substantial loss of nitrogen due to increased volatilization and leaching.

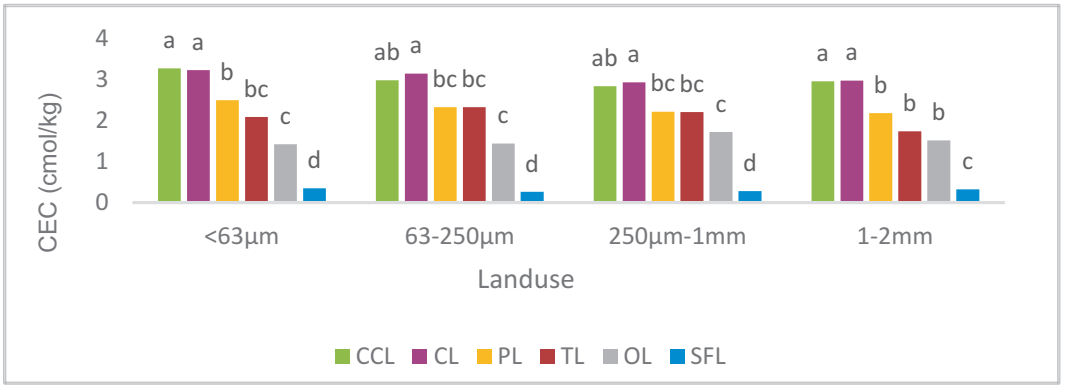

Figure 1: Influence of land-use on CEC distributions within aggregate size fractions.
SFL =Secondary Forest; TL = Teak Plantation; OL = Oil palm Plantation; PL = Paddock; CL = Cocoa Plantation; and CCL = Continuous cropping.

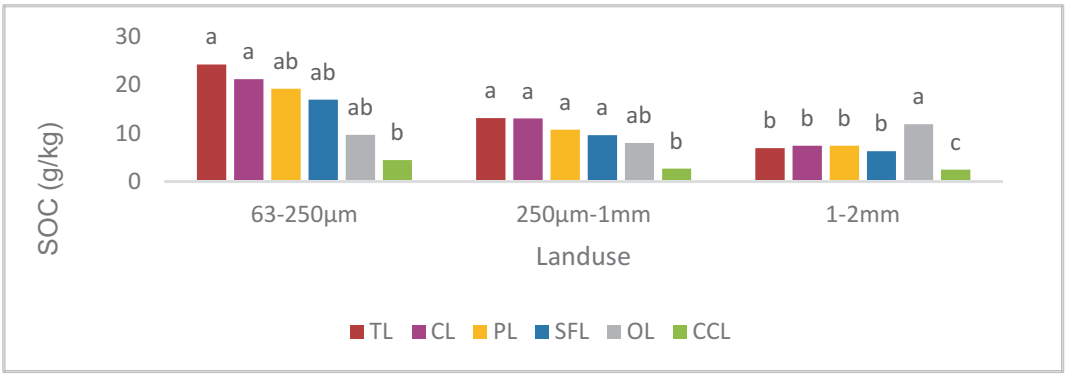

Figure 2: Influence of land-use on SOC distributions within aggregate size fractions .
SFL =Secondary Forest; TL = Teak Plantation; OL = Oil palm Plantation; PL = Paddock; CL = Cocoa Plantation; and CCL = Continuous cropping.

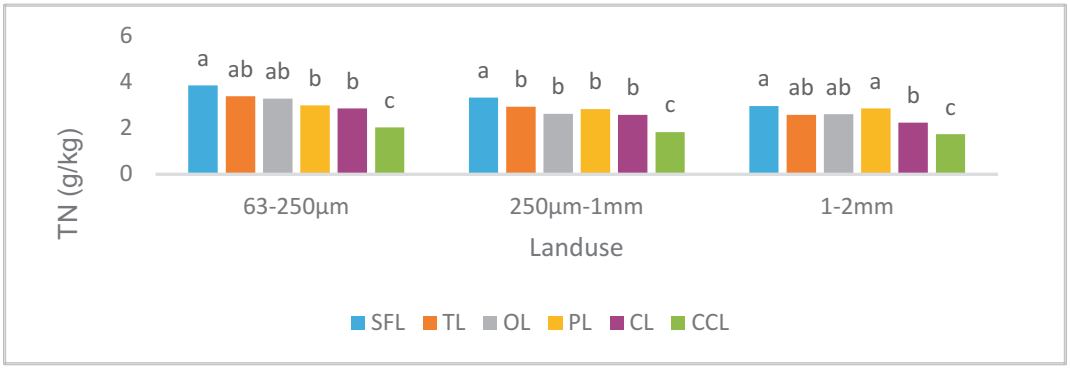

Figure 3: Influence of land-use on TN distributions within aggregate size fractions
SFL =Secondary Forest; TL = Teak Plantation; OL = Oil palm Plantation; PL = Paddock; CL = Cocoa Plantation; and CCL = Continuous cropping

Effects of various agricultural land-use types on CEC, SOC and TN of the whole soil

The CEC value under CL and CCL were statistically similar, but were significantly higher compared to other land-use types (Figure 4). Secondary forest unexpectedly had the least value of CEC. This unexpected observation could be due to other factors that affects CEC (Akinde *et al.*, 2020), such as clay mineralogy, leaching, low content of basic cations in the parent material and proportion of clay (Muche *et al.*, 2015). The highest value observed under cocoa plantation land-use could be due to its clay and organic carbon content. However, continuous fertilizer application into CCL may lead to increase in concentration of cation because depletion of organic carbon and intensive cultivation is expected to reduce the CEC of the soils (Kiflu and Beyene, 2013).

The soil OC of the land-use types were statistically the same except for the CCL which is also the least in value (Figure 5). The very low concentration of organic carbon (OC) observed under CCL was probably related to the increased oxidation of the soil organic carbon (SOC) due to increased disturbance of the soil by continuous and intensive tillage operations resulting in reduction in SOC and soil structure (Lal *et al.*, 1998). This is coupled with low vegetation cover that exposed the soil to intense heat of the sun. This observation is also similar to the report of Balesdent *et al.*, (2000) who stated that soil aeration was increased by tillage while the climate of the topsoil with respect to temperature and moisture was altered leading to an increased rate of SOC decomposition.

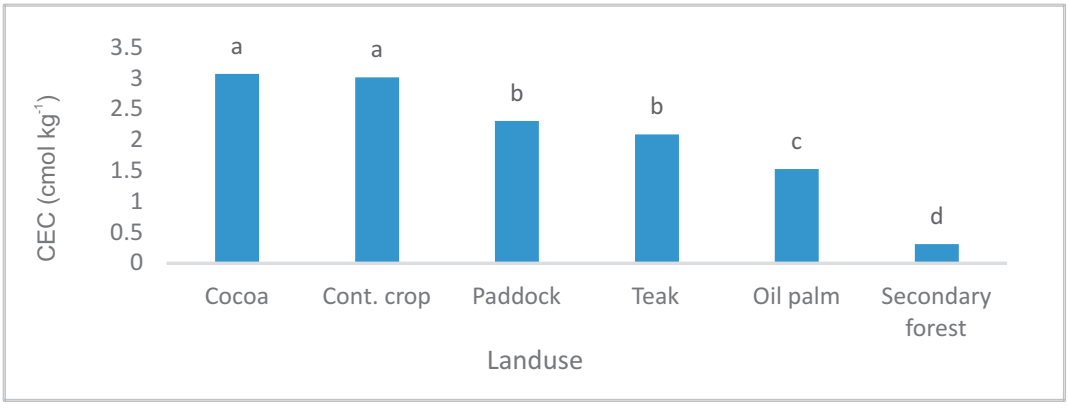

Figure 4: The CEC of soil under different land-use

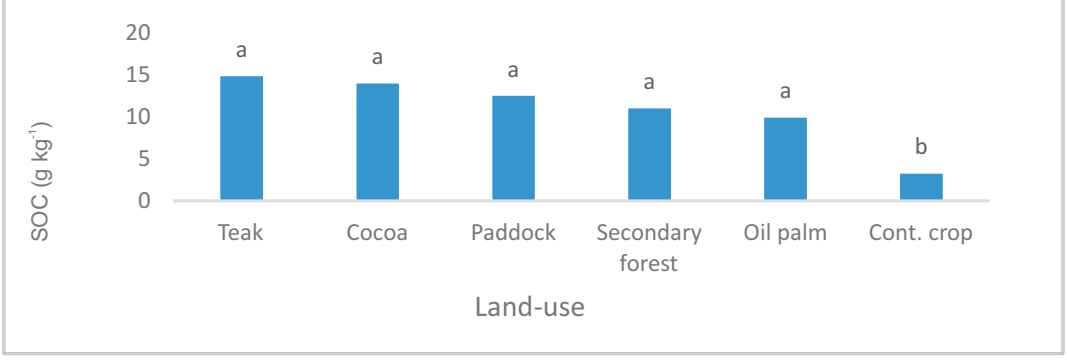

Figure 5: The SOC of soil under different land-use

Total nitrogen (TN) content of soils under the different land-use types were different though TL, PL and OL were statistically the same. The highest ($P < 0.05$) was observed at the secondary forest land-use while the least value was observed under continuous cropping land-use (Figure 6). The relatively very low value of TN observed under CCL may be due to its low SOC content. It can also be due to volatilization of nitrogen resulting from increased oxidation of nitrogenous compounds in the soil (Oguike and Mbagwu, 2009). Oguike and Mbagwu (2009) reported similar result, they stated that continuous cultivation of soils caused a substantial loss of nitrogen due to increased volatilization and leaching. This may have been triggered by high exposure of the soil to air and increased temperature by frequent tillage operations.

Also, the increased mobility of nitrogen caused by incessant pulverization of the soil possibly resulted to losses by leaching. On the other hand, the relatively high value of total N observed under forest land-use may be due to the micro-climate created by adequate vegetation cover of the area which increased return of residues and reduced disturbance of soils which moderated the soil temperature, air and moisture against total N loss by volatilization. Percival *et al.,* (2000) reported that soils under pasture always resulted in better soil aggregation and carbon sequestration than in tilled crop lands. Generally, decrease in cultivation increases SOC and TN content Aweke *et al.,* (2013).

Conclusion

The results revealed that soil OC, TN and CEC were more associated with smaller sized soil aggregate fraction (<63μm, and 63μm-250μm sized soil aggregate fractions). This implies that smaller sized aggregate fraction contributes immensely to availability of nutrient in the soil and, hence, crop productivity. Therefore, land management practices should be geared towards preventing the loss of smaller sized aggregate, especially, to erosion. The study also showed that, all the land-use types considered had most of their soil OC and TN associated with smaller sized soil aggregate fraction (63μm-250μm), except for oil palm plantation, which had most of its soil OC associated with larger sized soil aggregate (1mm-2mm). In the whole soil, continuously cropped land had the least soil OC and TN which was due to land management activities associated with cultivation. The unusual trend followed by the CEC, especially, in secondary forest and continuously cultivated land could prompt further study into factors that affects CEC.

Conclusively, land-use type affects the distribution of SOC, TN and CEC associated with soil aggregate fractions. Most of the land-use type had their SOC, TN and CEC associated with micro-aggregates (<250μm sized soil aggregate fraction) except for oilpalm plantation. Land-use practices that protects the land from losing its

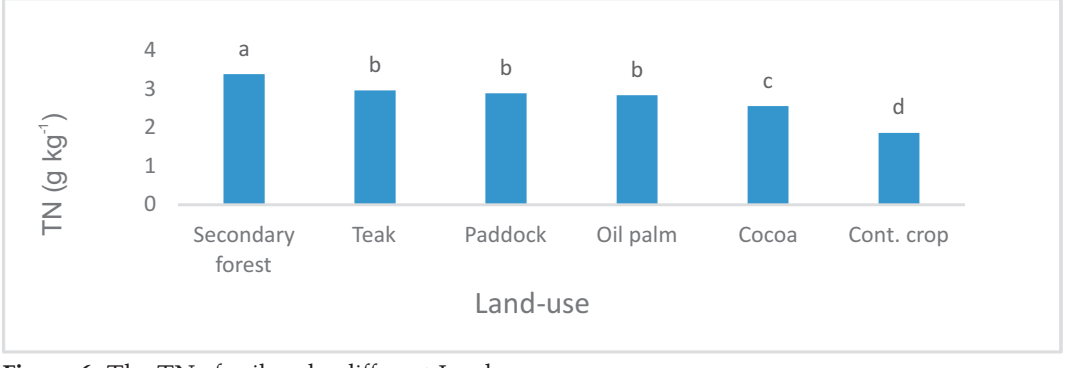

Figure 6: The TN of soil under different Land-uses

micro-aggregates (such as conservative tillage, mulching, manuring, erosion control etc.) should be encouraged to conserve the soil nutrients. In addition, adoption of restorative land-uses such as tree-based cropping system and other less intensive cultivation practices are required to stabilize soil organic carbon, minimize nutrient loss and make for sustainable use of soil resources in the study area.

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Evaluation of Herbal Leaf Meal as an Alternative to Feed Grade Antibiotics on Pork Technological Qualities and Colour

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Abstract
The effect of sole or combined herbal leaf meal as alternative to feed grade antibiotics on pork technological qualities and colour was assessed in this study. A total of thirty (30) large white growing pigs of eight weeks old were placed on five dietary treatments for 16 weeks. Six pigs were placed in each treatment with three replicates of two pigs in each replicate. Pigs on Treatment 1 served as negative control since it contained neither synthetic feed antibiotics (oxytetracycline) nor herbal leaf meal while those on Treatment 2 served as positive control as the feed contained only synthetic antibiotics. Pigs on Treatments 3, 4 and 5 were fed rations containing 10% Moringa oleifera leaf meal, Neem leaf meal, composite of moringa (6%) and neem (4%) respectively. One pig per replicated group was collected at the end of the 16th week study, fasted, slaughtered and samples were obtained from the ham muscle for determining the pork quality and colour. Data obtained were subjected to one-way analysis of variance as contained in SAS (2010) while significant means were separated using New Duncan Multiple Range Test. Results showed that technological quality of the pork was positively influenced by the dietary treatments. The intrinsic and extrinsic meat colour was significantly affected ($p<0.05$) by experimental diets. In conclusion, diet with composite moringa and neem leaf meals had the best technological pork qualities and colour.

Keywords: Pork, Colour, Meat quality, Neem, Moringa, Herbal plants.

Évaluation de la Farine de Feuilles à Base de Plantes Comme Alternative aux Antibiotiques de Qualité Alimentaire sur les Qualités Technologiques et la Couleur du Porc

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Résumé
L'effet de la farine de feuilles de fines herbes seule ou combinée comme alternative aux antibiotiques de qualité alimentaire sur les qualités technologiques et la couleur du porc a été évalué dans cette étude. Un total de trente (30) gros porcs blancs en croissance âgés de huit semaines ont été soumis à

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cinq traitements diététiques pendant 16 semaines. Six porcs ont été placés dans chaque traitement avec trois répliques de deux porcs dans chaque réplique. Les porcs du traitement 1 ont servi de contrôle négatif car ils ne contenaient ni antibiotiques synthétiques (oxytétracycline) ni farine de feuilles d'herbes, tandis que ceux du traitement 2 ont servi de contrôle positif car l'aliment ne contenait que des antibiotiques synthétiques. Les porcs soumis aux traitements 3, 4 et 5 ont été nourris avec des rations contenant 10% de farine de feuilles de Moringa oleifera, de farine de feuilles de neem, un composé de moringa (6%) et (4%) de neem respectivement. Un porc par groupe répliqué a été collecté à la fin de l'étude de 16 semaines, jeûné, abattu et des échantillons ont été prélevés sur le muscle du jambon pour déterminer la qualité et la couleur du porc. Les données obtenues ont été soumises à une analyse unidirectionnelle de la variance telle que contenue dans SAS (2010) tandis que les moyennes significatives ont été séparées à l'aide du nouveau test à portée multiple de Duncan. Les résultats ont montré que la qualité technologique du porc était positivement influencée par les traitements diététiques. La couleur intrinsèque et extrinsèque de la viande a été significativement affectée ($p < 0,05$) par les régimes expérimentaux. En conclusion, le régime avec des repas composés de moringa et de feuilles de neem avait les meilleures qualités technologiques et la meilleure couleur de porc.

Mots clés: Porc, Couleur, Qualité de la viande, Neem, Moringa, Plantes à base de plantes.

Introduction

In spite of antibiotics achieving good performance, their possible negative effects became a global public health concern globally (Donoghue, 2003) which ultimately led to the ban of the products. In 2018 (www.nafdac.gov.ng), the National Agency for Food and Drug Administration and Control (NAFDAC) reportedly banned the use of antibiotics as growth promoter in livestock feed following concerns about food-related terminal diseases. As a result, this prompted an interest in the use of herbs and spices as well as their products as supplements in animal feed rations (Owen, 2011) which are considered as an addition to the set of non-antibiotic growth promoters, such as organic acids and probiotics. The dietary supplementation of ration with probiotics has improved pork quality, reduced drip loss, and enhanced water holding capacity of meat and meat colour (Jiang, 2011). Diverse authors have disclosed the nutritional values of different leaf meals that are available for use in Nigeria (Ogbuewu, 2008). Among the various herbal plants with medicinal values and growth promoters are moringa (*Moringa oleifera)* and neem (*Azadirachta indica* A. Juss) plants.

Neem (*Azadirachta indica*) is a primitive tropical plant prevailing in Nigeria (Ogbuewu *et al.*, 2008) and has been considered as an important plant used in therapeutic conditions because of the variety of bioactive constituents' present (Fernandes *et al.*, 2019).

Moringa oleifera Lam. (*M. oleifera*) of the family Moringaceae, is a nutritive plant, distributed in various countries of the tropic and sub-tropic regions (Anwar *et al.*, 2007). Studies have indicated that the leaves contain high amount of nutritional and antibiotic properties, thus, a potential valuable resource for improving the quality and oxidative stability of meat (Moyo *et al.*, 2011).

There are benefits of integrating these herbal plants in the ration of farm animals but only a handful information exists on synergistic effects that exist in mixing more than one herbal plants in relation to meat quality characteristics. Hence, this study evaluated the pork quality of growing pigs to ration containing sole or combination of herbal leaf meals as alternative to feed grade antibiotics.

Materials and Methods

The on-site research work was carried out at the Piggery Unit, Directorate of University Farms, Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State. The farm site is located

on latitude 7°13'48 N, longitude 3°26'14 E (Google Map, 2019).

Moringa oleifera and *Azardirachta indica* were sourced locally around the environment of Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The in-feed antibiotics (oxytetracycline©) was purchased from a reputable Veterinary Pharmacy within Abeokuta metropolis. The harvested leaves were air-dried for three-five days and constantly turned every four hours (thrice daily) to avoid fungal growth until leaves became crispy while retaining its green colouration. The leaves were then tightly packed in jute bags, sealed and kept at room temperature until it was used.

Experimental Pigs and Management

A total of thirty (30) growing large white pigs at eight weeks old with mean weight range of 14.54 - 16. 35 kg were purchased from a reputable farm in Abeokuta, Ogun State. Experimental pigs were raised under an intensive housing system. Prior to stocking, the floor of the house was cleaned and disinfected and each pen was made conducive with feeding and drinking troughs properly positioned. The pigs were grouped into five treatments with three replicates of two pigs per replicate in a Completely Randomized Design. The pigs on Treatment 1 (negative control) were served ration that contained no synthetic in-feed antibiotics and herbal leaf meal, while those on Treatment 2 (positive control) were offered feed that contained synthetic feed grade antibiotics. Pigs on treatments 3, 4 and 5 were offered diets with 10% inclusion levels of moringa, neem, and composite of moringa-neem leaf meals, respectively. The feeding duration lasted for 112 days. The gross composition of the experimental diet is as shown in Table 1.

Table 1: Gross Composition of Experimental Diets (%)

Ingredients	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Maize	50.00	50.00	50.00	50.00	50.00
PKC	11.00	11.00	3.50	0.30	2.20
Soy	18.00	18.00	18.00	18.00	18.00
GNC	10.00	10.00	6.50	9.70	7.80
Fish	1.00	1.00	1.00	1.00	1.00
Wheat-offal	6.90	6.90	6.90	6.90	6.90
Bone Meal	3.00	3.00	3.00	3.00	3.00
Lysine	0.30	0.30	0.30	0.30	0.30
Methionine	0.25	0.25	0.25	0.25	0.25
Premix	0.30	0.30	0.30	0.30	0.30
Salt (Nacl)	0.25	0.25	0.25	0.25	0.25
Moringa	0.00	0.00	10.00	0.00	6.00
Neem	0.00	0.00	0.00	10.00	4.00
Total	**100**	**100**	**100**	**100**	**100**
Determined Analysis					
ME (Kcal DE Kg)	2832.77	2832.77	2567.022	2825.58	2670.41
Crude Protein (%)	20.41	20.41	20.40	20.42	20.41
Ether Extract (%)	4.55	4.55	4.13	3.96	4.06
Crude Fibre (%)	4.78	4.78	5.94	4.99	5.56

**Positive Control = In-feed Antibiotics (Oxy-tetracycline)

Premix Composition to be supplied per Kg diet; Vit A 12600 IU; Vit D3 2800 IU; Vit k3 2.8 mg; Vit B1 1.4 mg; Vit B2 5.6 mg; Vit B6 1.4 mg; Vit B12 0.014 mg; Niacin 21 mg; Panothenic Acid 14 mg; Folic Acid 1.4 mg; Biotin 0.028 mcg; Chlorine Chloride 70 mg; Manganese 70 mg; Zinc 140 mg; Iron 140 mg; Copper 140 mg; Iodine 1.4 mg; Selenium 0.28 mg; Cobalt 0.7 mg; Antioxidant 168 mg.

Data Collection

At the end of the study, one pig per replicate group was selected, fasted, slaughtered and the ham muscle was excised, while samples were taken for pork quality analysis and colour evaluation.

Cooking Loss

Meat excised from ham muscle was dissected, 50g meat sample was weighed, placed in a thin walled plastic bag and cooked in a water-bath at 70°C for 30 minutes. Each sample was allowed to cool down to room temperature. The muscle was weighed again for determination of cooking loss (%). The cooking loss was expressed as a percentage of the initial sample weight.

$$\text{Cooking loss (\%)} = \frac{\textit{Initial Weight of raw meat sample-weight of cooked meat sample}}{\textit{Initial Weight of raw meat sample}} \times 100$$

Chilling loss

Approximately 15g sample of ham meat was chilled in a refrigerator at 4ºC for 24 hours, after which the meat was allowed to thaw and weighed. Chilling loss was calculated as follows:

$$\text{Chilling loss (\%)} = \frac{\textit{Initial Weight Before Refridgeration (g)- Final Weight After refrigeration (g)}}{\textit{Initial Weight Before Refrigeration}} \times 100$$

Thermal Shortening

Thermal shortening was determined by dissecting the ham muscle into strips, the length was assessed and then placed in a thin walled plastic bag and cooked in a water-bath at 70°C for 30 minutes. Each sample was then allowed to cool at room temperature and the length was later determined and used for determination of thermal shortening (%).

$$\text{Thermal shortening (\%)} = \frac{\textit{Length of raw meat sample-Length of cooked sample}}{\textit{Length of raw meat sample}} \times 100$$

Cold Shortening

A known length of ham muscle from the carcass was packaged into plastic bags and placed inside the refrigerator at 4°C for 24 hours. After 24 hours, the meat samples were removed and weighed again.

$$\text{Cold shortening (\%)} = \frac{\textit{Initial Length of meat sample - Final length of the sample after refrigeration}}{\textit{Initial length of meat sample}} \times 100$$

Water Absorption Capacity (WAC) of Meat Sample

A modified centrifugation method was used to determine water absorption capacity following the procedure of Arganosa *et al.* (1991). Five grams of the ham meat sample was blended with 10ml of distilled water for one minute. The homogenized mixture was poured and rinsed with 10ml of distilled water into a pre-weighed centrifuge tube. The mixture was centrifuged (MERLIN 503, Spectral scientific Ltd, Great Britain) at 2000rpm for 25 minutes. The unabsorbed water was decanted after centrifugation and the water absorbed by meat was calculated.

$$WAC\ (\%) = \frac{gram\ of\ water\ absorbed}{gram\ of\ meat} \times 100$$

Water Holding Capacity (WHC) of Meat Sample

Water holding capacity of the meat sample was determined using a centrifugation technique modified by Hamm (1960). Triplicate 15g samples of the ham meat were slurred using mortar and pestle and placed in centrifuge tubes, 22.5ml of saline solution was added and the contents stirred for one minute with a glass rod. After stirring, the sample was placed in a refrigerator for 15 minutes. The meat slurry was stirred again for a minute and immediately centrifuged at 2000rpm (MERLIN 503, Spectral scientific Ltd, Great Britain) for 15 minutes. The supernatant layer was decanted and the volume recorded. The amount of added solution retained by the meat was reported as the water holding capacity in ml per 100g meat.

$$WHC\ (\%) = \frac{Before\ centrifuge - After\ centrifuge}{Before\ centrifuge} \times 100$$

Determination of Meat Colour

The colour of the muscle was determined by placing the inner meat sample from the ham muscle using a Colorimeter (CHROMA METER CR- 410, JAPAN).

The values of L*, a* and b* colorimetric coordinates were determined on scale (Riegel *et al.,* 2003): L* = corresponds to Lightness, a* = corresponds to Redness, b* = corresponds to yellowness. On the basis of a* and b* values were calculated as follows:

Chroma (Ñ) $= (a^{*2}+b^{*2})^{0.5}$

Data Analysis

The data generated were arranged and analysed using one-way analysis of variance (ANOVA) in a Completely Randomized Design. Significant differences among means were separated using New Duncan Multiple Range Test as contained in SAS (2010) package.

Results

Effect of dietary levels of sole or combined herbal leaf meal on the qualities of ham muscle of growing pigs

Table II shows the result of dietary inclusion of sole or combined leaf meal on pork technological quality of growing pigs. Water holding capacity values (40.68 %) were highest ($p<0.05$) in growing pigs fed diet with Moringa leaf meal while water absorptive capacity (63.44%) was lowest ($p<0.05$) in ham muscle sampled from growing pigs fed ration containing antibiotics. Cooking loss (21.24%), thermal shortening (26.46 %) and chilling loss (2.30 %) values were lowest ($p<0.05$) in growing pigs fed diet Moringa+Neem leaf meal. Cold shortening (5.48 %) was lowest ($p<0.05$) in pigs fed ration with neem leaf meal.

Effect of dietary inclusion of sole or combined herbal leaf meal on the pork colour is presented in Table III.

The result showed that dietary inclusion levels of sole or combined herbal leaf meals had significant impact ($p<0.05$) on pork colour. Extrinsic L (lightness) with value of 56.29, B (yellowness) with value of 5.72, L* (correspondence to lightness) with value of 62.35 and B* (correspondence to yellowness) (6.78) values were highest ($p<0.05$) in pork fed diet containing neem leaf meal while extrinsic chroma value (15.86) was highest in pork fed diet containing moringa leaf meal.

Intrinsic L (lightness) and L* (correspondence to lightness) with values of 43.16 and 50.19 respectively were lowest ($p<0.05$) in pork fed diet containing moringa leaf meal. B (yellowness) and

B* (correspondence to yellowness) with values of 5.36 and 6.79 were highest ($p<0.05$) in pork fed diet containing neem leaf meal. Inner A (redness) with value of 13.26 and Chroma values were highest ($p<0.05$) in pork fed diet feed grade Antibiotics.

Discussion

Some of the physio-chemical parameters such as cumulative drip loss, colour and conductivity immediately after slaughter and during storage are important in determining meat quality (Janisch *et al.,* 2012). Water holding capacity is the ability of meat to retain water during processing or

Table 2: Effect of Dietary Levels of sole or combined leaf meal on Technological Qualities of Ham Muscle of Growing Pigs

Parameter (%)	Control	Antibiotics	Neem	Moringa	Moringa+Neem	SEM	P-value
Water Holding Capacity	33.17^{b}	24.46^{c}	32.61^{b}	40.68^{a}	21.75^{c}	1.56	0.0000
Water Absorptive Capacity	78.04^{a}	63.44^{b}	79.50^{a}	76.81^{a}	74.36^{a}	2.99	0.0230
Cooking Loss	20.50^{a}	21.24^{a}	19.76^{a}	22.76^{a}	14.98^{b}	1.04	0.0040
Thermal Shortening	34.57^{ab}	32.42^{b}	36.10^{ab}	38.40^{a}	26.46^{c}	1.73	0.0010
Cold Shortening	11.41^{a}	7.30^{ab}	5.48^{b}	11.57^{a}	7.57^{ab}	1.48	0.0300
Chilling Loss	1.61^{b}	2.30^{a}	1.55^{bc}	1.85^{ab}	1.06^{c}	0.17	0.0050

$^{a, b,c}$ Means not followed by the same superscript are significantly different ($P<0.05$) along the row.
SEM: Standard Error of Mean

Table 3: Effect of Dietary Inclusion of Sole or Combined Herbal Leaf Meal as alternative in-feed Antibiotics on Meat Colour of Growing Pigs

Parameter	Control	Antibiotics	Neem	Moringa	Moringa+Neem	SEM	P-value
Outer							
L	48.63^{c}	52.33^{b}	56.29^{a}	47.28^{c}	53.98^{ab}	0.77	0.0000
A	11.48	10.46	11.68	12.60	9.91	0.63	0.0800
B	4.43^{b}	4.09^{b}	5.72^{a}	4.21^{b}	3.96^{b}	0.23	0.0020
L*	55.67^{c}	59.13^{b}	62.35^{a}	53.55^{c}	60.89^{ab}	0.75	0.0000
A*	13.34	12.04	13.24	14.86	11.29	0.75	0.0560
B*	5.60^{b}	5.07^{b}	6.78^{a}	5.49^{b}	4.78^{b}	0.33	0.0140
Chroma	14.02^{abc}	13.11^{bc}	15.27^{ab}	15.86^{a}	12.38^{c}	0.67	0.0210
Inner							
L	48.80^{a}	45.41^{bc}	49.74^{a}	43.16^{c}	47.30^{ab}	0.81	0.0010
A	11.17^{b}	13.26^{a}	10.88^{b}	12.13^{ab}	12.47^{ab}	0.47	0.0300
B	4.67^{b}	3.72^{c}	5.36^{a}	4.46^{b}	4.40^{b}	0.14	0.0000
L*	56.25^{a}	52.53^{bc}	56.78^{a}	50.19^{c}	54.42^{ab}	0.77	0.0010
A*	13.01	15.57	11.34	14.45	14.53	0.94	0.0690
B*	5.90^{b}	4.80^{c}	6.79^{a}	5.86^{b}	5.65^{b}	0.18	0.0000
Chroma	13.99	16.30	13.28	15.60	15.60	0.79	0.1060

$^{a, b,c}$ Means followed by different superscripts are significantly different ($P<0.05$) along the row
L- Lightness, A- Redness, B- Yellowness. L*, A* and B* are colour directions. A* is the red axis, A is the green axis, B* is the yellow axis and B is the blue axis. NB: Area around the centre represents achromatic colours and moving outwards, colour saturation increases.
SEM: Standard Error of Mean

storage (Pearce *et al.,* 2011). The improvement in water holding capacity in the muscle of pigs fed diet containing *Moringa Oleifera* leaf-meal when compared to that of pigs fed diet with antibiotics and composite herbal leaf meal of *Azardirachta indica* and *Moringa Oleifera* demonstrated that *Moringa oleifera* is rich in selenium and α-tocopherol that stabilizes the muscle membrane (myofibrils) thereby improving the water holding capacity (Alabi *et al.,* 2017). Higher water holding capacity indicates a reduction in protein denaturation resulting in an increase in the conservation of water in muscle cells (Honikel, 1998). This report correlates with Ashgar *et al., (*1991) and Lisiak *et al.,* (2014) who stated that selenium has been found to increase the water holding capacity in pork by its ability to stabilize membrane integrity. Water absorptive capacity involves the ability of meat to absorb moisture from surrounding aqueous solution (Damoradan *et al*., 2010). The water absorptive capacity of pigs fed diet that contained feed grade antibiotics decreased statistically. This implies that its residue in pork must have resulted to protein denaturation thereby reducing the ability of myofibrillar protein to bind water (Honikel, 1998). The polyphenolic substance in moringa and neem leaf meal reduced the cooking loss and thermal shortening in the pork by maintaining the integrity of the cell membrane (Liu Tian-yang *et al.,* 2013) which causes reduction in protein and myosin denaturation. This prevents the rigidity and shrinkage of the myofibrillar structure that occurs due to heat of cooking as reported in literature by earlier researchers (Meade *et al.,* 2005; Tornberg, 2005). Cooking and heat denature proteins causing a depletion of cell membranes, shrinkage of fibres and gelling of myofibrillar and sarcoplasmic proteins (Yu *et al.,* 2017). The phenolic content responsible for the antioxidant activity of plant found in neem and moringa leaf meals may have resulted to significant reduction in the chilling loss and cold shortening of pork (Riazi *et al.,* 2016).

Meat colour is one of the important indications of quality since it influences the attractiveness of fresh pork when purchased by consumers (Joo *et al.,* 2013). The significant difference observed in pork from pigs on dietary supplementation of *Azardirachta indica* in terms of lightness and yellowness of the pork colour depicts higher presence of beta carotene in *Azardirachta indica*. Bonsu *et al., (*2012) reported that variation in skin and meat colour can be attributed to the carotenes in neem-based diets. The higher extrinsic chroma value in the pork sample from growing pigs fed moringa leaf meal indicates that the colour of the pork was more saturated and intense. These improvements can be attributed to the presence of the phyto-chemicals (such as tannins) in *Moringa oleifera that* possesses colour-stabilizing anti-oxidative properties (Mukumbo *et al.,* 2014). The phenolic-rich extracts of *Moringa oleifera* could have resulted to the significant reduction in intrinsic lightness of the pork in this present study. According to Jia *et al.* (2012), phenolic-rich extracts inhibit colour change in meat and its products. This observation aligns with Yu-yue *et al.* (2013) who depicted that other rich phenolic extracts such as pomegranate juice exhibited a reduced lightness on pork.

Conclusion

Pigs fed ration containing composite of moringa-neem leaf meals had the least thermal shortening, cooking loss, chilling loss, while pigs fed ration containing neem leaf had the least cold shortening effect. *Moringa oleifera* leaf meal has shown to improve the water holding capacity of pork due to its antioxidant properties. Feed grade antibiotics reduces the water absorptive capacity of pork. The colour intensity of pigs on ration containing moringa leaf meal diet progressed positively when compared to the values obtained for pigs on negative and positive control diets which promotes the level of acceptability of pork.

Recommendation

Herbal leaf meal can be incorporated in the ration of pigs as an alternative to feed grade antibiotics to improve the technological meat quality and colour of pork.

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The Effect of Organic Amendments on *Sorghum almum* Yield and the Proximate Analysis in Makurdi, Benue State, Nigeria

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Abstract
In an attempt to supply adequate organic soil nutrient needed for forages to increase their nutrient content that will meet animal needs in Makurdi, Benue State, this research was carried out to determine the treatment that would adequately meet animal's nutrient requirement for productivity. Different organic materials used for the research are; poultry droppings, cattle dung, sheep and goat droppings and rabbit faeces. The study used 5 treatments with3 replicates each laid out in a complete randomized design (CRD). There were significant differences between amended plots and the control amended, plots recorded the highest values expected for dry matter percent (DM%),ether extract percentage (EE%) and crude fibre percentage (CF%) where the control amended recorded more values than the organic amendment treatments. Biomass yield was 6.70 to 16.33 t/ha, fresh leaf ranged between 1.67 and 4.00 t/ha, fresh stem was observed to vary from 3.33 to 10.67 t/ha, leaf stem ratio to be between 1:2.0 and 1:3.0 grain yield ranged between 0.34 and 0.75, DM yield varied between 0.34 and 0.75 t/ha, % DM ranged between 94.84 and 96.25, ash recorded between 5.60 and 6.17 %, EE ranged from 6.13 % to 10.42 %, Crude fibre from 26.04 to 35.56, crude protein percent varied between 4.06 and 6.19 neutral detergent fibre recorded 37.63 to 62.09 %, acid detergent fibre percent was seem to vary between 26.78 and 35.68, phosphorus percent values ranged from 1.71 to 3.36, Sodium percent recorded 0.21to 0.4, calcium percent ranged from 0.69 to 1.18, Magnesium percent 0.07 to 0.08 and potassium percent was between -0.32 and 0.19. Rabbit faeces (T_4) is the recommended treatment for sustainable forages production in Makurdi, Benue State.

Keywords: *Sorghum almum*, Nutritive Content, Organic Amendments, Benue State.

L'effet des amendements organiques sur le rendement du *sorgho-almum* et l'analyse de proximité à Makurdi, État de Benue, Nigéria

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Résumé
Dans une tentative de fournir les éléments nutritifs biologiques adéquats du sol nécessaires aux fourrages pour augmenter leur contenu en éléments nutritifs qui répondront aux besoins des animaux à Makurdi, dans l'État de Benue, cette recherche a été menée pour déterminer le traitement qui

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répondrait adéquatement aux besoins en éléments nutritifs des animaux pour la productivité. Les différents matériaux organiques utilisés pour la recherche sont; excréments de volaille, excréments de bovins, excréments de moutons et de chèvres et excréments de lapins. L'étude a utilisé 5 traitements avec 3 réplicas chacun disposés dans un plan randomisé complet (CRD). Il y avait des différences significatives entre les parcelles modifiées et le contrôle modifié, les parcelles ont enregistré les valeurs les plus élevées attendues pour le pourcentage de matière sèche (MS%), le pourcentage d'extrait d'éther (EE%) et le pourcentage de fibres brutes (CF%) où le contrôle modifié a enregistré plus de valeurs que les traitements d'amendements biologiques. Le rendement de la biomasse était de 6,70 à 16,33 t / ha, les feuilles fraîches variaient entre 1,67 et 4,00 t / ha, la tige fraîche variait de 3,33 à 10,67 t / ha, le rapport de la tige des feuilles se situait entre 1: 2,0 et 1: 3,0 rendement en grains variait entre 0,34 et 0,75, le rendement MS variait entre 0,34 et 0,75 t / ha, le% MS variait entre 94,84 et 96,25, les cendres enregistrées entre 5,60 et 6,17%, EE variait de 6,13% à 10,42%, fibre brute de 26,04 à 35,56, le pourcentage de protéines brutes variait entre 4,06 et 6,19 fibres détergentes neutres enregistrées de 37,63 à 62,09%, le pourcentage de fibres détergentes acides semblait varier entre 26,78 et 35,68, les valeurs de pourcentage de phosphore variaient de 1,71 à 3,36, le pourcentage de sodium enregistré de 0,21 à 0,4, le pourcentage de calcium variait de 0,69 à 1,18, le pourcentage de magnésium 0,07 à 0,08 et le pourcentage de potassium était compris entre 0,32 et 0,19. Les excréments de lapin (T4) sont le traitement recommandé pour la production durable de fourrages à Makurdi, dans l'État de Benue.

Mots clés: *Sorghum almum*, contenu nutritif, amendements organiques, état de Benue.

Introduction

Sorghum almum known as Columbus grass or forage sorghum is a genus of plants in the grass family Poaceace; subfamily Panicoideae and the tribe Andropogoneae (the tribe of big bluestem and sugarcane). One specie is grown for grain while many others are used as fodder plants either intentionally cultivated or allowed to grow naturally in pasture lands. The plants are cultivated in warm climates worldwide and naturalized in many other places. Forage quality can be estimated by evaluating the nutrient composition; however, there is currently no one method that completely assesses forage quality. Good management of pasture, such as applying legumes and/or fertilizer, will go a long way towards the development and improvement of good quality forages (Scott *et al*., 2008).

The quantity of soil organic matter in the soil has been found to depend on the quantity of organic material which can be introduced into the soil either by natural returns through roots, stubble, slough off roots nodules and root exudates or by artificial application in the form of organic manures which can otherwise be called organic fertilizers. The need to use renewable forms of energy and reduce costs of fertilizing crops has revived the use of organic fertilizers worldwide; also improvement of environmental conditions and public health are important reasons for advocating increased use of organic materials.

Sustainable pasture production demands the use of fertilizers because of loss of soil fertility. However the use of chemical fertilizers has declined drastically in Sub-Saharan Africa and other tropical countries. For example about 70% of farmers engaged in dry season vegetable farming in Sokoto State of Nigeria have no access to chemical fertilizers due to their high cost and scarcity. Also, though farmers know that fertilizers are important for maximizing crop yield, they are still reluctant to use these fertilizers for crops (Olasantan, 1994).

Hence for the planting of vegetables at household levels, the use of chicken droppings, cow dungs, wood ash and other plant residues is adopted particularly in Southeastern Nigeria (Ogbalu, 1999). Opara-Nadi *et al*. (1987) had observed that

further studies are required to evaluate comparative effects of organic manures under field conditions and different agro-ecological zones.

Aim of Study

The aim of the study was to assess the effect of four types of animal manure on performance and nutrient composition of four tropical forage species.

The specific objectives included;

- to determine the composition of the soil before and after the manure application,
- to determine the DMyield of the four forage species.
- to determine the proximate and mineral composition of the four forage species.

Materials and Methods

Study Area

The study was conducted at the Pasture Unit of the Livestock Teaching and Research Farm of the University of Agriculture, Makurdi, Benue State. It lies within longitude 7.7322°N and latitude 8.5391°E within the Guinea savannah zone of Nigeria and located in the Benue valley with a climate that has two distinct seasons (i.e. wet/and dry). Wet season starts in April and ends in October while the dry season starts November through March. High temperature is experienced between February and April, while harmattan with cool chilly weather is experienced from December to early February. Temperature ranges between 15°C-31°C with an annual rainfall of 1500mm-1800mm. Makurdi is the hottest area of Benue State with temperature range of 21°C – 31°C.

Source of Manure

The four manure types *viz* cattle dung, sheep and goats dung, rabbit faeces and poultry litters were collected from the Livestock Unit of the College of Animal Science Livestock Teaching and Research Farm, University of Agriculture Makurdi, Benue State. It was collected in the month of March when they were dried and stored in a room to avoid being drenched by the rain.

Source of Forage Seeds

Sorghum almum was purchased from the National Animal Production Research Institute (NAPRI), Shika, Ahmadu Bello University Zaria, Kaduna State, Nigeria. They were kept in the store and scarification was carried out to remove dormancy before it was sown in the first week of the month of August when rain has fully established.

Experimental Treatments and Design

Control (T_0), poultry litter (T_1) cattle dung (T_2), sheep and goat dung (T_3) and rabbit faeces (T_4).

Thus, the experimental plot layout was a 5 treatment by 3 replicate with each laid out in a complete randomized design (CRD).

Parameters measured were:

- *Plant yield:* Each plant was measure 6cm above the ground and knife was use to clip them and the samples were weighed fresh to obtain the biomass yield.
- *Height at harvest:* Recorded height of each forage plant was taken 6cm above the ground. The measurement was taken using a ruler.
- *Leaf and stem yield:* After the biomass was measured, the leaves were cut-off; then weighed, while the stem was also weighed without the leaves. The leaf-stem ratio was also taken.
- The grains were collected, threshed, winnowed and weighed.
- *Dry matter yield:* Samples from the three replicates of each treatment of the four forages were taken, bulked together and 200grams was oven dried at 80 degrees for 24 hours until it was ensured certain that a constant weight was obtained.

Chemical Analysis

Physical and chemical soil/amendments analysis

Soil samples were collected from different parts of the plot before commencement of trials. These samples were bulked, sub-sampled and air-dried. Particle size analysis was done using hydrometer method, soil Organic Matter (OM) was determined by wet Dichromate Oxidation Method, total N by

Micro-kjeldahl method and available P by molybdenum blue colorimetry after Bray-1 extraction. Exchangeable cations were extracted with ammonium acetate; K was determined using flame photometer and Ca and Mg by EDTA titration. Soil pH in 1:1 soil-water suspension was determined according to the method of Tel and Hagarty (1984).Soil samples were analysed in the analytical soil laboratory of the Agronomy Department, Federal University of Agriculture, Makurdi.

Leaf Analysis

Leaf samples were collected; bulked together and 200grams was oven dried at 80 degrees for 24 hours until it was certain that a constant weight was obtained and milled. Nitrogen was determined using Micro-Kjeldahl method. Samples were ashed using Nitric-perchloric-Sulphuric acid mixture for determination of P, K Ca and Mg.

Phosphorus was determined using vanadolmolbdate colorimetry, K by flame photometer and Ca and Mg by EDTA titration (Tel and Hagarty, 1984). Samples of air-dried animal manures were also subjected to analyses to determine their chemical contents as done for forage leaf samples.

Results

The result of the physical and chemical soil/ amendment analysis is presented in Table 1. It was observed that rabbit faeces had the highest pH at 6.7,cattle dung contained (76.08%), sheep and goat droppings contained 7.92 %, the control had more silt percent (15.0%), T_3 had 2.49% organic carbon, T_3 also had the highest organic matter (4.31 %), nitrogen richest in $T_3$0.68%,4.8 ppm, potassium was observed to have more value in T_3 (0.34 cmolkg^{-1}), Sodium was highest in T_0(0.34 cmolkg^{-1}), Magnesium was seen to record more value in T_0 and T_1 with 3.2cmolkg^{-1}respectively, calcium was highest in T_3(3.7 cmolkg^{-1}), exchangeable base (alkaline and alkaline earth metals; calcium, magnesium, potassium and sodium) was observed to record highest value in T_3 (7.64cmolkg^{-1}), exchangeable acid had more value in T_4(1.16cmolkg^{-1}), cation exchange capacity was highest in T_3 (8.77cmolkg^{-1}) and base saturation record highest value in T_0(88.02 %).

Table 1: Physical and Chemical Soil/Amendments Analysis

Physical Soil Analysis

	T_0	T_1	T_2	T_3	T_4
pH	.64	6.5	6.2	6.4	6.7
Sand (%)	69.80	75.80	76.08	73.36	75.36
Clay (%)	15.20	13.20	13.92	17.92	15.92
Silt (%)	15.0	11.0	10.0	8.72	8.72
Chemical Soil Analysis					
Organic matter %	2.46	3.75	2.63	4.31	3.08
Nitrogen (%)	0.43	0.63	0.50	0.68	0.56
Phosphorus (ppm)	3.9	4.6	4.0	4.8	4.3
Potassium (cmolkg^{-1})	0.30	0.30	0.28	0.34	0.28
Sodium (cmolkg^{-1})	0.34	0.29	0.25	0.30	0.27
Mg(cmolkg^{-1})	3.2	3.2	2.8	3.3	3.0
Calcium (cmolkg^{-1})	3.4	3.4	3.0	3.7	3.2
Exchangeable Base (cmolkg^{-1})	7.24	7.18	6.33	7.64	6.75
Exchangeable Acid (cmolkg^{-1})	0.98	1.10	1.01	1.13	1.16
Cation Exchange Capacity cmolkg^{-1})	8.22	8.28	7.34	8.77	7.91
Base Saturation (%)	88.02	86.7	86.2	87.1	85.3

Table 2: Effects of Four Animal Manure on forage Leaf, Stem, Leaf:stem ratio, Grain and Dry matter (DM) yield

Treatment(t/ha)	Biomass	Fresh leaf 1	Fresh stem	Leaf:stem Ratio	Grain yield	DM	Height at at harvest
T_0	6.70^{e}	2.33^{c}	7.00^{c}	1:3.0	0.45^{c}	1.05^{c}	232.00^{b}
T_1	8.27^{d}	1.67^{d}	3.33^{e}	1:2.0	0.36^{d}	0.71^{e}	218.50^{c}
T_2	9.33^{c}	2.00^{cd}	6.00^{d}	1:3.0	0.34^{e}	0.75^{d}	189.50^{d}
T_3	13.33^{b}	3.33^{b}	8.33^{b}	1:2.5	0.75^{a}	1.40^{b}	234.50^{b}
T_4	16.33^{a}	4.00^{a}	10.67^{a}	1:2.7	0.65^{b}	1.80^{a}	261.00^{a}
SEM	0.37	0.30	0.50		0.12	0.13	6.37

Standard Error of Mean (SEM); Means in column with different superscript(s) are significantly different at the 5 % level of probability

Biomass, Leaf, Stem, Leaf:stem ratio and Grain yield

S. almum biomass yield varied between 6.70 t/ha (T_0) and 16.33 t/ha (T_4) as shown in Table 2. T_4recorded the highest biomass yield (16.33 t/ha) which was significantly different ($P<0.05$) from the other treatments, secondly T_3yield (13.33 t/ha), T_2 was the third9.33 t/ha. T_1had 8.27t/ha yield and lastly T_0which yielded (6.70 t/ha).

The fresh leaf yield varied from1.67t/ha (T_1) to 4.00 t/ha (T_4). The highest yield was T_4 (4.00 t/ha), followed by T_3 3.33 t/ha. The third was T_0 (2.33 t/ha) andT_2 (2.00t/ha)showed no significant ($P>0.05$) difference with the yield of treatment T_1 (1.67t/ha).

Fresh stem yielded 3.33t/ha (T_1) to10.67t/ha (T_4).It was noted that T_4 (10.67t/ha) had the highest yield, T_3 had the second highest yield (8.33t/ha) which was also significantly ($P<0.05$) different from the other three treatments viz.

The leaf-stem ratio varied from 1:2.0 (T_1) to 1:3.0 (in both T_0 and T_2). T_4 recorded the second highest value (1:2.7), followed by T_3 (1:2.5) and the least was T_1(1:2.0).

Grain yield varied from 0.34t/ha (T_2) to 0.75t/ha (T_3). T_3 recorded the highest grain yield of 0.75t/ha T_4(0.65t/ha) was the second, the third was T_0(0.45t/ha) The grain yield of T_1 was 0.36t/ha which was significantly different ($P<0.05$) from T_2(0.34t/ha).

Dry matter (DM) ranged from0.71t/ha in $T_1$to 1.80t/ha in T_4.T_4 had the highest DM yield, T_3 yielded the second highest (1.40t/ha). The control recorded the third highest (1.05t/ha) which was significantly ($P<0.05$) different from the other two treatments.

The height ranged from 189.50cm in $T_2$to 261.00cm in T_4. T_4 (261.00cm) had the highest height. It was observed that T_3(234.50 cm) and T_0 (232.00 cm) showed no significant ($P>0.05$) difference, while T_1 (218.50cm) and T_2(189.50cm) were significantly different.

Table 3: Effect of Four Animal Manures on Proximate Composition, Neutral Detergent Fiber and Acid Detergent Fiber Composition of Leaf

Treatments	DM	Ash	EE	CF	CP	NDF	ADF
T_0	96.25^{a}	5.60^{c}	10.42^{a}	35.56^{a}	5.19^{c}	39.98^{d}	26.78
T_1	95.98^{ab}	5.89^{b}	6.13^{d}	31.56^{c}	5.25^{c}	43.75^{c}	35.63
T_2	95.51^{abc}	4.60^{d}	9.52^{b}	34.35^{a}	4.06^{d}	62.09^{a}	28.26
T_3	94.84^{c}	6.09^{a}	9.15^{c}	35.32^{a}	6.19^{a}	49.82^{b}	33.54
T_4	95.17^{bc}	6.17^{a}	8.98^{c}	26.04^{d}	5.25^{b}	37.63^{c}	29.40
SEM	0.53	0.07	0.10	0.19	0.07	1.07	5.67^{ns}

Means in column with different superscript(s) are significantly different at the 5 % level of probability
Dry matter (DM), Ash, Ether extracts (EE), Crude fibre (CF), Crude protein (CP),
Neutral detergent fibre (NDF) and Acid detergent fibre (ADF)

Proximate, Neutral Detergent Fiber and Acid Detergent Fiber Composition

Result of the proximate composition, neutral detergent fiber and acid detergent fiber is presented in Table 3. The result indicated that the percentage dry matter (DM ranged from 94.84% in $T_3$to 96.25% in T_0. The control treatment recorded the highest DM (96.25%) which was not significantly ($P>0.05$) different from treatment T_1 (95.98%) and T_2 (95.51%)but was significantly ($P<0.05$) different from T_4 (95.17%) and T_3 (94.84%). T_1, T_4 and$T_3$the values observed followed each other in descending order respectively.

The ash varied from4.60%in T_2 to 6.17% in T_4. The content of ash in T_4 (6.17%) was highest which showed no significant ($P>0.05$) different with T_3 (6.09 %) which was the second highest, third was T_1(5.89%), T_0(5.60%) and thenT_2(4.60%).

The Ether extract (EE) was between 6.13% in $T_1$and 10.42% in T_0. The control recorded the highest EE (10.42%), followed by T_2 (9.52%), the third was T_3 (9.15%) which was not significantly ($P<0.05$) difference from T_4 (8.98%) but was different from T_1 (6.13%) and others.

Percentage Crude fibre (CF) varied from 26.04% (T_4) to 35.56% (T_0). T_0 had the highest CF value of 35.56% which was not significantly ($P>0.05$) different from T_3 (35.32 %). T_2 with 34.35% CF and T_1 (31.56%) was observed to be significantly ($P<0.05$) different from that of T_4 (26.04%).

It was observed that the Crude protein (CP) was between 2.23% and 6.19% in $T_0$and T_3 respectively. The CP in treatment T_3 (9.69 %) was the highest, followed by T_4 (5.25 %), thirdly T_1 (4.06%), lastly T_2 (4.06%) and the least value observed was T_0.

The Neutral detergent fibre (NDF) ranged from 37.63% (T_4) to 62.09% (T_2). T_2 62.09% had the highest content, followed by T_3 with 49.82%, T_1 (43.75%) was the third highest and it was also observed that T_0 (39.98%) recorded value that was significantly ($P<0.05$) different from T_4 (37.63 %).

The Acid detergent fibre (ADF) found varied from 26.73% (T_0) to 35.63% (T_1). $T_1$was the highest recorded and it was observed that there was no significant ($P>0.05$) difference between the entire five treatments which had values of 33.54% (T_3), 29.40% (T_4), 28.26% (T_2) and 26.78% (T_0).

Mineral Content

The result of the mineral content of *sorghum almum* is presented in Table 4. It was noted that phosphorus varied from 1.71% (T_4) to 3.36% (T_3). It was higher in T_3 which was significantly ($P<0.05$) different from the other treatments. It was followed by T_2 (2.12%) which was not significantly ($P>0.05$) different from T_1 (2.09%) and T_0 (1.84%) but significantly ($P<0.05$) different from T_4 (1.71 %).

The sodium content found in the leaves as a result of the treatments varied from 0.21% in T_3 to 0.48% in T_1. T_1(0.48%) was highest, T_4(0.34%) was observed to have second value. There was no significant ($P>0.05$) difference between T_0 (0.31 %) and T_2 (0.31%) but it was significantly ($P<0.05$) different from T_3 (0.21%).

The calcium varied from 0.69% (T_0) to 1.18% (T_4). (T_4) 1.18% had the highest value, T_2 (0.95 %) was the second highest, T_3 was the third (0.86%) then T_1 (0.86 %) and T_0 (0.69 %).

Table 4: Effect of Four Animal Manures on Mineral Content (%) of Leaf

Treatment	P	Na	Ca	Mg	K
T_0	1.84^{bc}	0.31^{c}	0.69^{d}	0.08^{ab}	0.05^{b}
T_1	2.09^{b}	0.48^{a}	0.86^{c}	0.08^{a}	0.32^{c}
T_2	2.12^{b}	0.31^{c}	0.95^{b}	0.08^{a}	0.32^{c}
T_3	3.36^{a}	0.21^{d}	0.86^{c}	0.08^{a}	0.32^{c}
T_4	1.71^{c}	0.34^{b}	1.18^{a}	0.07^{b}	0.19^{a}
SEM	0.20	0.01	0.01	0.004	0.01

Means in column with different superscript(s) are significantly different at the 5% level of probability.

The magnesium percent ranged from 0.07% (T_4) to 0.08% (T_3). Treatment with the highest value was observed in T_3 (0.08%) which was not significantly ($P>0.05$) different from treatment T_2 (0.08%), T_1 (0.08 %) and T_0 (0.08%) but was significantly ($P<0.05$) different from T_4 (0.07%).

The potassium content varied from -0.32% to 0.19% to -0.32% in T_2 and T_4 respectively. The highest value was observed in T_4 (0.19%), followed by T_0 (0.05%), then T_1 (-0.32%), T_3 (-0.32%) and T_2 (-0.32%) there was no significant difference between T_1, T_2 and T_3.

Discussion

The highest biomass observed in T_4 could be attributed to the nutrient content of the animal manure used and the lowest could be limited by various factors, such as topography and decomposition rate of manures (Carneiro *et al*., 2014). The biomass increased and responded well to organic fertilization, Masebo and Menamo (2016) reported higher biomass in fertilized *Sorghum bicolor* than control.

There was increase in fresh leaf yield similar to the work of Mojeremane *et al.,* (2015) who showed that the fresh weight of rape plants amended with 10kgm$+-^{2}$ of organic fertilizer increased in weight. Xu *et al*., (2005) observed same with leafy vegetables.

The fresh stem recorded was shown to be heavier in T_4 due to its richness in N, P, K content; based on the result obtained from the soil analysis which led to increase in biomass weight of forages. This observation agrees with Shamme *et al*., (2016) who opined that the stem weight was noted to increase with the application of N fertilizer in *sorghum bicolor* and also Soleymani and Shahrajabian (2013) who recorded the highest and the lowest stem fresh yield from the application of 60kg N/ha and 0kg N/ha (control treatment) respectively on forage maize in semi–arid region of Iran.

The leaf-stem ratio in T_2 and T_0 were the highest which is not in line with the work of Amodu *et al*. (2001) who reported similar leaf-stem ratio (1:2) at all harvest stages on pearl millet that was fertilized with inorganic superphosphate prior to planting and NPK after establishment .

Grain yield in T_3 was more as the proof of the higher content of NPK in the manure, although, the control recorded higher value than two of the amendments which could be as a result of the topographical location of the soil or the nutrient uptake of the forages. This study is not in total agreement with the findings of Hajighasemi *et al*. (2016) who observed barley grain yield increased as N was applied; when they studied barley grain Hamdy *et al*. (2015) recorded the greatest grain yields when N fertilizer was applied.

T_4 had more dry matter which could be as a result of N, P, and K content in rabbit faeces. The finding agrees with the works of Okwori and Aken'Ova (2017) who recorded higher yield on forage grasses fertilized with NPK in Makurdi. Hasan *et al.* (2010) reported that increasing doses of nitrogen fertilizer resulted in progressive increase in DM of cowpea forage.

For dry matter (DM), the control gave the highest yield which could be due to the level of nutrient uptake of the plant and the decomposition rate of manure applied. This study is not in total agreement with the work of Hamdy *et al*., (2015) who revealed that application of FYM and N fertilizer alone or in combinations significantly ($P<0.05$) increased almost all growth parameters and in most cases led to significant increase in forage DM of sorghum.

In the present study, the ash content was observed to increase with the application of amendments which is in agreement with the findings of Aderinola *et al.,* (2011) that reported increase in the ash content with age and increased fertilizer application respectively when they studied *Andropogon tectorum*. Afzal *et al*. (2012) observed the effect of nitrogen application on ash contents which showed significant effect on sorghum forage and Chattha *et al.,* (2017) reported 8.97% ash content increase when they also worked on forage sorghum.

The EE values was highest in the control (T_0) which is in agreement with the study carried out by Abusuwar (2017) who reported a higher EE

content in the control than in the treatments when he worked on *clitoria*.

The CF was observed to be highest in T_0, which is in line with the works of Hamdy *et al*. (2015) who opined that application of FYM and N fertilizer alone or in combinations significantly ($P< 0.05$) decreases forage CF of sorghum: Mohan *et al*. (2017) also observed that the control plot significantly produced maximum crude fibre (32.02%) when they worked on teosinte fodder.

It was also established that CP content of forages increased with increased level of N contained in each treatment (Hasan *et al*., 2010). Serba and Obour (2017) reported that forage CP concentration increased linearly with high level of N in fertilizer applied on pearl millet. Afzal *et al*., (2012) and Chattha *et al.,* (2017) recorded maximum CP on forage sorghum with increased dose of N in fertilizer.

The NDF observed was similar to the findings of Doeko'os *et al*. (2018) who recorded that NDF was higher in treated plots than the control when organic manure was used to produce *centrosema pascuorum*. Also, Rahman *et al.* (2008) reported that the NDF value of maize ranged from 55.93 to 57.22 with the application of fertilizer.

There is no significant difference ($P>0.05$) in the ADF among the treatments. This is in line with the studies of Rahman *et al.* (2008) where ADF ranged from 34.11 to 35.37 and the application of cattle slurry did not show a significant effect on ADF in maize. Hazary *et al*., (2015) also reported that the effect of P and N fertilizers on ADF content of jumbo grass was non-significant ($P>0.05$).

The phosphorus (P) content of the forage was increased substantially in various treatments which are not in total agreement with the work of Roy and Khandaker (2010) reported an increase in the phosphorus content of sorghum fodders fertilized with phosphorus fertilizer than the control.

The sodium in the forage was higher in treatments richer in NPK content. This agrees with Shaahu *et al*., (2018) who observed higher sodium in treatments with organic fertilizer than the control in *Stylosanthes hamata*. Masanobu *et al*., (2016) reported that sodium content was highest in amaranths with NPK treatment than the control. PDA (2005) reported that sodium fertilizers increased the Na content of grass which will improve the palatability of herbage and may reduce the chance of grass staggers.

The Ca content was high when rabbit faeces were applied. This is similar to the findings of Masanobu *et al*. (2016) where calcium content was highest in amaranths with NPK treatment. This finding is in contrast with that of Doeko'os *et al*. (2018) who observed higher calcium in the control than the treatments when organic manure was used for *centrosema pascuorum*.

Magnesium was not significantly affected by application of animal manure. Kering *et al*., (2011) observed that N fertilization increased forage Mg when they worked on midland Bermuda grass.

Potassium declined in most of the treatments which could be as a result of harvesting it late when the grains were fully dried; which could be similar with the finding of Galloway and Cowling (2002); Aderinola (2013) who worked on *P. maximum* in which the potassium content increased with increased fertilizer application and age at harvest.

Conclusion and Recommendation

The result obtained in this study revealed that *Sorghum almum* amended with rabbit faeces better enhanced both the composition and quality of *Sorghum almum* as forage which will supply adequate nutrients for ruminant animal production and is therefore recommended for use in forage crop fertilization programme.

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Determinants of Organic Integrated Farming System Utilisation Among Smallholder Farmers in Southwestern, Nigeria

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Abstract
Integrated farming systems (IFS) is a cross-linked farming system where farmers make use of renewable energy for the production of crops and livestock on the same piece of farmland. The study investigated determinants of organic IFS as a choice farming system among smallholder farmers in Southwestern Nigeria. Respondents' socio-economic characteristics, knowledge, attitude, benefits derived and factors influencing organic IFS production were studied. A multistage sampling procedure was used to select 194 respondents. Interview schedule was used for data collection. Data were analysed using descriptive statistics, Chi-square, Pearson Product Moment Correlation and Multiple Regression at 0.005 level of significance. Respondents' mean age, household size, farm size and monthly income were 44.60±28.02 years, 4.26±1.03 farmers, 1.61±1.15 acres and ₦32, 299.50 ± ₦26,241.60 respectively. More than half (54.7%) practiced commercial agricultural production and had 7.9±5.3 years of farming experience. Source of labour for 60.0% was family and 90.7% had no access to extension services. Respondents' knowledge was high (60.5%) with favorable attitude (59.8%) to IFS. Benefits derived from organic IFS include increased yield and income, healthy breeds of crops and animals, improved produce quality and market. Respondents' monthly income (β= 0.077), years of farming experience (β= 0.188), access to inputs/credit facilities (β= 0.102) and benefits derived from organic IFS production (β= 0.016) were the determinants of organic IFS as a farming system of choice in the study area. Organic IFS helped farmers in the study area to maximize profit and available resources well managed using organic principles. The study recommended that farmers should be further sensitized on organic agricultural practices and principles as well as necessary technical support services to improve their agricultural production.

Keywords: Integrated Farming System, Smallholder farmers, Determinants and Production.

Déterminants De L'utilisation Des Systèmes Agricoles Intégrés Biologiques Parmi Les Petits Agriculteurs Du Sud-ouest Du Nigéria

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Résumé
Les systèmes agricoles intégrés (SAI) sont un système agricole interconnecté où les agriculteurs utilisent des énergies renouvelables pour la production de cultures et de bétail sur la même parcelle

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de terre agricole. L'étude a examiné les déterminants du SAI biologique en tant que système agricole de choix parmi les petits agriculteurs du sud-ouest du Nigéria. Les caractéristiques socio-économiques des répondants, leurs connaissances, leur attitude, les avantages dérivés et les facteurs influençant la production biologique des SAI ont été étudiés. Une procédure d'échantillonnage à plusieurs degrés a été utilisée pour sélectionner 194 répondants. Le calendrier des entretiens a été utilisé pour la collecte des données. Les données ont été analysées à l'aide de statistiques descriptives, du chi carré, de la corrélation du moment du produit de Pearson et de la régression multiple à un niveau de signification de 0,005. L'âge moyen des répondants, la taille du ménage, la taille de la ferme et le revenu mensuel étaient respectivement de 44,60 ± 28,02 ans, 4,26 ± 1,03 agriculteurs, 1,61 ± 1,15 acres et ₦32, 299,50 ± 26 241,60 ₦. Plus de la moitié (54,7%) pratiquaient la production agricole commerciale et avaient 7,9 ± 5,3 ans d'expérience agricole. La source de travail pour 60,0% était la famille et 90,7% n'avaient pas accès aux services de vulgarisation. Les connaissances des répondants étaient élevées (60,5%) avec une attitude favorable (59,8%) à l'égard du SAI. Les avantages dérivés du SAI biologique comprennent une augmentation des rendements et des revenus, des races saines de cultures et d'animaux, une amélioration de la qualité des produits et du marché. Le revenu mensuel des répondants (β = 0,077), les années d'expérience agricole (β = 0,188), l'accès aux intrants / facilités de crédit (β = 0,102) et les bénéfices tirés de la production du SAI biologique (β = 0,016) étaient les déterminants du SAI biologique comme un système d'élevage de choix dans la zone d'étude. Le SAI biologique a aidé les agriculteurs de la zone d'étude à maximiser les profits et les ressources disponibles bien gérées en utilisant des principes biologiques. L'étude a recommandé que les agriculteurs soient davantage sensibilisés aux pratiques et principes de l'agriculture biologique ainsi qu'aux services de soutien technique nécessaires pour améliorer leur production agricole.

Mots clés: Système agricole intégré, petits exploitants agricoles, déterminants et production

Introduction

Agriculture is a prerequisite for community development. It has been proved to bring about community development through the generation of gainful employment, increased production of raw materials for industries, increased food for export and income for farmers (Oladele, 2006).

Generally, agricultural research efforts aim at contributing to existing knowledge and improving the quality of life through achievement of food self-sufficiency and by extension, food security.

Integrated farming' (IF) is a holistic farm management system which aims to deliver more sustainable farming. It is a dynamic approach which can be applied to any farming system around the world. Integrated farming combines the best of modern tools and technologies with traditional practices according to a given site and situation. Integrated farming is a whole farm management approach that combines the ecological care of a diverse and healthy environment with the economic demands of agriculture to ensure a continuing supply of wholesome, affordable food. Also, it represents a practical way forward for agriculture that will benefit all societies and not just the farmers. IF is capable of making vital contributions to sustainable development by adding consideration of economic, ecological and social objectives to the essential business of agricultural food production (DRUSSA, 2013). The sustenance of increased productivity must emphasize on the development of strategies aimed at maintaining improved yields without depleting natural resources or destabilizing the environment. Such strategies abound in IFS.
Integrated farming (or integrated agriculture) is therefore a commonly and broadly used word to explain a more integrated approach to farming as compared to existing monoculture approaches.

In order to maximize profit and available resources, many smallholders farmers engage in integrated farming system. However, there are

various factors responsible for the utilization of IFS. Although, a number of factors have been identified by researchers to influence the adoption of IFS. However, they vary depending on the size of the available farmland, human and economic resources. Aina and Mooko (2007) observed that many small scale farmers would have loved to increase their production but for the constraints of limited access to modern technologies designed to boost their agricultural productions. This is because the process of increasing the efficiency of productions through agricultural modernization depends mainly on the extent to which farmers incorporate improved agricultural technologies into their farming operations.

According to Odoemenem and Obinne (2010), small scale farmers in Nigeria need to transform their agricultural productions from being solely dependent on traditional inputs with low productivity to the one based on modern inputs with higher productivity. The authors also identified the major factors influencing farmers' utilization of improved agricultural systems in Nigeria to be dependent on the intensity of extension contact, amount and use of credit, and cooperative membership - all of which are institutional in nature. However, despite the various identified benefits and factors responsible for farmers' involvement in IFS, dearth of information still exists on the determinants for the utilization of organic integrated farming system by smallholder farmers in Nigeria. Against this background, the objective of the study is to determine farmers' utilization of organic integrated farming system in Southwestern, Nigeria.

Methodology

Study Area

The study was conducted in the Southwest, geopolitical zone in Nigeria. The zone lies between latitude $5^0 8^1$ and $9^0 10^1$ and has an area of 77,818 square kilometres. It is one of the six major geopolitical zones of Nigeria. The population of the zone is 27,581,982 (National Population Commission, 2006). The region/zone comprise of six states which are Ogun, Osun, Lagos, Oyo, Ondo and Ekiti states. From the south of the zone to the North, the ecology is characterized by fresh water swamp, tropical rainforest and derived savannah. It is bordered by the Republic of Benin in the West, the Atlantic Ocean to the South, Edo and Delta State in the East and Kwara and Kogi States in the North. The climate of Southwest Nigeria is tropical in nature and is characterized by wet and dry seasons. The mean annual rainfall ranges from 1,500mm to 3,000mm per annum while the mean monthly temperature ranges from 18 – 24^0C during the rainy season and 30^0C - 35^0C during the dry season. Agriculture is the main source of livelihood of the inhabitants of the zone, therefore, farmers predominate the area with diverse farming systems dictated by ecology and culture of the people. Crops cultivated in the southern part of the zone includes both arable and cash crops like maize, cassava, yam, vegetables, pepper, cocoa, kolanut, oil palm, plantain and banana. The northern part, which is drier with lesser rainfall, contains shea butter, locust bean, cashew and mango trees. The zone is also suitable for millet and cowpea cultivation.

Population of the Study

The population of the study comprises all integrated smallholder farmers in Southwestern Nigeria

Sampling procedure and sample size

Multistage sampling procedure was used to select the respondents for the study. The first stage involved purposive selection of three out of the six Southwestern States with predominance of registered organic smallholder farmers involved in IFS which includes Oyo, Ogun and Ekiti States. The second stage involved purposive sampling of 3 rural Local Government Areas (LGAs) from each of the selected States which were Saki East, Atisbo and Itesiwaju LGAs from Oyo State, Ipokia, Egbado South and Ogun Waterside from Ogun State and Aiyekire, Emure and Moba LGAs from Ekiti State. The third stage involved simple random sampling of two communities from each of the selected LGAs with prevalence of smallholder farmers involved in IFS. The selected communities

were Ago-Amodu and Sepeteri from Saki East, Tede and Ofiki from Atisbo while Otu and Ipapo were seleted from Itesiwaju LGAs of Oyo State.

Ipokia and Idiroko communities were selected from Ipokia LGA of Ogun State, Ilaro and Owode from Egbado South while Abigi and Ayede communities were selected from Ogun Waterside.

Ode and Iluomoba Ekiti were selected from Aiyekire, Oke Emure and Ogbontioro communities were selected from Emure while Otun and Ira Ekiti communities were selected from Moba LGA of Ekiti State.

The fourth stage involved a purposive selection of eleven smallholder farmers practisingIFS from each of the 18 selected communities to give a total of 198 respondents out of which 194 were retrieved.

Data collection Procedure

Well-structured interview schedule was used to obtain data on respondents' socio-economic characteristics, knowledge, attitude, benefits and constraints to utilisation of IFS in the study area.

Data Analysis

The data collected for the study were analysed using descriptive and inferential statistics.

Descriptive statistical tools included frequencies, percentage distribution, mean and standard deviation while Chi square, Pearson Product Moment Correlation (PPMC) and Multiple Regression analysis constitute inferential statistical tools used.

Results and Discussion

Table 1 shows that majority (83.7%) of the farmers sampled were male and almost all of them (97.7%) were married. This indicated that most of the respondents had some family support for their agricultural production. The study also revealed that the mean age of the farmers was 44.6 years indicating that they were mostly youths with mean household size of four suggesting that the farmers most likely had access to family support. More than a third of the farmers (40%) had secondary education, 35% of them had tertiary education as the remaining 26% had primary and adult education. This implies that the literacy level of sampled farmers was relatively high and this conforms to the findings of Ajumoyegbe *et al.*, (2018) that education could help to achieve high level of innovation for increased production.

Table 1 further revealed that a high percentage of farmers (42%) were into crop and livestock production, 63% hired labours and had average farming experience of 12 years. This indicates that majority of the farmers had enough farming experience to enhance sustainability of their agricultural production. Sarah *et al.,* (2016) also attested that most integrated utilizing farmers in India had good number of farming experience in integrated farming but had to employ more labour to enhance their agricultural production. The mean monthly income of farmers was N32, 299.50 ± N26, 241.60 with average farm size of 1.61 ± 1.15 acres indicating that majority of them are small scale farmers – although, more than half of the farmers produce on commercial scale (58%) while just 19% produce on both commercial and subsistence scale. FAO (2015) also confirmed that most smallholder farmers in Nigeria had farm size of less than 2 acres with apparently low income which utilization of IFS may give them more advantage or benefits.

Table 1: Socio-economic characteristics of respondents in Chi square (N=194)

Variables	Percentage	Mean	S.D
Sex			
Male	83.7		
Female	16.3		
Marital Status			
Single	2.3		
Married	97.7		
Age (in years)		44.60	28.02
<30 years	2.3		
30-39 years	25.6		
40-49 years	44.2		
50-59 years	23.3		
≥60 years	4.7		
Household size		4.26	1.03
1-2 persons	2.3		
3-4 persons	60.5		
above 4 persons	37.2		
Education level			
Adult Education	6.9		
Primary Education	18.6		
Secondary Education	39.5		
Tertiary Education	34.9		
Farming Experience		7.9	5.3
1-5 years	44.0		
6-10 years	24.7		
11-15 years	16.0		
> 15 years	15.3		
Monthly income		32299.50	26241.60
<10,000	11.3		
10,001-30,000	36.7		
30,001-50,000	40.0		
>50,000	12.0		
Farm size (acre		1.61	1.15
1-2	64.6		
3-4	18.7		
> 4	12.0		
Source of labour			
Family	60.0		
Hired	32.7		
Communal	7.30		
Scale of production			
Commercial	54.7		
Subsistence	6.70		
Both	38.7		
Access to Extension service			
Yes	9.30		
No	90.7		

Source: Field survey, 2018

Knowledge of Respondents on IFS

Table 2a reveals that all the farmers (100%) attested that integrated farming system involves the cultivation of crop with livestock production on the same piece of land. Almost all farmers (93.0%) knew that netting of fishpond is necessary to prevent predators and that rice field must be cultivated on lowland for easy cultivation (97.1%). Majority (95.3%) of the farmers also affirmed that cage/pen must be connected to a soak pit for sedimentation and that harvesting in a IFS must be done with drag net respectively. It was discovered from 93.0% of the farmers that livestock in IFS are always reared using intensive system and that harvesting of fishes is usually between 12 to 14 weeks (90.7%). Majority (90.7%) of the farmers also affirmed that IFS involves the use of livestock waste to generate maggots for feeding fish while 88.4% knew that integrated farming system can be practised on any type of farmland. However, Table 2b further explained that majority of the farmers (60.5%) had high knowledge about organic integrated farming production which shows that their expertise from years of experience in the agricultural production culminated into high knowledge of the agricultural enterprise. Vinodakumar (2014) also found out in a similar study that smallholder farmers practicing integrated farming system usually have good knowledge of the agricultural practices with respect to their farming experience.

Table 2a: Distribution of respondents' knowledge on IFS

Knowledge statements on IFS	Correct (%)	Incorrect (%)
Integrated farming system involves the cultivation of crop with livestock production on the same piece of land.	100.0	0.0
IFS involves the use of livestock waste to generate maggots for feeding fish as well as manure for crop cultivation.	90.7	9.3
Integrated farming system can be practiced on any type of farmland (loamy, clayey or sandy).	88.4	11.6
Liming of pond helps to maintain soil PH to increase productivity.	88.4	11.6
Pipes into the fish pond must be covered with fine meshes to prevent predators.	93.0	7.0
Mechanization is allowed for Integrated farming system.	93.0	7.0
Fishpond serves as regular source of irrigation for crop cultivated.	86.0	14.0
Juveniles are better stocked for faster growth than fingerlings.	90.7	9.3
Rice must to able to retain water to a depth of 30cm.	93.0	7.0
Harvesting of fishes must always be done with dragnet.	95.3	4.7
Changing of pond water is better done on monthly basis.	44.2	55.8
Harvesting of rice cannot be done when fishes are stocked.	69.8	30.2
Moringa leaves and pawpaw seeds can be used as antibiotics for fishes.	46.5	53.5
Rice should be raised in nursery for about 2wks before transplanting.	81.4	18.6
At stocking point containers are raised over surface water.	88.4	11.6
Harvesting of fishes is usually between 12 to 14 weeks.	90.7	9.3
Livestock in IFS are always reared using intensive system.	93.0	7.0
Rice field must be cultivated on lowland for easy cultivation.	97.1	2.3
Livestock cage/pen must be connected to a soak pit for sedimentation.	95.3	4.7

Source: Field Survey 2018

Table 2b: Distribution of respondents' overall knowledge on IFS

Knowledge category	Percent	Min.	Max.	Mean	S. D
Low	39.5	13.0	19.0	16.84	1.68
High	60.5				

Source: Field Survey 2018

Attitude of Respondents to Organic IFS production

Table 3a shows that some of the farmers (30.0%) strongly agreed that IFS help reduce pest infestation while many (4.56%) agreed that IFS produces higher crop yield than other farming systems. Some, (41.9%) of the farmers agreed that IFS increases soil fertility through the usage of poultry dung for compost manure and that organic IFS products are always toxin free and usually has a better taste (41.9%). Result further shows that many (62.8%) of the farmers disagreed that IFS causes land degradation, more than half (55.8%) of the farmers disagreed that IFS cannot be practiced where there is constant rainfall to avoid loss of fishes, 53.5% disagreed that IFS is only possible with subsistence farming and few of the farmers (44.2%) disagreed that IFS increases pest infestation of crop cultivated on fish pond and that nutrient uptake is slow in IFS production (44.2%). This indicates that farmers' knowledge and benefits derived from IFS are indicators of favourable perception towards it.

Table 3a: Distribution of respondents' attitude on the use of IFS

IFS Attitude statements	SA	A U	D	SD	Mean	
	%	%	%	%	%	
IFS is an organic agricultural practice	11.6	23.3	34.9	27.9	2.3	4.19
IFS is capital intensive	25.6	39.5	16.3	11.6	7.0	3.63
IFS is time consuming	27.9	34.9	23.3	11.6	2.3	3.77
IFS causes land degradation	0.0	0.0	11.6	62.8	25.6	4.14
IFS contradicts my religious belief	0.0	11.6	20.9	44.2	23.3	3.79
Fishes and crop produced using IFS are always more nutritious than those produced from other farming systems	11.6	39.5	25.6	14.0	9.3	3.30
IFS is highly labor intensive	2.3	4.7	18.6	41.9	32.6	3.98
IFS agricultural products are always toxic free and usually has a unique taste	11.6	41.9	23.3	18.6	4.7	3.37
IFS does not require a specific type of soil to be practiced	16.3	37.2	32.6	9.3	4.7	2.49
IFS reduces environmental pollution	9.3	32.6	30.2	23.3	4.7	3.19
IFS increases soil fertility through the usage of poultry dung for compost manure	7.0	41.9	27.9	16.3	7.0	3.26
IFS agricultural products usually have longer shelf life	9.3	25.6	25.6	27.9	11.6	2.93
IFS is more sustainable than other farming systems	25.6	39.5	16.3	11.6	7.0	4.05
IFS cannot be practiced where there is constant rainfall to avoid loss of fishes	2.3	2.3	11.6	55.8	27.9	2.33
IFS increases pest infestation of crop cultivated on fish pond	30.0	9.3	0.2	44.2	16.3	4.23
IFS is only possible with subsistence farming	0.0	4.7	4.7	53.5	37.2	3.49
IFS produces higher crop yield than other farming systems	9.3	46.5	30.2	11.6	2.3	4.09
Nutrient uptake is slow in IFS	0.0	4.7	6.3	44.2	34.9	2.86

Table 3b: Overall attitude category of respondents on the use of IFS

Attitude category	%	Min.	Max.	Mean	S.D
Unfavourable	40.2	59.0	76.0	66.72	4.31
Favourable	59.8				

Source: Field Survey 2018

However, Table 3b further explains that more than half of the farmers (59.8%) had favourable attitude towards organic IFS production in the study area. This is corroborated by FAO (2015) that smallholder farmers' attitude towards agricultural production depends on the benefits derived from such enterprise especially based on amount of income generated from the enterprise. Aykut *et al.*, (2018) also attested in a similar study that farmers had favourable perception of issues related to sustainable agricultural practices.

Benefits of Organic IFS production

Table 4 reveals that benefits derived from organic IFS production by farmers in the study area included increased income (1.69), increased yield (1.69), healthy breeds of crops and animals (1.63), improved product quality (1.58), improved market for agricultural products (1.49), higher pest resistance (1.42), more nutritious products (1.33), cheap and available raw materials (1.09) and better soil and environmental condition (0.88). This result indicates that farmers' sustainability of the farming enterprise depends so much on the benefits they derive from it. Nguyen *et al.*, (2015) also attested that income and other benefits derived from sustainable agricultural practices including organic agriculture production determine farmers' adoption or utilization of such practices.

Determinants of organic integrated farming system

Result obtained from the regression analysis (Table 5) reveals that monthly income (β= 0.077, p=0.003), years of farming experience (β= 0.188, p=0.001), access to inputs/credit facilities (β= 0.102, p=0.002) and benefits derived from organic IFS production (β= 0.016, p=0.004) were the major determinants for organic integrated farming system production utilisation in the study area. This practically implies that the monetary income that farmers derived over years of production and access to raw materials used for their agricultural production was their motivating factors to continue in the utilization of IFS for their farming enterprise. This result is in agreement with Ajumoyegbe *et al.*, (2018) that factors affecting the level of productivity among integrated farmers in Southwestern Nigeria included expertise, access to inputs, capital and labour.

Table 4: Benefits derived by respondents on the use of IFS

Benefits of IFS	To a great extent	To a lesser extent	Not at all	Mean	Rank
	%	%	%		
Increased yield	72.1	25.6	2.3	1.69	1st
Increased Income	62.8	32.6	4.7	1.69	1st
Healthy breeds of crops and animals	65.1	32.6	2.3	1.63	3rd
Improved product quality	74.4	20.9	4.7	1.58	4th
Improved market for products	53.5	41.9	4.7	1.49	5th
Higher pest resistance	51.2	39.5	9.3	1.42	6th
More nutritious products	39.5	53.5	7.0	1.33	7th
Cheap and available materials	30.2	48.8	20.9	1.09	8th
Better soil/environmental condition	16.3	55.8	27.9	0.88	9th

Table 5: Distribution of factors affecting utilization of IFS

	B	SE	T	Sig.	Inference
(Constant)		15.244	3.684	.001	
Age	.105	.126	.507	.616	NS
Marital status	.215	5.842	1.174	.250	NS
Religion	.011	2.337	.062	.951	NS
Education level	.088	1.754	.491	.627	NS
Household size	.278	1.177	1.118	.273	NS
Monthly Income	.077	.192	.441	.003	S
Years of Experience	.188	.936	1.081	.001	S
Extension services	.191	1.250	1.060	.025	NS
Access to inputs/Credit facilities	.102	1.114	.614	.002	S
Knowledge	.311	.511	1.766	.088	NS
Attitude	.263	.139	1.89	.027	NS
Benefits	0.16	0.039	0.637	.004	S
R = 0.607					
R^2 = 0.368					
Adj R = 0.339					

Conclusion and Recommendations

Results from the study indicated that majority of the farmers practicing IFS in the study area were young males who possess one level of education or the other. Respondents mostly made use of hired labour for their agricultural production and were mostly involved in organic crop production than livestock. Respondents had favourable perception towards IFS production practices with high knowledge on IFS due to good number of farming experience as well as benefits derived from the agricultural enterprise. Benefits derived from organic IFS production included increased income and yield, healthy breeds of crops and animals, improved product quality and market. Major factors influencing organic IFS production in the study area included income derived, benefits derived from IFS production, access to credit and inputs.

The study recommends that farmers should be further sensitized on organic agricultural practices and principles and be provided with necessary organic agric-support services to improve their agricultural production. Farmers are also encouraged to belong to farmer groups or associations relevant to their agricultural production for easy access to certain agricultural facilities.

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Consumers' Motivating Factors to Purchasing Organic Foods in Oyo State, Nigeria

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Abstract
Health concerns have frequently been found to be the main motivator of consumers purchasing organic products. Literature on consumers' preferences are less clear about what 'health' means to consumers and because of this, it remains unclear what exactly drives consumers to choose organic products. This study investigated motivating factors to purchasing organic foods among consumers in Oyo State, Nigeria. Purposive sampling was used to select 120 organic foods' consumers across the three (3) Local Government Areas (LGAs) in Oyo State because of the prominence of the areas in the production of organic crops. in. Structured questionnaire was used to elicit information on consumers' information sources, knowledge of organic foods, frequency of purchase and motivating factors to purchasing organic foods while an interview schedule was used to obtain information from the respondents who cannot read nor write. Data were analysed using descriptive statistics like frequencies, percentages and mean. The results revealed that respondents' sources of information about organic foods were friends ($\bar{x}$ =0.78) and social media ($\bar{x}$=0.75) while over half (55.8%) had high level of knowledge of organic foods. Fruit vegetables ($\bar{x}$= 3.91), leafy vegetables ($\bar{x}$ = 3.70) and egg ($\bar{x}$ = 3.69) were ranked first, second and third respectively as most frequently purchased organic foods. Consumers were highly motivated by freshness of organic foods ($\bar{x}$ = 1.76), better taste ($\bar{x}$ = 1.76) and health benefits (x = 1.75). Since consumers are highly knowledgeable and motivated to purchasing organic foods, production should be encouraged.

Keywords: Motivating factors, Organic vegetable, Organic foods, Health benefits, Consumers.

Facteurs de Motivation des Consommateurs à Acheter des Aliments Biologiques dans l'État d'Oyo, au Nigéria

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Résumé
Les problèmes de santé se sont souvent avérés être le principal facteur de motivation des consommateurs qui achètent des produits biologiques. La littérature sur les préférences des consommateurs est moins claire sur ce que signifie «santé» pour les consommateurs et, pour cette

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raison, on ne sait toujours pas ce qui pousse exactement les consommateurs à choisir des produits biologiques. Cette étude a examiné les facteurs de motivation à l'achat d'aliments biologiques parmi les consommateurs de l'État d'Oyo au Nigéria. Un échantillonnage raisonné a été utilisé pour sélectionner 120 consommateurs d'aliments biologiques dans les trois (3) Zones d'Administration Locale (ZALs) de l'État d'Oyo en raison de la prédominance des zones de production de cultures biologiques. Un questionnaire structuré a été utilisé pour obtenir des informations sur les sources d'information des consommateurs, la connaissance des aliments biologiques, la fréquence d'achat et les facteurs de motivation à acheter des aliments biologiques, tandis qu'un calendrier d'entretien a été utilisé pour obtenir des informations auprès des répondants qui ne savent ni lire ni écrire. Les données ont été analysées à l'aide de statistiques descriptives telles que les fréquences, les pourcentages et la moyenne. Les résultats ont révélé que les sources d'information des répondants sur les aliments biologiques étaient les amis ($\bar{x}$=0.78) et les médias sociaux ($\bar{x}$=0.75), tandis que plus de la moitié (55,8%) avaient un niveau élevé de connaissance des aliments biologiques. Les légumes-fruits ($\bar{x}$= 3.91), les légumes-feuilles ($\bar{x}$= 3.70) et les œufs ($\bar{x}$= 3.69) ont été classés respectivement premier, deuxième et troisième comme aliments biologiques les plus fréquemment achetés. Les consommateurs étaient très motivés par la fraîcheur des aliments biologiques ($\bar{x}$= 1.76), le meilleur goût ($\bar{x}$=1.76) et les bienfaits pour la santé ($\bar{x}$= 1.75). Étant donné que les consommateurs sont très bien informés et motivés à acheter des aliments biologiques, la production devrait être encouragée.

Mots clés: Facteurs de motivation, Légumes biologiques, Aliments biologiques, Bienfaits pour la santé, Consommateurs.

Introduction

Organic farming is a holistic production management system based on ecological principles. It also represents a deliberate attempt to make the best use of local natural resources in an environmentally friendly farming system (Lumpkin, 2009). It reduces the use of external production factors and avoids the use of synthetic chemicals such as fertilisers, pesticides and medical supplies for animals with the inclusion of a wide range of practices that are expected to be "socially, ecologically and economically sustainable" (Anderson, Jolly and Green, 2005; Bourn and Prescott, 2002). Hence, organic foods are foods that are produced using methods of organic farming that do not involve modern synthetic inputs such as synthetic pesticides and chemical fertilisers and are also not processed using irradiation, industrial solvents, or chemical food additives (Crinnion, 2010). The aspiration of food consumption is not only body nourishment but also health improvement over lifetime. Modern food consumers are highly concerned about their safety and quality of the foods as well as food products purchased. This concern goes simultaneously with their awareness of the nexus between the production practices and quality of food products as well as environmental concern (Thøgersen and Ölander, 2002).

Moreover, the awareness has contributed towards growing demand for food from non-conventional production practices as well as an increasing consumers' interest in having a closer relationship with the food producers (Botonaki, Polymeros, Tsakiridou and Mattas, 2006). This change has been especially significant in the demand for organic foods, since the global annual organic sales are estimated at around 38.6 billion US Dollars in 2006 which is double the figure in comparisons with the figure in 2000 (Willer, Yussefi and Sorensen, 2008).

Share of organic agricultural land in the Nigeria is less than one percent in 2010 as the country is not ranked among the ten African countries with the most organic agricultural land (FiBL-IFOAM 2012). Initially, organic agriculture existed in Nigeria by default because

of the unavailability and sparse use of chemical inputs by farmers forcing some to adopt the use of animal droppings as manure, (Obayelu, Agboyinu, and Awotide, 2014). Although, the situation has since changed as farmers are now aware and gradually adopting organic production and consumption. The high rate of adoption in Nigeria especially in Oyo State could probably be driven and strengthened by non- governmental organisations like Nigerian Organic Agriculture Network (NOAN), Organic Agriculture Project in Tertiary Institutions in Nigeria (OAPTIN) and Olusegun Obasanjo Centre for Organic Agriculture Research and Development (OOCORD) among others. Therefore, the market of organic products continues to grow as the number of people willing to eat organic food across the state.

Furthermore, organic foods provide essential nutrients to humans affordably with its vantage cheap and reliable sources of protein, vitamins and minerals for body development and repair. Fruits, nuts and vegetables in the daily diet have been strongly associated with reduced risk for some forms of cancer, heart diseases, stroke and other chronic diseases (Hyson, 2002). Mitchell, Hong, Koli, Barrett, Bryant, Denison and Kaffka (2007) discovered that fruits and vegetables produced organically have increased levels of flavonoids which are reported to protect against cardiovascular disease (Hertog and Hollman, 1996) and to a lesser extent, against cancer and other age-related diseases such as dementia (Commenges, Scotet, Renaud, Jacqmin-Gadda, Barberger-Gateauand Dartigues, 2000).

Consumers are becoming more interested in environmentally friendly products, such as organic food thereby raising the demand against a limited supply (Ahmad and Juhdi, 2010; Vietoris, Kozelová, Mellen, Chreneková, Potclan, Fikselová, Kopkáš and Horská, 2016). The growth of organic products is seen as part of emerging marketing trends where consumers seek to know what an organic product can deliver before making purchase decisions (Thøgersen, Zhou, and Huang, 2016).

On the other hand, health, environmental and economic problems connected with conventional farming was the main facts behind organic farming initiative in Nigeria (Adeoluwa, 2014). Pimentel, Paul, James, Rita, and David (2005) supported this assertion by stating that heavy agricultural reliance on synthetic-chemical fertilisers and pesticides is having serious impacts on public health and environment. According to Maroni, Fanetti and Metruccio (2006), in spite of the economic and social importance of agriculture, the health protection of agricultural workforce has been over looked for too many years. This caused a heavy tribute paid in terms of avoidable disease, human sufferance and economic losses. Scientific investigations revealed that there are lots of dangers associated with food intake; increases in diseases like cancer have been linked to increase in the use of chemical input.

Therefore, the use of synthetic fertilisers and other agrochemicals may cause pollution and contribute to environmental degradation. Thus, making agricultural practices unsustainable. Some inorganic fertilisers which are used to increase crop yield are leached or washed away by erosion to nearby rivers leading to water pollution which is dangerous to aquatic life and human health.

However, literature has shown that organic foods stand a chance of addressing the problems of conventional foods. According to Gelatini and Rosell (2006), acceptance and popularity of organic foods are growing mostly due to environmental and health related concerns. Consumers advocate for organic foods just because its production tends to be more natural, environmentally friendly and also sustains the health of soils, ecosystem and people (Gbadegesin, 2011). Despite the global awareness of environmental degradation and health issues that could arise from continuous consumption of inorganic foods coupled with the threats they pose on sustainable agricultural production and the increase in organic production in Oyo State, consumers are not quite motivated to purchase and consume organic foods probably because they are a bit costly than the conventional ones. Also, due to the unavailability of preferred varieties in large quantity, people are still in the habit of purchasing inorganic produces.

Therefore, the need to determine respondents' motivation to purchasing organic foods in Oyo state.

Objectives of the study

The general objective of the study was to determine consumers' motivating factors to purchasing of organic foods in Oyo State.

The specific objectives of the study were to:

1. ascertain respondents' source of information about organic foods;
2. determine respondents' knowledge about organic foods; and
3. ascertain respondents' frequency of purchase of organic food.

Methodology

The study was carried out in Oyo State. It is located in the Southwest geo-political region of Nigeria. There are thirty-three Local Government Areas (LGAs) in the state. The state occupies a land mass of about 28,454 square kilometre with a population of about 5,580,894 persons (NPC, 2006).The state has some tropical rainforest in the south around Ibadan the state capital but is covered mostly by a "derived" savannah.

Agriculture and handcrafts are the backbones of the state's economy while, Oyo State is known for agricultural products such as yam, corn, cassava, beans, palm oil, cotton, kola nuts, vegetables and fruits. Although, organic production of these crops is still handled by small-scale farmers under the third party guarantee system (PGS).

The PGS is coordinated by NOAN - an organisation that is situated in Ibadan the capital of Oyo State.

The target population comprised of all consumers of organic foods in Oyo State. Multi-stage sampling procedure was used to select the respondents for the study.

Stage 1

Purposive sampling technique was used in selecting three (ten percent) of the thirty three (33) Local Government Areas (LGAs) in Oyo State due to organic agriculture promotion activities that have been carried out in these domains. The selected LGAs were Ibadan North, Akinyele and Ogbomoso North.

Stage 2

Simple random sampling technique was used to select three (10 percent) of the wards in each of the selected LGAs. In all, nine wards were selected including Bodija/Secretariat/Obasa in Ibadan North Local Government Area, Ajibode/Ojo/ Lanibain Akinyele Local Government Area and IsaleAfon/Jagun/Sabo from Ogbomoso North Local Government Area.

Stage 3

Twenty percent of the communities in the selected wards were randomly selected to have; six communities in Ibadan North, nine from Akinyele and five from Ogbomoso North. This gave twenty communities in all.

At the final stage, random sampling technique was used to select a hundred and twenty (120) organic food consumers from the selected communities across the state.

Data on respondents' sources of information, knowledge of organic foods, frequency of purchase of organic foods and motivating factors to purchasing organic foods were obtained through the use of structured questionnaire that contained both open and close ended questions. This was administered as interview schedule to illiterate respondents.

Consumers' sources of information about organic foods were measured by providing them with likely sources in which they could obtain information about organic foods with two response options of "Yes" and "No" with scores of 1 and 0 assigned, respectively. Maximum score obtainable was 13, while the least score was 1. Subsequently, mean scores were computed for each sources to identify their sources of information about organic foods in ascending order.

Respondents' knowledge about organic food was measured by providing them with twenty knowledge items. The items were generally on identification of organic foods in the market, health and nutritional benefits of organic foods among others. Some of the questions were generated in an open ended format, some with response

options where respondents were expected to tick the correct answers. Correct answers were assigned 1 while wrong answers were assigned 0. Maximum score obtainable was 20, while the least score was 0. Respondents were categorised into high and low knowledge level through the mean score criterion. Respondents with the mean scores and above were categorised as having high knowledge about organic foods, while those with scores below the mean score were considered as having low knowledge about organic foods.

To measure frequency of purchase of organic foods, respondents were provided with a list of organic foods such as organic vegetable, organic yam, organic rice, organic fruits etc. and were asked to indicate how frequent they purchase food items with a 3- response options of "Always", "Occasionally" and "Never". A score of 2, 1 and 0 was assigned to response options of "Always", "Occasionally" and "Never" respectively. The maximum score obtainable was 34, while the least score was 0. Thereafter, mean score was generated for each item to rank the frequently purchased organic food items. The organic food item with the highest mean was the most frequently purchased item.

Respondents' motivating factors for purchasing organic foods was measured by providing the consumers with ten possible reasons that could motivate them to purchase organic foods such as freshness of food item, health and nutritional benefits among others. Respondents were asked to indicate from the three response options provided; the extent to which the factors motivate them to buy organic foods. The response options were "To a large extent", "To a lesser" and "Not at all". Score of 2, 1 and 0 were assigned to response option of "To a large extent", "To a lesser" and "Not at all" respectively. Maximum score obtainable was 20, while the least score was 0. Mean score was computed for each motivational factors and used to rank them in ascending order; the factor with the highest mean score was ranked highest. Afterwards, mean score computed to categorise respondents' motivation into high and low level. This was done in such a way that respondents with mean score and above were categorised highly motivated while those with scores below mean score were categorized as low.

Descriptive statistics which include frequency count, percentages and mean were used to analyse data collected.

Results and discussion

Respondents' sources of information about organic foods

Table 1 shows that friends($\bar{x}$=0.78), social media ($\bar{x}$=0.75), television ($\bar{x}$=0.65), family ($\bar{x}$=0.61), other consumers ($\bar{x}$=0.59) and radio ($\bar{x}$=0.55) were identified by the respondents, were the sources in which respondents obtained information about organic produce and they were ranked first, second, third, fourth, fifth and sixth respectively. This implies that respondents in the study area have a wide range of information sources on purchase and consumption of organic foods.

Table 1: Distribution of respondents by sources of information on organic foods, n=120

Source of information	Yes		Mean	Rank
	F	%		
Friends	94	78.3	0.78	1st
Social media	90	75.0	0.75	2nd
Television	79	65.8	0.65	3rd
Family	74	61.7	0.61	4th
Other Consumers	71	59.2	0.59	5th
Radio	67	55.8	0.55	6th
Neighbours	61	50.8	0.50	7th
Magazines	58	48.3	0.48	8th
Health officer	55	45.8	0.45	9th
New paper	53	44.2	0.44	10th
Extension agents	46	38.3	0.38	11th
Bulletin	43	35.8	0.35	12th
Posters	33	27.5	0.27	13th

Source: Field Survey, 2019

Consumers' knowledge of organic foods

Table 2 indicates that majority (75.8%) of the respondents knew that people with allergies to food chemical and preservative always find organic foods appropriate alternative, organic food items are nutritious than conventional because they are free from synthetic chemical and preservatives

respectively. Most (75.0%) of the respondents also knew that label on organic foods connote that organic foods are 100% certified while 72.5% of the respondents discerned that naturally grown foods taste better as 71.7% were sure that organic foods are high in nutrients and that organic food items have more beneficial nutrients such as antioxidants than the conventional respectively. This implies that consumers are quite aware of what and why they are buying organic foods; they knew so many things about organic foods than one can think of. Table 1 also reveals that more than half (55.8%) of the respondents had high knowledge on organic food consumption while 44.2% of the respondents had low knowledge on organic food consumption. The implication of the high level of knowledge is that the respondents understand what organic food entails and benefits they could derived from it, which means people that are patronising organic foods are those that are directly in need of alternative food items probably for their health or nutritional benefits. Hence, the consumers took their time to know more about their food consumption and hence positive development towards organic agriculture production. This corroborate Yilmaz and Ilter, (2017) who opined that positive development in the fields such as education, income and media also increases the knowledge and consciousness level of consumers purchase.

Table 2: Distribution of respondents based on knowledge of organic foods

Questions	Correct (%)	Incorrect (%)
How would you identify organic food items in the market?	40.8	59.2
What is the main difference between organic food items and inorganic when they are put together on shelf?	58.3	41.7
What are health benefits of organic food to consumers?	45.8	54.2
Presently where can you get organic food items?	43.3	56.7
Do you know that organic food is high in nutrients than inorganic food?	71.7	28.3
How popular are organic food items to consumers?	57.5	42.5
What does then label on organic food items means?	75.0	25.0
Organic food item does not have any side effects when eaten	70.8	29.2
Organic food is GMOs free	65.8	34.2
Organic food items are purchased for the following reasons except	47.5	52.5
A food item that contains100% organic means	68.3	31.7
Organic food items are nutritious than conventional food items	75.8	24.2
Organic food items often have more beneficial nutrients such as antioxidants than their conventional foods	71.7	28.3
People with allergies to foods, chemicals and preservatives always find organic food items	75.8	24.2
Do you agree that naturally grown food tastes better?	72.5	27.5
When you buy organic food items, you are guaranteed	37.5	62.5
Nigeria's certified organic label for food items is	42.5	57.5
What's the relationship between organic food and local food?	40.0	60.0
Organic foods are more nutrient dense than conventionally grown foods?	65.8	34.2
When you buy organic meat, you can be sure you're getting	55.0	45.0
Knowledge level	%	Mean
High	55.8	11.52
Low	44.2	Low
Total	120	Total

Frequency of purchase of organic food

Results in Table 3 reveal that majority of respondents' frequently purchase organic fruit vegetables were tomatoes, okra, cabbage, lettuce and pepper ($\bar{x}$=1.81), organic fruits such as pawpaw, banana, mango, grape, apple and cucumber ($\bar{x}$ =1.63), others are organic leafy vegetable like *celosia, scent leaf, bitter leaf* and *amaranthus* ($\bar{x}$ =1.54). It was also evident from result of findings that respondents' least organic food purchased were cassava ($\bar{x}$=1.18), wheat ($\bar{x}$ =1.06) and mushroom ($\bar{x}$=0.62). This implies that respondents in the study area purchase more of organic fruit vegetables, organic fruits and leafy vegetables when compare to other organic food products such as organic meat, rice and the likes. This could be because these are only available foods in the study area. Stolton (2003) stated that approximately two third of organic foods marketed are fresh vegetables and fruits with lower sales in processed and packaged foods.

Consumers' motivation factors for purchasing organic foods

Table 4 reveals that majority of the respondents were motivated to a large extent by freshness of foods ($\bar{x}$=1.76), better taste ($\bar{x}$=1.76), health value ($\bar{x}$=1.75), nutritional value of the food ($\bar{x}$=1.68) and high quality of food (x=1.63).

The implication is that respondents in the study area are more motivated toward purchasing organic foods due to the freshness, better taste, health and nutritional benefits derived from organic foods. This result for health consciousness aligned with those of Mohammed *et al* (2012), and Grubo and Djokic (2016) who stated that factors that motivate them to purchase organic foods is influenced by consumers' belief on safety and health aspects. In addition, Crinnion

Table 3: Distribution of the respondents based on frequency of purchase of organic food n=120

Organic food items	Never	Occasionally	Always	Mean	Rank
Fruits vegetables (tomatoes, okra, cabbage, lettuce, pepper)	5.0	25.0	68.3	1.82	1st
Fruits (pawpaw, banana, mango, grape, apple, cucumber)	4.2	28.3	67.5	1.63	2nd
Leaf vegetables *(celosia, scent leaf, bitter leaf, amaranthus)*	5.8	34.2	60.0	1.54	3rd
Meat	12.5	30.8	55.8	1.50	4th
Egg	12.5	25.8	61.7	1.49	5th
Rice	14.2	27.5	58.3	1.44	6th
Milk	14.2	27.5	58.3	1.44	6th
Garri	17.5	30.8	51.7	1.34	8th
Beans	12.5	41.7	45.8	1.33	9th
Yam flour	14.2	55.0	30.0	1.33	9th
Groundnut	15.0	40.0	45.0	1.30	11th
Yam	10.0	50.8	38.2	1.29	12th
Sweet potatoes	11.7	48.3	40.0	1.28	13th
Melon	12.5	55.8	31.7	1.19	14th
Cassava	23.3	50.0	25.8	1.18	15th
Wheat	20.0	53.3	28.7	1.07	16th
Mushroom	54.2	29.2	16.7	0.62	17th

(2010) stated that organic foods are perceived to contain great nutritional value and few toxic chemicals. Although nutrient contents in organic foods vary from farmers to farmers.

Table 4 also shows that 56.7% of the respondents had high motivation toward purchasing organic food while 43.3% of the respondents had low motivation toward purchasing organic food. This result implies that respondents in the study area are likely to consume organic foods compared to inorganic foods probably because of the health challenges and nutritional benefits derived from organic foods. This is similar to the findings of Davis *et al.,* (1995) who revealed that purchase motives are attributed to health and environmental consciousness, safety and quality concern and exploratory food buying behaviour as well as to specific product attributes such as nutritional value, taste and freshness.

Conclusion and Recommendations

Consumers heard about organic foods from friends, social media and television. They are highly knowledgeable and understand what organic foods entail as well as the benefits they could derived from it. Consumers frequently purchase organic tomatoes, okra, cabbage, lettuce, pepper, pawpaw, banana, mango, grape, apple, cucumber, *celosia, scent leaf, bitter leaf and amaranthus* among others food items. Finally, they are highly motivated by freshness, better taste and health benefits of organic foods.

Therefore, because consumers are highly knowledgeable and motivated to purchase organic foods, both organic livestock and crop production should be encouraged in order to be able to cater for the teeming population in the state and the country at large.

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Table 4: Distribution of the respondents based on consumers' motivation factors for purchasing organic food

Motivating factors	Larger extent	Lesser extent	Not at all	Mean ($\bar{x}$)	Rank
Freshness of foods	80.0	15.8	4.2	1.76	1st
Better taste	69.2	22.5	8.3	1.76	1st
Good for my health	80.2	15.0	4.2	1.75	3rd
Nutritional value of the food	75.0	17.5	7.5	1.68	4th
High quality of food	69.2	24.2	6.7	1.63	5th
Good for my children	64.2	22.5	13.3	1.51	6th
No pesticide residue	54.2	31.7	14.2	1.40	7th
Longer shelve life	49.2	37.5	13.3	1.36	8th
Good for the environment	46.7	35.0	18.3	1.28	9th
Level of motivation	Frequency	Percentage %			
Low	52	43.3			
High	68	56.7			
Total	120	100.0			

Source: Field Survey (2019)

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Ecological Structure of African Ebony *Diospyros mespiliformis* Across two Climatic Zones and Habitats for its Availability in Benin, West Africa

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Abstract

Differences in ecological structure of *Diospyros mespiliformis* Hochst. ex A. Rich. fruit trees resources have often been indicated by foresters while complete structural characterization of the species' populations has never been performed. This study using circular and rectangular plots assessed ecological structure of these species across different climatic zones in Benin in order to contribute to its conservation. Information on total number of species and relative abundance of all living trees were recorded within each plots. Bearing and architectural parameters (diameter at breast height (DBH), total height (Tot-h), bole height (Bo-h), crown diameter (Cro-d) and crown height (Cro-h) were measured from 735 individual adult trees across two climatic zones of four main habitats. Principal Components Analysis as well as clustering and canonical discriminate analysis were performed on the data collected using the correlation matrix. Diameter and height class distribution revealed a bell shaped curve characteristic of young stands. Principal components analysis indicated some significant difference among climatic zones and habitats. Adult ebony individuals were grouped into tree clusters with greater accessions from similar climatic zone and habitat. Since bearing parameters exhibited large variability; there are pathways for selection purposes. Optimizing the conservation of the species would require its inclusion in formal conservation policies.

Keywords: Ecological structure, Availability, Populations, *Diospyros mespiliformis*, Benin Republic.

Structure écologique de *Diospyros mespiliformis* Hochst. ex A. Rich. à travers deux Zones Climatiques et Habitats au Bénin

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Résumé

Des différences dans la structure écologique du fruitier indigène *Diospyros mespiliformis* Hochst. ex A. Rich. ont souvent été signalées par les forestiers alors qu'une caractérisation structurale complète des peuplements de cette espèce n'a jamais été effectuée. La présente étude utilisant des placettes circulaires et rectangulaires a pour objectif d'évaluer la structure écologique de cette espèce en vue de contribuer à sa conservation. Des informations sur la densité et la relative abondance des individus adultes de toutes les espèces présentes ont été enregistrées au sein de chaque placeau. Des paramètres structuraux et architecturaux nt été mesurés pour un total de 735 individus adulte de l'espèce à travers les deux zones climatiques et les quatre types d'habitats. L'analyse en composante principale, la classification hiérarchique ainsi que l'analyse canonique discriminante ont été exécutée sur les données collectées en utilisant la matrix de corrélation. La distribution par classes de diamètre et de hauteur a révélé une courbe en forme de cloche caractéristique des jeunes peuplements. L'analyse en composantes principales a révélé une différence significative de densités entre zones climatiques et habitats. Les individus adultes d'ébénier sont groupés en catégories d'arbres avec de plus grandes accessions provenant de zones climatiques et d'habitats similaires. Etant donné que les paramètres structuraux présentaient une large variabilité, il existe des possibilités de sélection d'individus d'ébénier intéressants. Optimiser la conservation de cette espèce forestière implique son inclusion dans des programmes formels de conservation

Mots Clefs : Structure écologique, Distribution, Populations, *Diospyros mespiliformis*, Bénin

Introduction

Ecosystem is the interconnectedness of many flora and fauna species with each other and their environment. Among plant species growing in forests, there are wild fruit trees which are an important source of food with sufficient vitamins and macronutrients consumed by the rural and urban population (Assogbadjo, 2005). Fruit trees globally and indigenous fruit trees in particular constitute one of the most diverse groups of organisms on earth and also form an important part of terrestrial ecosystems. They have continued to gain recognition and elicit different interests and questions as potentially resourceful tool in economic modulation pari passu prevailing resilience on leafy plants. Indigenous fruit trees play an important role in livelihood and are the best-known part of the earth's biodiversity.

Knowledge about good number of wild fruit trees is abysmally low and this impacts negatively in conservation of these resources. The tropical region comprising West Africa which is undoubtedly hosting the highest biodiversity has been inadequately sampled and the fruit tree flora scarcely documented. For probably as long as people have lived, they have eaten culturally and traditionally important indigenous fruits such as *Adansonia digitata* (baobab), *Balanites aegyptiaca* (Desert date), *Blighia sapida* (Akée), *Dacryodes edulis* (African Pear Fruit), *Parkia biglobosa* (Néré), *Sclerocarya birrea* (marula), *Tamarindus indica* (tamarind), *Vitellaria paradoxa* (Karité), *Vitex doniana* (black plum) and *Diospyros mespiliformis* (African Ebony) (Biaou, 2017; Dicko *et al.* 2017).

As regards African ebony, many factors contribute to the degradation and loss of its natural habitat such as widespread deforestation resulting from population growth, cutting of trees for firewood or charcoal, and in some cases industrial agriculture or other business interests.

In recent decades, several extensive studies have shown that habitat loss and fragmentation due to agriculture have negative effect on tropical wild trees' communities in the world while few studies have focused on indigenous fruit trees ecological characteristics in Africa and there is a little or no available data on their abundance and distribution across habitats where they are found. According to (Gnonlonfin, 2018), the inadequate knowledge of wild fruit tree is of particular concern because the biome contains over half of the world species. Although, African ebony trees appear to be widely distributed, very few studies

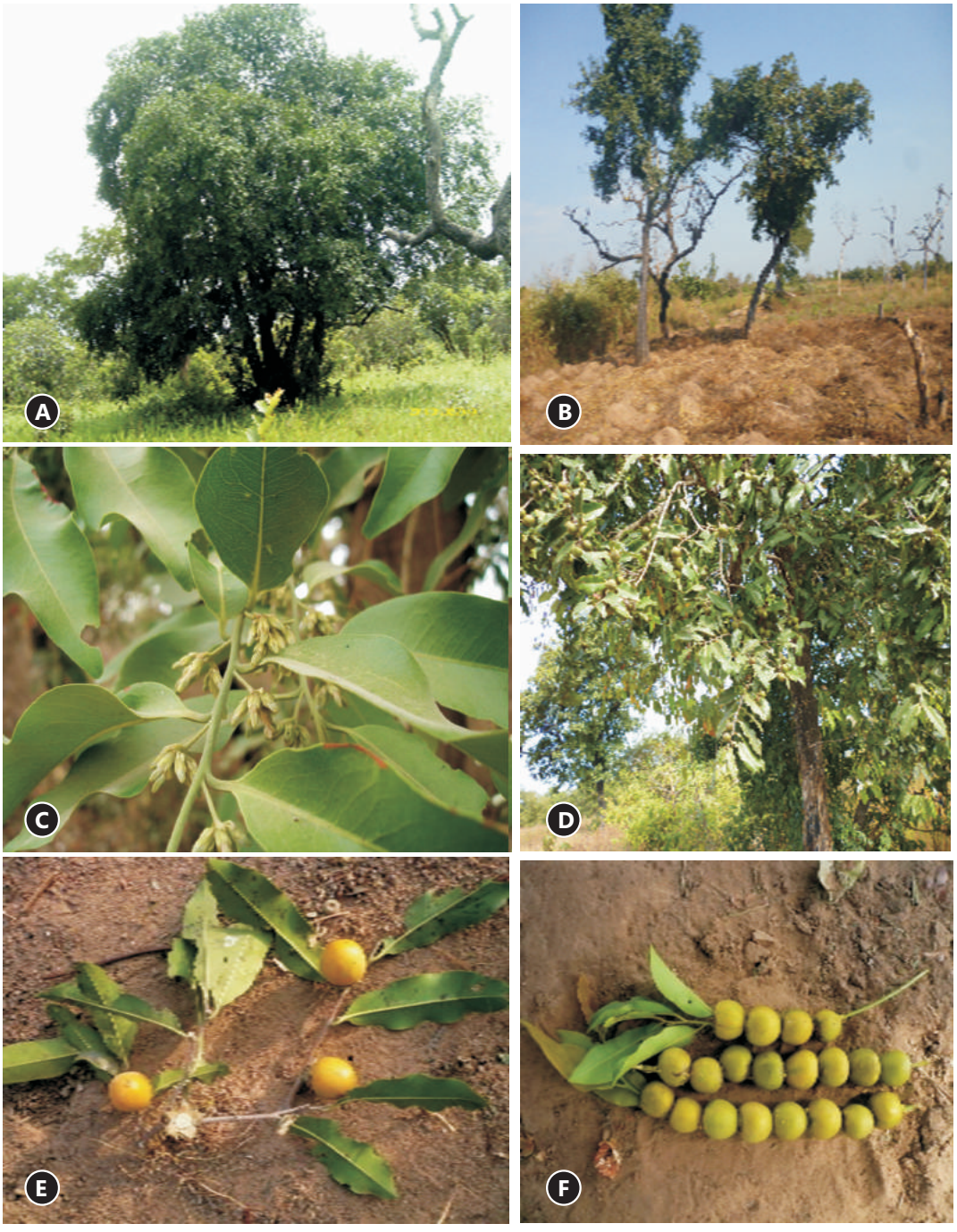
have been conducted on them. Some of such studies are mostly based on distribution while status survey had not been investigated (Akoegninou, 2006; Fandohan, 2007). First attempt of International Union of Conservation of the Nature (IUCN) placed African ebony under the least concerned category owing to its supposed wide distribution and relative abundance, but there is little information on it. In West Africa, forest fragmentation is an extremely severe challenge due to rapid population growth and agricultural land use (Abasse and Weber, 2011). According to (Assogba *et al.* 2018), habitat loss, destruction and degradation are the major treats to African ebony species richness and diversity. Researchers have attributed this loss of habitats to man-made or natural causes (Fandohan *et al.* 2017).

In time past, African ebony *Diospyros mespiliformis* 'populations has not been quantified, but it has not reached the threshold vulnerability under the population size criterion (Agbahoungba *et al.* 2017; Assogbadjo 2017). Considering the fact that the population status of African ebony is globally unknown research indicates that the species might be facing serious threats from habitat loss and human pressures (Shackleton *et al.* 2017; Idohou *et al.* 2017; Gandji *et al.* 2018; Agbahoungba *et al.* 2017; Assogbadjo 2017). Information on sizes of populations and levels of distribution and diversity of species of interest is important for the development of the appropriate natural resources management and conservation schemes for different groups of plants and animals. No form of wildlife management can be possible or successful without any reliable background information on their population structure, distribution, morphometric traits and conservation status of the species concerned. Therefore this study is aimed at assessing the ecological structure of the species across different bio-geographical zones in Benin in order to contribute to its conservation. Specifically, study will create inventory on existing ebony in Benin, establish the distribution map of the species and propose sustainable management approach in order to secure conservation of the species.

Materials and Methods

Study species

Diospyros mespiliformis (Ebenaceae) is an evergreen woody tree (a, b) of importance in ethno-medicine with dense, rounded and buttressed stem (Wallnöfer, 2012). It is found in the tropical forest in Sub-Saharan Africa from Ethiopia to the Swaziland according to (Arbonnier 2002a). It is has also been discovered in Angola, Nigeria, South Africa, Tanzania, Uganda, Yemen, Republic of Zambia and Zimbabwe and it found in four main different habitats (parklands, woodlands, savannahs and along riverbanks) in the study area. It prefers areas with permanent water that helps in natural regeneration, and it grows faster in frost-free areas. It favours heavy soils on riverbanks rocky soils along seasonal water courses and swamps but also occurs in open woodland and is commonly found on termite mounds. It grows well in moist, red loams, volcanic and loamy sands. Its biophysical limits indicate an altitudinal exigency mean of 350-1250 m with mean annual temperature of 16-27 deg. C and mean annual rainfall of 500-1 270 mm. Research reports indicate that adult ebony trees can grow up to 20 – 40 m in total height, and 150-200 cm diameter at breast height (see images). The ebony leaves are generally alternate (a & b), shiny-green above, and paler beneath, 3.5-19 cm long, 1.5-7.5 cm wide, oblong elliptic. Flowers (c) are pentamerous, white and fragrant. Flowering starts in April-May during the rainy season and fruits reach maturity in November -January during the dry season. Edible fruits (d, e and f) are usually globosely, fleshy, up to 3 cm in diameter, greenish and pubescent when young, yellowish to orange yellow and glabrous when ripe with dark brown seeds. The wood, because of it is not easy to work with is highly valued as fuel and is used to make canoe.



Figures 1: Images of mature individuals and organs of the study species

Study area

The study site occupies a total area of 83723 Km^2 (74%) of the total area of Benin (112622 Km^2). The survey was conducted between October 2017 and May 2019 in the two northern climatic zones of Republic of Benin which lies between latitudes

7° 30' N and 12°40' N, and longitudes 1°6' E and 3°45' E where the species grow widely. The study area experiences a unimodal rainfall with two distinct seasons : wet season May – September and dry season from October to April with an average of seven months rainy season (Adomou, 2005)). The Soudano-guinean climatic zone or transitional zone (between humid Guinean zone and the Soudanian zone) is characterized by a vegetation mosaic of forest islands, gallery forests and savannahs. Mean annual temperature in this zone is 35° C and mean annual rainfall 900 – 1100 mm. The soudanian climatic zone is a woodland and savannahs region with ferruginous soils. Mean annual temperature in this zone is 35° C and mean annual rainfall 400 – 850 mm. Vegetation in the area has been categorized into four namely biological types, (i) trees, (ii) herbs, (iii) shrubs and (iv) climbers comprising a wide diversity each. This vegetation has beautiful greenery with numerous wild trees such as *Adansonia digitata, Blighia sapida, Bombax* costatum, *Diospyros mespiliformis, Khaya senegalensis, Parkia biglobosa, Tamarindus indica* and *Vitellaria paradoxa* which has well been identified for more than one intended use, either for commercial purposes, household use, or for land protection/ improvement. The other plant species include *Chromolaena odorata*, *Sida acuta* among others. Estimated at 2,941,180 inhabitants with the farm population around 90 2,626,430 inhabitants (INSAE 2015), the population of the study area is mostly composed of dominant ethnic groups such as Batonou, Fulani/Peuhl, Dendi, Mokole, Boko, Nagot, Yom, Haoussa, Adja and Fon (Dicko, 2016).

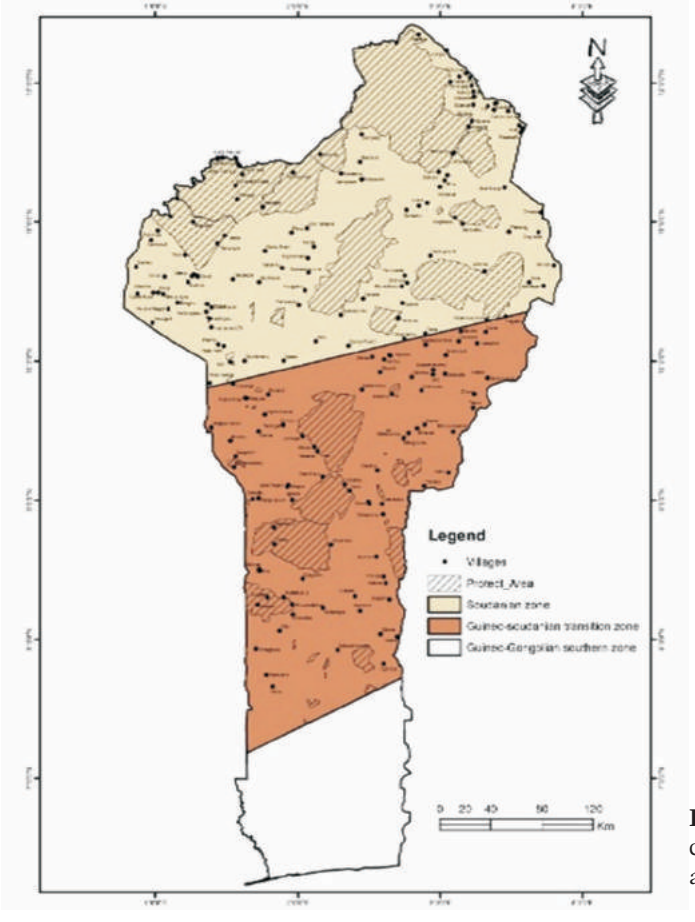


Figure 2: Location of the two climatic zones of the study area in Benin Republic

Study Methods

Sampling population and e-species inventory (data collection)

All structural characteristics in the present study were recorded using forms well-planned with the aid of Smartphone with Kobo toolbox (Olajide 2019). A multi-stage sampling procedure was carried out in this study. This involved a purposive selection. Data collection was carried out in the two climatic zones (Sudano-guinean transition and Sudanian zones) representing the geographical distribution area of the species. From the Benin administrative unit map, twenty-two districts were selected which is the representative the study area a great diversity of vegetation. Based on the exploratory survey, the species habitat was grouped into four: in the protected area, there is the group of inundated forests or swampy forests where individuals of the species live in aggregative distribution and the group of woodland as well as the group of savannah where individuals are isolated. In the unprotected area, there is a group which included farmlands, fallow, plantations and parklands. The unit of sampling is constituted by the plot (Dadegnon, 2015). The installation of the plot is conditioned by the presence of the ebony species. Along those districts and for each habitat, four circular or rectangular plots were randomly selected based on the presence of at least one ebony adult tree. This resulted into 16 plots of 1000 m^2 per selected village where the species was found. In total there are 263 circular and 88 rectangular plots installed along the study area. In each plot, the vegetation type and species other than *D. mespiliformis* (adult individual and regeneration) were noted (Akoegninou, 2006; Arbonnier, 2002a). An inventory of all adult ebony trees (DBH > 10 cm) as well as the registration with the use of Global Positioning System (GPS) were taken. The recorded geographical coordinates of the central ebony individual trees were plotted on the Benin map (Figure 1).

Data Recorded for Structural Characterization of Ebony Populations

The following variables were collected for structural characterization of ebony populations: diameter at the breast height (DBH) and crown diameter (cd) using digital Venier caliper and tape; total height (Tot_h) and bole height (Bol_h) with the aid of Suunto clinometers, which were systematically measured for each of the censured ebony tree (Ouinsavi 2010).

Data Treatment and Analysis

We assessed *D. mespiliformis* population structure and calculated densities per climatic zones and habitats using DBH and total height as measures of tree size. Also the number of trees were used to determine and compare tree abundance across habitats and climatic zones using Wilcox on test with R Software. Three indexes (Pielou evenness, Shannon) and specific richness (Herman, 2015) were used to characterize habitats and climatic zones. Shannon Wiener entropy index H and the tree diversity D were used to characterize each climatic zone and habitat. Then each index calculated per climatic zone and habitats was compared using ANOVA analysis test. Bearing and architectural measures were used to draw size class distribution histogram. Also, diameter size class and Skewedness' index were used to characterize species structure. Then a Generalized Linear Model (GLM) was used to test effect of climate zones and habitats on tree densities and abundance (all species and ebony adult trees with regeneration densities). Principal component analysis (PCA) was performed on the untransformed dendro-metrics data using the FactoMineR and factoextra packages and correlation matrix with R 3.6.2 software. Correlogram was finally generated to explain degree of link between bearings and architectural parameters.

Results

Habitat characteristics, companion species and abundance of *D. mespiliformis* across climatic zones and habitats.

Adult individuals (DBH >10 cm)

Eleven variables (including bearing and architectural parameters) were used for ecological characterization of the study species across climatic zones (agro-ecological zones) and habitats (Table 1). The results indicated the presence of the study species in the two 160 agro-ecological zones (transition zone and the soudanian zone) found in the four habitats (parkland, gallery forests, woodland and savannah). In the parklands, the species were spared while clearing new lands for agricultural crops and it was associated with other indigenous fruit trees such as *Adansonia digitata*, *Blighia sapinda, Parkia biglobosa*, *Vitellaria paradoxa*, *Tamarindus indica et al.* In the protected areas (gallery forests, Woodlands and Savannah) the species was mainly associated with *Mitragyna inermis, Tamarindus indica, Anogeissus leiocarpa*, *Isoberlinia doka*, *Combretum spp,* etc. The density of the adult individuals of the study species varied from one climatic zone habitat to another, with most of the adult individuals recorded in riverbanks (gallery, inundated or swampy forests). The higher DBH (682 cm) and tree height (more than 50m) were noted in inundated forests and parklands in the Soudanian zone while the higher density in adult tree of *D. mespiliformis* was obtained in the Soudano-guinean zone and gallery or swampy forests (Table 1).

The DBH size class distribution was significantly different between the climatic zones (Log-linear analysis, $\chi 2 = 84.31$, $p = 0.011$). All DBH classes (from DBH 10 cm to 682 cm) were represented in the Soudano-guinean zone and gallery (inundated) forests while in the other habitats for example parklands, there was some missing class (es). On the one hand, trees with DBH 50-350 cm were the most abundant in both the Soudano-guinean and Soudanian zones as well as in all habitats (inundated forests, woodlands, savannah and parklands). On the other hand, trees with DBH< 50 cm were the most abundant in Atacora -Mountains, Natitingou and Tanguieta.

Table 1: Structural characteristics of *D. mespiliformis* across climatic zones and habitats

	Tot_D	di_D	Spe_Ri	DBH	Tot_h	Bo_h	Cro_d	Cro_h	Seedlings	Saplings	Pole
Climatic zones											
Guineo-Souda-zone											
Mean±Sdd	9,95±6,7	4,92±4,2	35,58±9,3	147,96±102,8	16,46±6,6	6,67±3,8	7,46±3,6	6,76±2,5	152,01±143,4	49,16±39,2	16,66±14,2
Soudanian-zone											
Mean±Sdd	6,74±4,3	3,23±3,1	34,75±6,9	104,89±91,6	13,61±6,4	6,04±3,4	6,66±3,1	6,30±2,5	106,33±95,6	30,35±25,3	13,31±11,5
Habitats											
Riverbank											
Mean±Sdd	8,27±4,9	3,64±2,1	41,00±4,2	60,72±89,4	14,02±6,0	5,88±3,3	6,56±3,2	6,30±2,5	4,70±3,8	22,55±19,1	12,02±8,5
Parkland											
Mean±Sdd	8,96±7,3	1,44±5,0	8,5±0,7	130,99±99,0	15,34±6,6	6,54±3,7	7,33±3,6	6,41±2,4	2,44±95,2	2,55±18,5	2,19±6,7
Savannah											
Mean±Sdd	9,48±6,0	2,83±4,2	43,51±0,0	35,42±72,9	12,25±5,1	5,71±3,7	5,97±2,5	6,04±2,4	209,96±136,8	60,32±67,8	20,46±14,1
Woodland											
Mean±Sdd	7,03±4,7	2,47±3,3	28,97±2,8	176,60±108,5	18,20±7,3	7,22±3,6	8,28±3,6	7,33±2,5	191,54±146,6	43,7±39,7	18,79±15,6

Source: Field report, 2018.

Occurrence of seedlings, saplings and poles through climatic zones and habitats

Saplings and poles' densities were higher in inundated forests than in woodlands and savannah. There were no regenerative stems (seedlings, saplings and poles) in parklands both for the Soudano-guinean and Soudanian-zones. Occurrence of regenerative stems (saplings and poles) differed significantly among protected habitats. There was low seedlings (2-4 stems/ha) in inundated forests and parklands as compared to saplings and poles (Table 1). However, seedlings, saplings and poles were more present in different proportions in woodlands and savannah.

Table 2 a & b: Variations of Shannon diversity and Pielou's eveness indexes through climatic zones and habitats.

Analysis of Table 2 a indicates that significant differences were observed among habitats.

However, only parklands indexes differ from indexes of other habitats ($p = 0.007 < 0.05$) indicating low species diversity in this habitat. This low diversity could be due to habitat clearing for installing crops by farmers (Table 2 a b; Figure 2) . On the other hand, Shannon diversity indexes were 3 times higher in gallery forests (inundated forests) than in other three habitats (savannah, woodland and parkland) (Figure 2). The permanent presence of water and shade in inundated forests and savannah could be used to explain high value of the Shannon diversity index (Figure 3).

Variables	Shanonn diversity		Pielou's evenness	
Climatic Zones	mean±sd	P	mean±sd	P
SZ	2.50±0.084	0.591	0.71±0.03	0.490
SGZ	2.57±0.24		0.72±0.03	
Habitats				
Gallery Forest	2.66±0.20		0.71±0.02	
Parkland	2.33±0.007	0.0077**	0.69±0.03	0.2625
Savannah	2.65±0.12		0.70±0.03	
Woodland	2.52±0.04		0.75±0.04	

Table 2 a

Species Richness	mean	sd
Climatic Zones		
SZ	34.75	6.99
SGZ	35.5	9.33
Habitats		
Gallery Forest	41	4.2
Parkland	8.5	0.7
Savannah	43	0
Woodland	28	2.8

Table 2 b

Source: Field report, 2018.

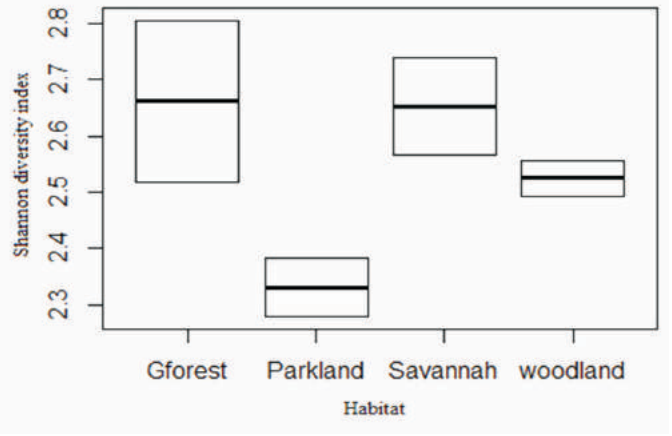


Figure 3: Boxplot showing variations of Shannon diversity indexes across habitats

Acording to wilcoxon test, all species density were higher in the Soudano-guinean zone as compared with all species densities obtained in the Soudanian zone. This indicated that the Soudano guinean zone is a favourable zone to existence and prosperity of vegetative resources (v = 6418.5; p = 0.5041) (Figure 3). Regarding the study species densities, it was found that height values of *D. mespiliformis* densities were observed in Soudano-guinean zone comparatively to densities obtained in Soudanian zone (v = 3115.5; p = 0.02591).

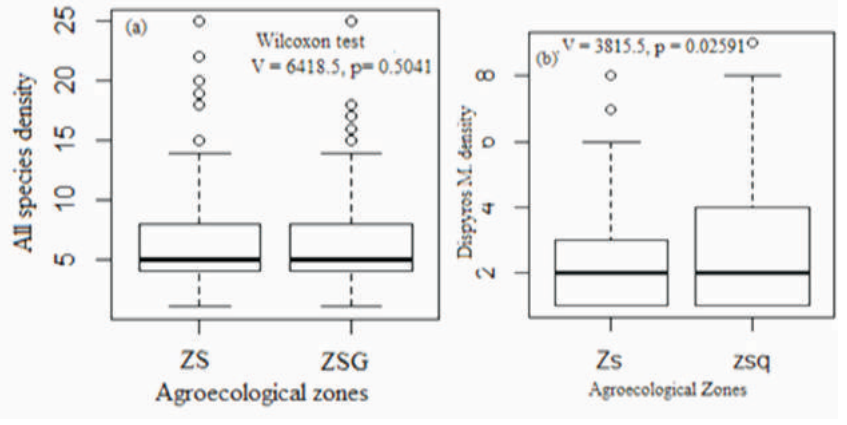


Figure 4: Variations of all species and ebony species densities across climatic zones

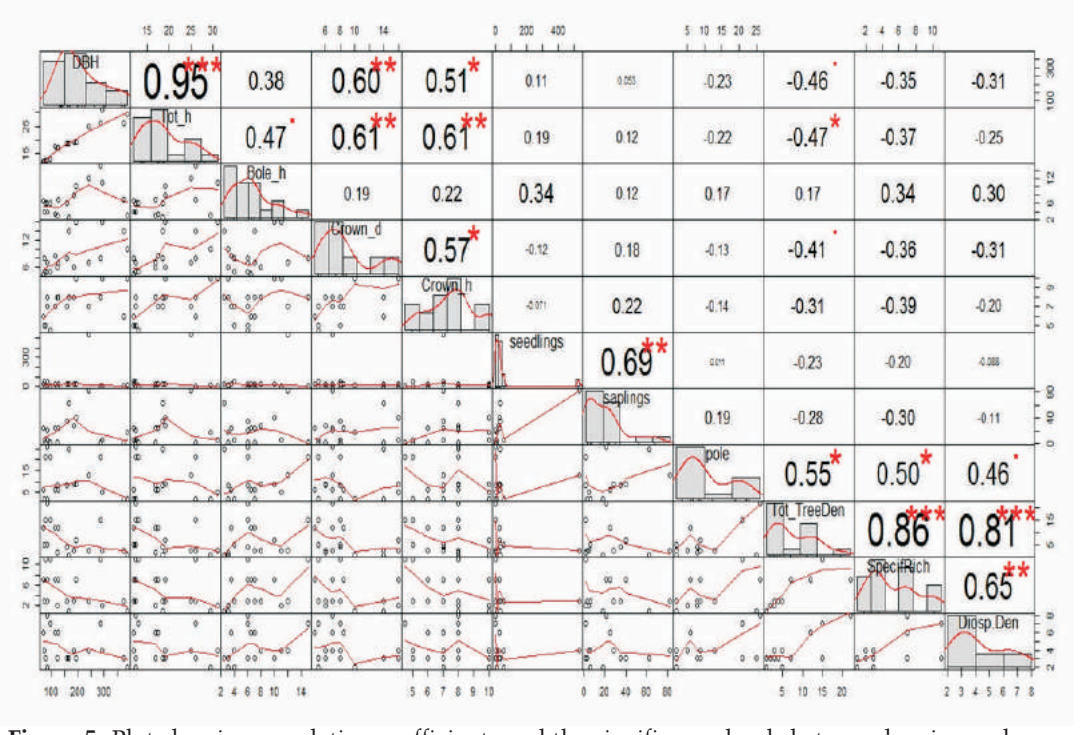


Figure 5: Plot showing correlation coefficients and the significance levels between bearing and architectural variables

The correlation analysis of all the eleven bearing and architectural parameters highlighted positive as well as negative correlations between tree size measurements (diameter, total-height, crown diameter, crown height, bole height), regeneration (seedlings, saplings and poles) and tree abundances in the plots ($p > 0.5$ and $p < 0.5$; Figure 4). There was a significant positive correlation between DBH and total height ($p=0.95$), DBH and crown diameter, DBH and crown height, Total height and crown diameter, total height and crown height ($p = 0.61$), total tree density and specific richness, total density and *Diospyros mespiliformis* density ($p = 0.81$), *Diospyros mespiliformis* density and specific richness ($p = 0.65$). However, for some variables, the correlations were weak ($P< 0.5$) negative.

Discussion

Ecological structure and companion species of *D. mespiliformis* (both adult and young). The most frequent companion species in all habitats were *Tamarindus indica*, *Vitellaria paradoxa*, *Parkia biglobosa*, *Mitragyna inermis* etc. (Amare, 2018; Assogbadjo, 2017; Moura *et al.* 2017). These species are found in immediate environment of *D. mespiliformis* and always with the presence of ant hills (Alemu *et al.* 2019; Dev *et al.* 2019; Moura *et al.* 2018; Dicko 2016).

Tree density across climatic zones and habitats

The study indicated higher abundance of adult, seedlings, saplings and poles in non-disturbed habitats (woodland, savannah and inundated forests where the biggest individuals were found) than in parklands. According to habitats and climatic zones, there is a significant difference in population structure of the species. Population structure investigation revealed that adult tree density was higher in Soudano-guinean zone compared to Soudanian zone and in inundated forests compared to Soudanian zone and other habitats (Okpanachi *et al.* 2019). The low adult tree density, seedlings, saplings and poles observed in parkland is as a result of the selective clearing of non-preferred tree species while establishing farms. The study noticed an absence or low density of seedlings in inundated forests while there was a greater saplings and poles density. The absence of seedlings in inundated forests is due to the streaming water which drops all the seeds at the beginning of the rainy season. These results of our finding seem to justify the contrary of those obtained by (Fandohan, 2007; Balakrishnan *et al.* 2017) who noticed a decreasing in seedlings density of *Tamarindus indica* in inundated forests.

This study has shown that *D. mespiliformis* has preference for moist conditions and occur on different type of soils (Arbonnier, 2002b). However, the study indicates that climatic conditions could negatively affect population abundance or limit the expansion of the species (low adult density observed in Soudanian zone).

Species diameter size class distribution

Size class distribution showed that the larger adult individuals were found in Soudanian zone (inverse J-shape) while in the Soudano-Guinean zone, population structure was bell-shaped indicating predominance of youth (low/short diameter) (Lankoandé, 2017; Gnonlonfin, 2018). The same diameter size class distribution among habitats revealed bell-shaped distribution (most youth individuals) in inundated forests and savannah while in woodland and parkland distribution was in inverse J-shape indicating predominance of larger adult individuals. The bell-shaped diameter class distribution presented by ebony population supported the fact that the species is a strongly light demanding species (Lompo *et al.* 2018).

Higher regeneration (seedlings) in the earlier stage under adult mother trees in all climatic zones and habitat (excepted parkland) could be explained by the species temperament (find in all types of habitats and soils) and seeds dispersal (by wind, water and fauna) pattern of ebony.

According to (Tsvuura, 2016; Schmidt, 2012), ebony is expected to show high number of seedling, large number of saplings and high pole density. But it did not. Only inundated forests populations of ebony showed a high number of saplings and higher pole density, this suggests propagation by root segment in this habitat. Some factors or

combination of factors such as human pressures (parklands), permanent presence of water (inundated forests) and the type of soil contribute to the success of this form of propagation.

Implication for African ebony plant resources conservation

The state of vulnerability of African ebony tree in Benin and the socioeconomic importance which it represents for local communities necessitate planning for the two conservation approaches in situ and *ex situ*. In fact, due to anthropogenic pressures it is advisable that the harvests of fruits intended for conservation *ex situ* in seed banks be organized on a national level. Co-operation and exchange of information and vegetable matter between the conservation organizations in the respective communes is then deemed necessary in order to put such a conservation and restoration project into operation. Besides, national 247 seed harvests planned for conservation *ex situ*, carried out in each locality, based on the parameters of the reproduction system, the genetic structure and the physiology of the species, as well as and the ecological characteristics of the sites, could be organized where a minimum infrastructure and appropriate equipment together with financial resources are available. In addition to the *ex situ* conservation, efforts aimed at ensuring *in situ* preservation of the species should be undertaken.

Conclusion

The results of this study indicated that ecological structure of African ebony tree greatly varied from one climatic zone to another (proving the abundance of the species in the Soudano-guinean transition zone) and from one habitat to the other (indicating the predominance of the young individual trees in the gallery forests). Moreover, trees mean diameter (DBH) varied from 35.42 cm to 176.60 cm while the total height varied from 12.25 m to 32.51 m. Since environmental factors (rainfall and temperature) seemed to be the main factors affecting ebony populations across zones and habitats, sustainable management of the species should mainly rely on regeneration and there is a priority need to address vegetative propagation of the species from roots.

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Assessment of Traditional Livestock Practices for Compliance with Organic Agricultural Standards in Nigeria

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Abstract
Organic agricultural production presupposes that certain standards need to be followed. Oftentimes, these standards are not strictly followed by many farmers who claimed to practice organic agriculture in Nigeria. The extent to which their agricultural practices comply with the Organic Agriculture Standards in Nigeria (OASN) is yet to be ascertained. This study, therefore, assessed traditional livestock practices for compliance with organic agricultural standards in Nigeria. Information was obtained from 133 livestock farmers in 6 states of 3 agricultural zones in Nigeria. Frequency counts, percentages, mean, and Pearson Product Moment Correlation were used to analyse the data. Respondents' age, year of formal education, farm size, farming experience, farm enterprise and monthly income were 47.7±11.3 years, 10.5±6.1 years, 5.8±1.3ha, 26.5±4.3 years and N 30,098.7±34,509, respectively. Majority of respondents were male (69.0%) and 52.0% had access to extension service fortnightly. The mean of the practices in use for livestock production are; use of ground pawpaw seeds (0.66±0.30), soaked Christmas melon (0.50±0.40) and soaked pawpaw leaves (0.40±0.10) were observed as traditional practices. Level of compliance with organic standards was low (55.6%) among livestock farmers. Years of formal education (r=0.19), access to extension service (r=-0.35) were significantly related to compliance with OASN. The study concluded that, possible compliance of traditional practices with organic agricultural standard is low. The study therefore, recommends the need to leverage on some of the farmers' traditional practices that align with organic principles *and*, enhancement *of extension services for* increased awareness of the standards and benefits of organic agriculture would enhance more rapid adoption of organic farming in Nigeria.

Keywords: Traditional agricultural practices, Compliance with standard, Livestock, organic agriculture.

Évaluation des pratiques d'élevage traditionnelles pour la conformité aux normes de l'agriculture biologique au Nigéria

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Résumé
La production agricole biologique suppose que certaines normes doivent être respectées. Souvent, ces normes ne sont pas strictement suivies par de nombreux agriculteurs qui prétendent pratiquer

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l'agriculture biologique au Nigeria. La mesure dans laquelle leurs pratiques agricoles sont conformes aux normes de l'agriculture biologique au Nigéria (OASN) reste à déterminer. Cette étude a donc évalué les pratiques d'élevage traditionnelles pour la conformité aux normes de l'agriculture biologique au Nigéria. Des informations ont été obtenues auprès de 133 éleveurs dans 6 états de 3 zones agricoles au Nigeria. Les nombres de fréquences, les pourcentages, la moyenne et la corrélation du moment du produit Pearson ont été utilisés pour analyser les données. L'âge, l'année de scolarité, la taille de la ferme, l'expérience agricole, l'entreprise agricole et le revenu mensuel des répondants étaient respectivement de 47,7 ± 11,3 ans, 10,5 ± 6,1 ans, 5,8 ± 1,3 ha, 26,5 ± 4,3 ans et 30 098,7 ± 34 509 N. La majorité des répondants étaient des hommes (69,0%) et 52,0% avaient accès à des services de vulgarisation tous les quinze jours. Les moyennes des pratiques utilisées pour la production animale sont; l'utilisation de graines de papaye moulues (0,66 ± 0,30), de melon de Noël trempé (0,50 ± 0,40) et de feuilles de papaye trempées (0,40 ± 0,10) ont été observées comme pratiques traditionnelles. Le niveau de conformité aux normes biologiques est faible (55,6%) parmi les éleveurs. Les années d'éducation formelle (r = 0,19), l'accès aux services de vulgarisation (r = -0,35) étaient significativement liés au respect de l'OASN. L'étude a conclu que la conformité possible des pratiques traditionnelles avec les normes de l'agriculture biologique est faible. L'étude recommande donc de tirer parti de certaines des pratiques traditionnelles des agriculteurs qui s'alignent sur les principes de l'agriculture biologique et, l'amélioration des services de vulgarisation pour une meilleure prise de conscience des normes et des avantages de l'agriculture biologique favoriserait une adoption plus rapide de l'agriculture biologique au Nigéria.

Mots clés: Pratiques agricoles traditionnelles, Conformité aux normes, Elevage, agriculture biologique.

Introduction

Livestock farmers are usually confronted with the challenge of enhancing their livestock's overall performance for economic advantage. Quite a few production techniques are adopted including the use of antibiotics and growth promoters to realize this goal (Kehinde *et al.*, 2010). Good performances when achieved is not without side effect on the livestock and health of consumers (Donoghue, 2003) Western world response to the adverse effects was the ban of the products (Nweze and Nwankwagu, 2010). Consequently, many sought for alternatives especially in the use of herbs and spices as supplements in animal rations (Bunyapraphatsra, 2007; and Owen, 2011).

Odoemelam *et al.*, (2013) reported that, commercial swine and chicken producers in Europe include about 33.3 percent of mixtures of herbs and spices in rations to improve growth and health performance.

Globally, farmers have shown interest in more holistic approaches to farming due to adverse effects of synthetic inputs in livestock production. The focus on organic agriculture as the alternative and holistic production system is borne out of the realization of its healthy production advantages. The concept of organic livestock production is creating a situation where the livestock contributes to the whole farm system and, at the same time, the system contributes to maintenance of the animal's health, welfare,d ultimate ability to exhibit its optimum physiological abilities and improved immunity. African farmers' prospects in organic agriculture are bright because, organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and good quality of life for all involved (IFOAM, 2011). Organic agriculture is a holistic production system based on the principles of health, ecology, care, and fairness (IFOAM, 2011).

Unlike conventional farming methods, organic livestock farming rejects the concept of maximizing short-term performance and rather attempts to achieve an optimum life performance of the animal. Organic livestock production is defined by guidelines which have been formulated

by IFOAM. The guidelines include basic standards for what can be labelled as "organic." The standards on animal husbandry management and veterinary medicine are presented as general principles, recommendations and standards (IFOAM, 2013). Aside certification purposes, compliance with organic standards, principles and practices make livestock farming organic. In many African countries, agriculture is predominantly traditional and usually with minimum use of external inputs like chemical fertilizers, pesticides and drugs.

Although, many Africans may perceive traditional agriculture as "organic" because of low input use, it would rather be referred to as "organic by default." Low inputs and non-use of chemicals is, however, not synonymous with "organic." Traditional extensive pastoral livestock production systems have also been referred to as organic simply because they fulfil the practice of "naturalness" characterizing organic systems. Against this background, the objective of the study is to assess the traditional livestock agricultural practices for compliance with organic practices in Nigeria.

Methodology

This study was conducted in Nigeria. A multistage sampling procedure was used to select respondents for the study. From three agricultural zones in Nigeria, six states; Ebonyi, Anambra, Benue, Niger, Ekiti and Oyo) were randomly selected for this study. From each state, 10% of the Local Government Areas (LGAs) were randomly selected to give 15 LGAs, and two rural communities were randomly selected from each of the LGAs, to give 30 rural communities. A total of 20% of the livestock farmers were proportionately selected to give 133 respondents. Interview schedule was used to collect data on respondents' socio-economic characteristics, traditional practices in use and extent of compliance with organic practices. The respondents were asked to identify traditional practices in use on a four point scale of; above 3 years, 2 years, 1 year ago and not at all, the weighted mean was used to rank the mostly use practices. Also, index of frequency of compliance was determined and the mean (39.60±7.58) to categorise respondents into high or low compliance with organic standard.

Results and Discussion

Table 1 reveals that the farmers had a mean age of 47.7 years. This shows that most of the farmers were still in the active and productive years. This finding is consistent with that of Meludu (2014), who reported a mean age of 49 years for farmers in Oyo State. The study shows that that majority (69.0%) of farmers were male, while female (31.0%), the average number of years spent for formal education was 10.5 years. This finding is in line with Adeniyi, and Yekinni (2015), who reported that the average formal education of farmers was 9.6 years. This result implies that there is considerable level of literacy among the farmers, which is an important factor that may likely influence application of new ideas and agricultural practice. The average year of farming experience was 26.5 years, implying that these farmers are knowledgeable on farming activities; the predominant mode of land acquisition in the study area was through inheritance (61.0%). The average farm size was 5.8Ha that indicate predominance of medium farmers. Above half (52.0%) of the respondents had access to extension service fortnightly. This could have influenced their practices from indigenous to modern agriculture that encourage use of agrochemicals. This is in line with the Adesope *et al.* (2012) that extension contact with farmers influenced their agricultural practices. The average monthly income of N30, 485.76 also emphasized that largely, the farmers in the study areas are low income earners; which could influence their quest for more income and avoid the use of indigenous practices. This is in agreement with the findings of Ezeh (2013) that most farmers were low income earners and use available agrochemicals to meet their production needs.

Table 1: Distribution of crop farmers by socio-economic characteristics n=177

Variables	Percentage	
Age		
21 – 33	8.70	Mean = 47.78±11.32
34 – 46	39.0	
47 -59	33.9	
60 -72	17.7	
73 – 85	0.7	
Sex		
Male	69.0	
Female	31.0	Mode = Male
Years of formal Education		
Primary education	30.96	Mean = 10.57±6.12
Secondary education	40.32	
Tertiary education	21.30	
No formal education	7.42	
Years of farming experience		
1 – 10	17.7	
11 – 20	27.4	Mean = 26.46±4.33
21 – 30	21.6	
31 – 40	18.1	
41 – 50	11.0	
51 – 60	4.2	
Land Acquisition		
Inheritance	61	
Lease	12	
Rent	22	
Purchase	5	
Farm size (acre)		Mean=5.8±2.18
< 1	3.95	
1-5	65.5	
6-10	21.4	
11-15	3.95	
> 15	5.6	
Access to extensive service		
None	32.7	
Once in a year	4.0	
Twice in a year	4.0	
Quarterly	7.3	
Fortnightly	52.0	
Monthly income		
1,000 - 20,000	50.24	
20,001 - 40,000	27.12	30,485.76 ± 21,834.27
40,001 - 60,000	11.86	
60,001 - 80,000	4.00	
80,001 - 100,000	2.26	
>100,000	4.52	

Source: Field Survey, 2017

The result in Figure 1 shows the livestock enterprises of respondents on multiple response bases. The figure shows that livestock reared by farmers are; poultry (78.9%), goat (82.0%), sheep (53.4%), cattle (28.6%), pig (25.6%), duck (21.1%), turkey (23.3%), rabbit (13.5%), guinea fowl (2.3%) and fish farming (1.5%). This connotes that the respondents were involved in multiple livestock farming and thus, provide opportunity for multiple sources of income. Majority of the livestock farmers were into goat, poultry, sheep cattle and pig farming.

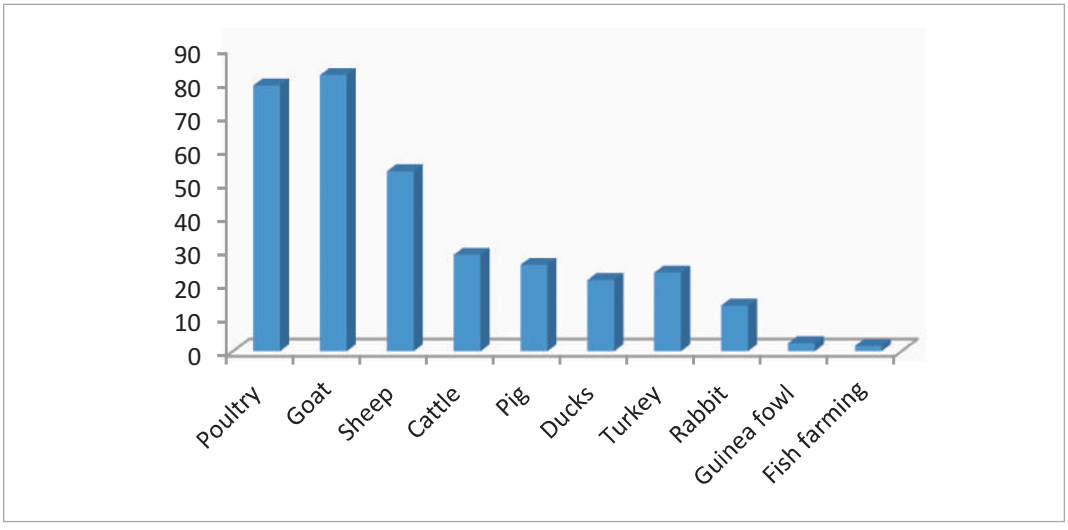

Figure 1: Distribution of respondents by livestock enterprise

Table 2: Distribution of livestock farmers' use of traditional practices (n=133)

Items	Mean	Rank
Intestinal worms		
Ground pawpaw seeds	0.66	1st
Soaked Christmas melon in water	0.50	2nd
Soaked pawpaw leaves	0.44	3rd
Sand paper leaves	0.39	4th
Ground tobacco	0.31	5th
Squeezed	0.29	6th
Boiled bark of *iroko* tree	0.26	7th
Ground the bark of Rauvolfia vomitoria	0.15	8th
Roasted seeds of *iroko*	0.14	9th
Baobab leaves	0.12	10th
Diarrhoea		
Aloe Vera leaves	0.79	1st
Squeeze scent leaves	0.39	2nd
Fermented white maize with salt	0.38	3th
Ground alligator pepper	0.35	4th
Neem leaves extract	0.12	5th

Source: Field Survey, 2017

Table 2 shows the mean distribution of traditional practices used for treatment of intestinal worm and diarrhoea. For the treatment of intestinal worm; the table shows that ground pawpaw seed ($\bar{x}$=0.66) was mostly used. Followed by soaked Christmas melon in water ($\bar{x}$=0.50), soaked pawpaw leaves ($\bar{x}$=0.44), sand paper leaves ($\bar{x}$=0.39) and baobab leaves ($\bar{x}$=0.12) was least used for the purpose. The table also shows that farmers used extract of Aloe Vera leaves ($\bar{x}$=0.79) mostly for the treatment of diarrhoea. This is closely followed by squeezed scent leaves ($\bar{x}$=0.39), fermented white maize with salt ($\bar{x}$=0.38), ground alligator pepper ($\bar{x}$=0.35) and neem leaves extract ($\bar{x}$=0.12) was the least used. This implies that farmers use some plants and plant extracts to treat some livestock ailments. This agrees with the findings of Moyin-Jesu (2010) and Eze *et al.* (2012) that African farmers use plant extracts to manage livestock ailments.

Extent of compliance of respondents' agricultural practices with organic standard

The distribution of the results as represented in Table 3 shows compliance of respondents' practices for the management of livestock. The table shows that only 18.0% of the respondents complied with total abstinence from synthetic antibiotics, 22.6% complied with avoidance of herbicides while 71.4 % complied with given access to pasture in/and outside for exercise on farm. Very few (9.8%) of the respondents indicated that they could control the use of chemical for control of pest by neighbour farmers. This findings show that majority of the respondents practices are not in compliance with organic practices and standards. Therefore, extent of compliance with organic practices is low. This implies that, educating farmers on the organic standard and practices are highly needed across the zones for conversion to organic agriculture.

Level of compliance of agricultural practices with organic standard

The result in Table 4 shows that majority (55.6 %) of the livestock farmers had low level of compliance with organic standards. This implies that the majority of the agriculture practices used by the respondents are not in compliance with organic practices. This further buttressed the finding of this study that majority of the respondents do not comply with any standard for the production. This is in line with the findings of Babalola

Table 3: Distribution of respondents by extent of compliance with organic practices (n= 133)

Items	Complied %	Not complied %
No use of synthetic antibiotics	18.0	82.0
No use of herbicides to control weed on farm	22.6	77.4
No use of insecticides to control insects on farm	19.5	80.5
Access to pasture in/and outside exercise on farm	71.4	28.6
No combination of synthetic medication with plant extract to treat diseases on livestock	34.6	65.4
No use of chemical to control pest by neighbour farmers	9.8	90.2
Use of plant extract to control pest	20.0	80.0
No use of chemical substances for plant extracts	49.6	50.4
No use of hormone inducing medicine for livestock	32.3	67.7
No use of growth promoter in the feed of livestock	33.0	67.0
No addition of abattoir waste to livestock feed	59.4	40.6
No addition of colouring material to feed of livestock to make it attractive	60.9	39.1
No marks on livestock with hot iron or anything that make permanent mark	59.4	40.6

Source: Field Survey, 2017

(2012); Issa (2015) and Oyekale (2016), that Nigeria farmers still have low compliance to sustainable agricultural practices.

Relationship between socioeconomic characteristics and level of compliance with organic standard

Table 5 shows that there was significant relationship between years of education (r= 0.19), access to extension services for livestock farmers (r= -0.35) and their level of compliance with organic standards. The significant relationship between education and compliance may be attributed to the fact that educational qualification of the respondents may expose them to several practices overtime as well as inform their decision on compliance to standards. This concurred with the findings of Chukwu (2013); Esiobu and Onubuogu (2014); Esiobu, Onubuogu, and Ibe (2015) that individuals with higher educational attainment mostly have the tendency to comply with the guidelines of improved farming practices and technology for the benefits attached to it.

Contacts with extension personnel have been affirmed to have significant relationship with farmers' adoption of improved agricultural practices (Oyesola and Obabire 2011; Fadare Akerele and Toritseju 2012; Ovwigho, 2014). The inverse relationship between extension services and compliance with organic standard implies that, the more farmers are in contact with extension service providers, the less their compliance to organic standards. This may be due to the messages of the extension service providers, which centre on convention farming. This also could be attributed to level of engagement of extension service providers in the promotion of organic agriculture.

Age, years of experience, labour size, and monthly income do not have significant relationship with compliance with organic standards.

Conclusion

Many Nigerian farmers use traditional agricultural practices alongside synthetic inputs for their production. Most common traditional agriculture practices used for treatment of intestinal worm and diarrhoea are; ground pawpaw seed, soaked Christmas melon in water, soaked pawpaw leaves, sand paper leaves, and extract of Aloe Vera, squeezed scent leaves, fermented white maize with salt, ground alligator pepper and neem leaves extract are used for the treatment of diarrhoea but without compliance with organic standards. The level of compliance with organic standards is low. Therefore, for rapid adoption of organic practices the need to leverage on the few traditional practices that are close to organic

Table 4: Distribution of respondents by level of compliance with organic standards (n=133)

Level	Percentage	Parameter
Livestock farmers		
Low	55.6	Min =12.00, Max =46.00, Mean = 27.56
High	44.4	

Source: Field Survey, 2017

Table 5: Relationship between socioeconomic characteristics and compliance to organic standards

Variable	r-value	p-value	Decision
Age	- 0.82	0.149	Not significant
Years of formal education	0.19	0.001	Significant
Years of farming experience	0.02	0.709	Not significant
Access to extension services (livestock)	- 0.35	0.000	Significant
Monthly income	0.038	0.599	Not significant

Source: Field Survey, 2017

principle is imperative as well as engaging agricultural extension officers to create awareness, advocacy and to promote organic agriculture as adaptable practices for health, economic and environmental benefits.

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Comparative Effects of Poultry Manure and NPK Fertiliser on Growth and Yield of Onion (*Allium cepa*) and some Soil Fertility Indices

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Abstract
A common method of cultivating onion (*Allium cepa* L.) for higher yield in Nigeria is through the application of mineral fertilisers. However, some crops have been proven to respond well to organic fertilisers' application such as poultry manure. This study compared the effects of poultry manure and NPK 15:15:15 fertilisers on onion yield, post planting soil fertility status and economic yield of onion for possible consideration of organic onion production. The experiment was carried out in the University of Ibadan, Nigeria in 2018 and 2019 in a randomized complete block design, replicated four times. Poultry Manure (PM) and NPK 15:15:15 were used as the fertiliser treatments at 90 kg/ha to obtain 100% NPK (T1), 75% NPK+25% PM (T2),50% NPK+50% PM (T3), 25% NPK+75% PM (T4), 100% PM (T5) and Control (T0 – no soil amendment). Data on dried onion bulb yield obtained was subjected to analysis of variance (ANOVA) and means separated using Least Significance Difference (LSD) at p=0.05. Post planting soil fertility data and profit estimation were subjected to descriptive statistics. The results obtained revealed that 100% PM resulted into best dried bulb yield (kg/ha) and profit margins of fresh yield ₦201 in 2018 and ₦146 in 2019. The PM amendments left the soil with better pH (pH 6.6 - pH 7.4), total nitrogen (0.6 g/kg – 1.6 g/kg) and available phosphorus (7 mg/kg – 21 mg/kg), Thus, poultry manure at 90 kg K/ha is recommended for onion production and further experimentation in organic onion production

Keywords: Fertiliser, Onion, Poultry manure and NPK 15:15:15.

Effets comparatifs du fumier de volaille et de l'engrais NPK sur la croissance et le rendement de l'oignon (*Allium cepa*) et de certains indices de fertilité du sol

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Resume
Une méthode courante de culture de l'oignon (*Allium cepa* L.) pour un rendement plus élevé au Nigéria consiste à appliquer des engrais minéraux. Cependant, il a été prouvé que certaines cultures répondent bien à l'application d'engrais biologiques comme le fumier de volaille. Dans cette recherche, nous avons comparé les effets du fumier de volaille et des engrais NPK 15:15:15 sur le rendement de l'oignon, l'état de fertilité du sol après la plantation et le rendement économique de l'oignon pour une éventuelle prise en compte de la production d'oignon biologique. L'expérience a

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été menée à l'Université d'Ibadan, au Nigéria en 2018 et 2019 avec des coordonnées de 7 ° 24'N, 3 ° 54'E et 234 m au-dessus du niveau de la mer, dans une conception de blocs complets randomisés, répliquée quatre fois. Le fumier de volaille (PM) et le NPK 15:15:15 ont été utilisés comme traitements d'engrais à 90 kg / ha pour obtenir 100% NPK (T1), 75% NPK + 25% PM (T2), 50% NPK + 50% PM (T3), 25% NPK + 75% PM (T4), 100% PM (T5) et contrôle (T0 - sans amendement du sol). Les données sur le rendement en bulbe d'oignon séché obtenues ont été soumises à une analyse de variance (ANOVA) et les moyennes séparées en utilisant la différence de moindre importance (LSD) à p = 0,05. Les données sur la fertilité des sols après la plantation et l'estimation des bénéfices ont été soumises à des interprétations descriptives. Les résultats obtenus ont révélé que 100% de PM entraînent le meilleur rendement en bulbe séché (kg / ha) et des marges bénéficiaires de rendement frais ₦201 en 2018 et ₦146 en 2019. Les amendements PM ont laissé le sol avec un meilleur pH (pH 6,6 - pH 7,4), azote total (0,6 g / kg - 1,6 g / kg) et phosphore disponible (7 mg / kg - 21 mg / kg), Ainsi, le fumier de volaille à 90 kg K / ha est recommandé pour la production d'oignon et d'autres expérimentations en bio production d'oignon.

Mots clés: engrais, oignon, fumier de volaille et NPK 15:15:15.

Introduction

Onion (*Allium cepa* L.) forms major part of ingredients of human diet, usually used in flavouring and seasoning of a wide variety of dishes. Although onion is a common crop grown in Nigeria for a long time, the yield is still low compared with other regions of the world. While the average yield per hectare is nearly 60 tons at the global level (Statista, 2020), it is about 14.8 tons per hectare in Nigeria (FAOSTAT, 2006). One of the challenges of onion production in Nigeria is inappropriate soil fertility which often requires application of fertilisers. Mineral fertilizer (NPK) is the easily available fertiliser for crop production in most developing countries. This is also applicable to onion production in Nigeria. The prohibitive cost of most mineral fertilisers and unavailability are major challenges to most resource poor farmers. In a situation where the farmers manage to source for fund to purchase the fertilisers, they are unavailable. However, there are some organic sources of fertilisers like animal manures that could be readily available to farmers, as well as very cheap to obtain.

Thus, there is a need to compare effectiveness of mineral NPK 15-15-15 fertiliser with poultry manure for production of onion, with the aim of using the outcome to stir further research for organic onion production. Organic materials such as compost and poultry manure improve soil physical and chemical properties. They are important for plant growth (Synman *et al*., 1998) and great sources of organic matter (Zhao *et al*., 2014).

Organic fertilisers have positive effect on root growth by improving the root conditions (structure, humidity, etc.). Plant growth is also encouraged by increasing the population of microorganisms (Shaheen *et al*., 2007). Xia *et al*., (2017) reported an overall increase in upland crop with 4.4% when manure partially substituted synthetic fertilisers.

Poultry manure has been reported to contain more plant nutrients than all other organic manure (Ali, 2005). Poultry manure contains most essential nutrients including micronutrients. It has been well documented that it provides a valuable source of plant nutrients (Harmel *et al*., 2009). Addition of poultry manure to soils not only helps to overcome the disposal problems but also enhances the physical, chemical and biological status of soils (McGrath *et al*., 2008). For example, continuous cultivation of arable soils often results in the deterioration of soil structure. This leads to reduced crop yield, thus poultry manure serves as fertiliser source to replenish the soil.

Fertiliser application is one of the critical factors limiting onion productivity. It has been observed that addition of animal manure resulted in higher vegetables yield like onion as compared to NPK fertilizer (Baitilwake *et al.*, 2011).

Though, some researchers have argued that organic and mineral fertilisers could be combined to improve crop yields (Seran *et al.,* 2011).
However, it should be noted that inorganic fertilisers are not allowed in organic production.

The objectives of this study are to:

1. Compare the effect of NPK 15:15:15, poultry manure and the combination of both.
2. Compare the influence of poultry manure and NPK 15:15:15 fertilisers on the yield of onion and post planting soil fertility status.
3. Evaluate the suitable ratio(s) of organic (poultry manure) and inorganic (NPK) fertiliser that would give an economic yield of onion.

Materials and Methods

Experimental Sites Description

The research was conducted on the field behind the Agronomy building, Faculty of Agriculture, University of Ibadan (7°24'N, 3°54'E, 234 m above sea level), within a period of two years between May 2018 and July, 2019. The research field was located in the derived savannah of Southwest Nigeria. The area has a bimodal rainfall distribution which peaks in June/July and September. The early rain occurs between late March and early April and ends in July while late rain occurs from August/September and November.

Fertiliser Sources and Application

Cured Poultry Manure (Organic Fertilliser) used was obtained from the Poultry Unit, Teaching and Research Farm, University of Ibadan while NPK 15:15:15 (Mineral fertiliser) was obtained from the Farm Management Unit, Department of Agronomy, University of Ibadan, Ibadan, Oyo State. The fertilisers were applied based on the recommended rate of fertiliser for onion 90 kg/ha (Oyeyinka, 2015). Organic fertiliser was incorporated into the soil a week before planting to allow mineralization at each planting spot. The mineral fertiliser was applied two weeks after planting in drills around each planting spot and covered with soil slightly; the mineral fertiliser was later top dressed a month after planting.

Fertiliser Combinations

T0 = Control (No Fertiliser), T1 = 100% NPK (90g NPK), T2 = 75% NPK + 25% PM (65.5g NPK + 1.69 kg PM), T3 = 50% NPK + 50% PM (45 g NPK + 3.38 kg PM), T4 = 25% + 75% PM (22.5g NPK + 5.06 kg PM), T5 = 100% PM (6.75 kg PM).

Laboratory Analysis Procedures for Poultry Manure

Nitrogen

Total nitrogen was determined by the Kjeldalh procedure using: Digestion (digestion block), Distillation (Kjeldalh apparatus) and Titration (auto- burette). Organic fertiliser weighing 0.2 g was placed in a 50 ml conical flask and 5ml of conc. Sulphuric acid (H_2SO_4) with one tablet of selenium as catalyst added, the solution was digested at temperature of 350°c for 3 hours. The digest was cooled and made up to 50 ml received at the condensing end into a 50 ml conical flask containing boric acid with an indicator; the solution was titrated against 0.1 KOH.

Phosphorus and Potassium

Poultry manure of 0.5 g was placed in a beaker; 5ml of Nitric acid was added. The beaker was placed on a hot plate at a temperature of about 200^{o}C between 20 and 30 minutes until a light clear yellowish solution (digest) was obtained. 5ml of this digest was measured into a standard volumetric flask of 50 ml. 5 ml of vanadomolybdate (colour reagent) was added and made up to mark (50 ml) with distilled water for 10 minutes for colour to develop. The absorbance of phosphorus was read with UV Visible spectrophotometer, model 752 (INESA). Potassium content in the digest was read by using a flame photometer.

Chemical Composition of Poultry Litters

Parameters	Values (%)
Total Nitrogen	1.4
Total Phosphorus	0.8
Total Potassium	2.0

Collection of Soil Samples

Core soil samples were randomly collected from the field with an auger at depth of 0-15 cm at different points of the field. Composite sample was made from the samples. The sample was air dried for twenty-four hours and sieved with 0.5 mm (for Nitrogen and Organic carbon and 2 mm for other macro and micro elements) sieves.

Experimental Design and Treatments, Source of Planting Materials

The experiment was laid in a randomized complete block design (RCBD) with four replicates per fertiliser treatment. The size of each plot was 1.5 m × 1 m consisting of 24 plots raised to allow for good bulb development and it also prevents bulb rot (Currah and Proctor, 2010). The total land area of the land used was 57 m^2 (6.0 m x 9.5 m). The seedlings were planted at a spacing of 30 cm x 20 cm inter-row, inter-bed spacing was 0.5 m. There were 16 plants per bed. The seed variety used was red creole.

Planting population (Pp.):

$$\frac{10{,}000\ m^2 \times 1}{(0.3 \times 0.2)\ m^2} = 166{,}666 \text{ plants/ha}$$

Planting population was 166,666 plants/ha.

Cultural Practices

Manual weeding was done by using hoe to remove weed in furrow and by the side of the bed while weeds within the beds were handpicked. Plants' bases were always covered with soil to prevent exposure of the onion bulb.

Laboratory Analysis of Soil Samples

Composite soil samples (0-15 cm depth) were collected from experimental field for the pre-soil analysis and composite surface soil sample from each treatment plot were also collected for post planting soil analysis. The samples were air dried and sieved, ready for laboratory analysis. Soil routine test were conducted on the experimental soil before and after planting to determine the pre and post-planting nutrient status of the soil. Particle size distribution was analysed using the hydrometer method (Bouyoucos, 1951). Organic carbon was determined using the chromic acid oxidation procedure (Walkey and Black, 1934).

Nitrogen was determined by the Kjeldalh procedure (Dewis and Freitas, 1970).

Available phosphorus was determined by extracting the soil with Bray P-1 and phosphorus concentration in the extract was measured by the blue colour method of Murphy and Riley (1945). Exchangeable acidity was determined by adding normal KCl to 2 g of sample. Three drops of Fehling indicator was added to the filtrate and titrated against 0.1N NaOH. Exchangeable bases were determined by adding 20 ml of 0.1N ammonium acetate, it was stirred for 15 minutes and filtered and the reading taken using Atomic Absorption Spectrophotometer (AAS). The concentration of potassium and sodium in the filtrate was read using a flame photometer. The pH of the soil was also determined by adding 10 ml of distilled water to 10g of soil sample, pH (1:1, H_2O), the solution was stirred for 10 minutes and pH meter was used to take the reading. Micro nutrients (i.e., zinc, copper, manganese and iron) content of the soil were extracted using Mehlich III method and reading was done using the atomic absorption spectrophotometer.

Financial Estimation

Market survey was carried out to determine the current selling price of onion for each year. The economic evaluation comprising cost of each treatment per hectare, and profit margin rate of return was carried out. To estimate economic parameters, the marketable bulb yield was valued based on average market price (₦/kg) collected from the local markets during the two consecutive years of production and multiplied with the mean yield (t/ha) of each treatment. Gross margin refers to the relative (without control) income of treatments.

The market price of onion bulbs in 2018 was N201/kg, while it was N146/kg in 2019. Average production per hectare of only 41.4 metric tons of

onions, 2017 had the smallest onion harvest in the seven-year period surveyed here. In 2020, production reached nearly 60 tons per hectare, a small decrease compared to 2019.

Statistical Analysis

Dry matter yield data obtained was subjected to analysis of variance (ANOVA) using GENSTAT 8 edition and means were separated using least significance difference (LSD) at (p=0.05). The results of the post planting soil fertility status and profit estimation were subjected to descriptive statistics.

Results

Physical and chemical properties of the experimental soil for 2018 and 2019 planting years

The pre-planting chemical and physical soil properties of the experimental site are shown in Table 1. The pH of the soil for the two-planting period of 2018 and 2019 was 6.9 and 6.6 respectively, indicating neutral soil pH. Soil total nitrogen (1.3 and 1.4 g/kg) and exchangeable Potassium (0.3 and 0.2 cmol/kg) for both years were below the critical level of 1.6 – 2.0 g/kg and 0.31 – 0.60 cmol/kg respectively. Organic carbon of the two planting years 17 g/kg (2018) and 16g/kg (2019) were above the critical range of 10 – 14 g/kg. The available phosphorus (P) for both 2018 and 2019 was 20 mg/kg and 17 mg/kg respectively which were within the critical range of 7 – 20 mg/kg. The textural class of the soil at the experimental site was sandy soil. The low nutrient status of the soil was intended to allow the soil respond positively to fertiliser application.

Dry matter yield of onion bubs for 2018 and 2019 planting years

The effects of fertiliser treatments on dried bulb yield of onion (means of 2018 and 2019) are shown in Figure 1. The result showed that there were significant differences in the onion bulb yield of the treatments due to application of fertilisers. The 100% poultry manure (T5) for the two years had the highest dry matter yield (0.9 t/ha), followed by 50% NPK + 50% PM (T3) with the mean yield of 0.6 t/ha which was not significantly different from 100% NPK (T1) and 25% NPK + 75% PM (T4).

Table 1: Chemical properties and particle size distribution of the experimental site for 2018 and 2019 planting years

Parameter	Year 2018	Year 2019	Critical Level
pH (H_20) 1:1	6.9	6.6	Neutral (6.6-7.2)
Organic Carbon (g/kg)	17	16	10-14
Total N (g/kg)	1.3	1.4	1.6-2.0
Available P (mg/kg)	20	17	7-20
Exchangeable bases (cmol/kg)			
Ca	19.5	9.7	
Mg	0.9	0.8	
K	0.3	0.2	0.31-0.60
Na	0.4	0.4	
Particle Size Distribution (g/kg)			
Sand	850	866	
Silt	93	82	
Clay	57	52	
Textural Class (USDA)	Sandy Soil	Sandy Soil	

Source: Chude *et al.*, 2012

Relative profit margin due to fertiliser application on fresh biomass of onion

The influence of applied fertiliser treatments on fresh yield of onion is presented in Table 2. In 2018, the highest relative gross profit margin (₦789,336) was from 100% poultry manure, while the least (₦171,157) was recorded in the 50% NPK + 50% Poultry Manure (T3) treatment. During 2019 planting year, the 100% Poultry Manure (T5) treatment still resulted into the highest relative gross profit margin (₦1,132,908). It is only the 50% NPK + 50% Poultry Manure (T3) that joined the 100% Poultry Manure to exceed the mean value (₦578,879.60). Both years revealed best performance with 100% Poultry Manure application on relative gross profit margin of onion fresh yield.

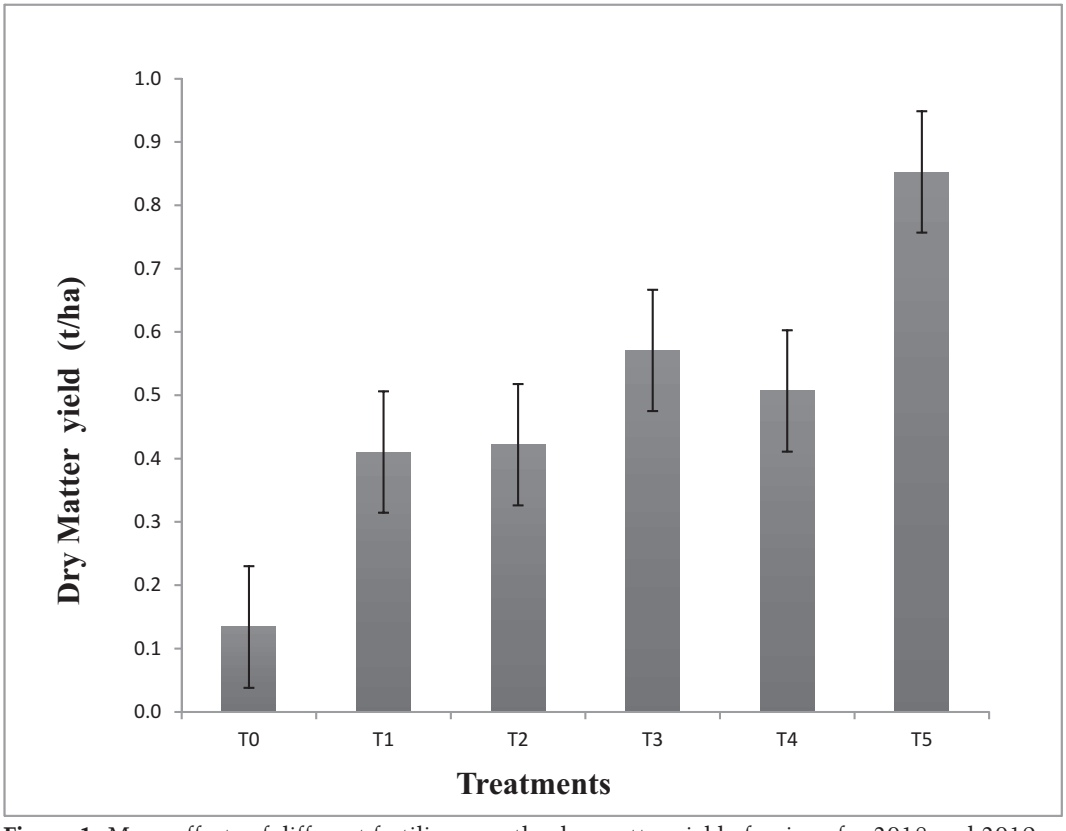

Figure 1: Mean effects of different fertilisers on the dry matter yield of onions for 2018 and 2019 planting years

Legend: T0 – Control, T1 - 100% NPK, T3 - 50% NPK + 50% PM, T4 - 25% NPK + 75% PM, T5 - 100% PM

Table 2: Estimated cost of fresh bulb weigh in 2018 and 2019 planting seasons

Treatments	2018			2019		
	FBW (t/ha) 2018	Income (₦)	Profit Margin (₦)	FBW (t/ha) 2019	Income (₦)	Profit Margin (₦)
T0	0.63	126,858	-	0.64	93,556.3	-
T1	3.47	698,723	571,866	1.98	289,440	195,884
T2	2.67	537,634	410,777	3.42	499,942	406,385
T3	1.48	298,015	171,157	6.75	986,727	893,170
T4	3.22	648,383	521,526	3.10	453,163	359,607
T5	3.92	789,336	662,478	7.75	1,132,908	1,039,352
Mean	2.6	516491.50	467560.80	3.9	575956.05	578879.60
SD	1.3	254967.08	188986.87	2.8	403629.90	365832.54

Legend
Estimated value of fresh onion bulb weight in 2018 and 2019 planting seasons was based on - ₦201/kg and ₦146/kg respectively, T0 – control, T1 - 100% NPK, T2 - 75% NPK + 25% Poultry Manure, T3 - 50% NPK + 50% Poultry Manure, T4 - 25% NPK + 75% Poultry Manure, T5 - 100% Poultry Manure, SD – Standard Deviation

Comparative effects of fertilisers on the post-planting soil fertility indices

Table 3 shows the post-planting soil fertility indices as influenced by fertiliser treatments with the mean and standard deviation (SD). The pH of all the treatments ranged from 6.6 to 7.4 with T2 (7.4) having the highest pH in 2018 and T5 (7.1) in 2019 which were above the mean (7.14 and

Table 3: Comparative effects of fertilisers on the post-planting soil fertility indices

Treatments	pH	OC (g/kg	TN (g/kg)	Av.P (mg/kg)	K	Na	Ca	Mg	Mn	Fe	Cu	Zn
2018					cmol/kg				mg/kg			
Pre	6.9	1.2	1.3	20.9	0.4	0.1	13.9	1.5	94	72	2	15
T0	7.1	1.7	1.4	14.7	0.5	0.1	9.3	1.0	41	79	2	20
T1	6.9	2.0	1.3	19.6	0.6	0.1	13.4	1.1	12	68	2	14
T2	7.4	2.5	1.5	14.5	0.6	0.1	17.2	0.4	18	34	2	2.
T3	7.2	2.1	1.4	14.6	0.5	0.1	11.2	1.2	15	34	2	1
T4	7.3	2.1	1.6	20.8	0.5	0.1	15.3	1.2	24	31	2	2
T5	7.2	1.9	1.1	17.6	0.4	0.1	12.2	1.2	13	28	2	1
Mean	7.14	1.92	1.37	17.53	0.7	0.06	13.21	1.10	31	50	2	79
SD	0.19	0.38	0.16	2.96	0.4	0.00	2.64	0.35	29	22	0.2	8
2019												
Pre	6.6	3.4	0.9	7.6	0.1	5.3	0.4	2.2	1	1	0.04	2.2
T0	6.6	3.5	0.9	6.6	0.1	3.2	0.4	1.4	1	1	0.03	2
T1	6.6	3.2	0.6	6.7	0.1	3.4	0.3	0.9	1	1	0.03	1
T2	6.8	4.6	0.6	9.3	0.1	3.8	0.3	1.1	1	1	0.03	2
T3	6.9	4.1	0.7	10.5	0.1	4.6	1.3	1.7	1	1	0.03	2
T4	6.8	4.3	0.8	10.1	0.1	4.1	0.4	1.6	1	1	0.03	2
T5	7.0	4.4	0.9	14.6	0.1	7.5	0.3	2.6	1	1	0.03	4
Mean	6.76	3.93	0.77	9.33	0.11	4.54	0.50	1.64	1	1	0.03	2
SD	0.16	0.57	0.14	2.81	0.02	1.49	0.38	0.59	0.2	0.2	0.00	0.7

Legend
SD - Standard Deviation, Pre = Pre-planting soil, T1 - 100% NPK, T2 - 75% NPK + 25% Poultry Manure, T3 - 50% NPK + 50% Poultry Manure, T4 - 25% NPK + 75% Poultry Manure, T5 - 100% Poultry Manure.

6.76) value for both years. Soil Organic Carbon of treated plots ranged from 2.5 g/kg to 4.6 g/kg which were both recorded for both years in the treatment 75% NPK + 25% Poultry Manure (T2). Total nitrogen of T4 (1.6 g/kg) after harvesting was recorded in 2018 to be the highest and T1 (0.6 g/kg) was the least recorded in 2019. The highest available phosphorus for 2018 and 2019 were recorded in T4 (20.8 g/kg)) and T5 (14.6 g/kg), respectively which were above the mean value for 2018 (17.53 g/kg) and 2019 (9.33 g/kg). The potassium for each treatment were similar and all were below the mean value for 2018 (0.65cmol/kg) and 2019 (0.11 cmol/kg), although the soil was in critical level. The result showed the mining effect of micronutrient of onion on the post planting soil analysis. During 2018 planting season, T5 had the highest mining effect on Mn (13 mg/kg) and Fe (28 mg/kg) while in 2019, Mn, Fe almost had zero value across the treatment.

Discussion

The pre-planting result of the physical and chemical analysis of the experimental soil showed that the textural class of the surface soil (0-15 cm).The pH values were 6.9 (2018) and 6.6 (2019), which are within neutral value according to the rating of Chude *et al*., (2012). The optimum pH for onion production lies between 6.6 and 7.2 (Chude *et al*., 2012). The total nitrogen and potassium of the soil for the first and second planting seasons (1.3, 1.4 g/kg) and 2019 (0.3, 0.2 cmol/kg) respectively are generally low according to Chude *et al*., (2012). The results further revealed that the soil is generally rich in organic carbon and phosphorus for 2018 (17 g/kg, 20 mg/kg) and 2019 (16 g/kg, 17 mg/kg) planting seasons. In general, soil of the experimental site is poor in their selected physicochemical properties for onion production. To improve the soil fertility status of the experimental site, it is therefore important to improve the soil organic matter, nitrogen and potassium by applying the optimum levels of organic manure and inorganic fertilizers to improve physical and chemical properties of the soil.

It was observed that 100% application of poultry manure significantly influenced the dry matter yield for the two planting year compared to other treatments. Arisha *et al*., (2003) reported that manure activates many species of living organisms which release phytohormones and may stimulate plant growth and absorption of nutrients for multiplication. An experiment carried out by Agbede *et al.* (2017) also alluded to the ability of poultry manure to increase yields of crops.

Although the fresh bulb yields recorded in this investigation were far from the documented average yield of onion in Nigeria (FAOSTAT, 2006). This low yield could be due to the poor soil fertility nature of the pre-treatment experimental soils, which was intended in order to allow manifestation of the applied treatments.

Therefore, the highest relative profit margin from the 100% Poultry Manure may be due to the superior contribution of the treatment to the soil, which in turn led to the highest yield performance, hence, the highest relative profit margin. The positive influence of poultry manure on the fresh yield of onion bulb might be related to the presence of plant growth substances, humic acids, increased microbial diversity and activity and improvement of the physical structure of the soil (Yohannes *et al*., 2017). It was also reported by Yohannes *et al*., 2017 that the yield of marketable onion bulbs increased with nitrogen application, although, excessive application of nitrogen fertilisers could cause low yield of onion bulbs. This agrees with Ayoola and Makinde (2008) who reported that appropriate application of poultry manure increased the water soluble and exchangeable cations (Ca, Mg, Na, K), thereby enhancing crop growth. According to Tekeste *et al*. (2018), reduced rate of inorganic fertilization and poultry manure indicate the value of good manure sources as a supplement to inorganic fertilisers only.

The post planting soil analysis shows potassium was readily lost from the treatments and decreased from the soils used. This could be due to uptake of potassium by the crop or leaching due to sandy nature of the experimental soil. There was notable decline in potassium during the second year. This result is in agreement with

the report of Nishanth and Biswas (2007) that potassium was easily leached from enriched compost, Hue and Silva (2000), reported that potassium is easily displaced by divalent cations, making it readily available in soil solution leading to leaching effect. Nitrogen in both plantings years was against the findings of Schmidt (2012) who reported that the application of organic materials slowly released significant amount of nitrogen and phosphorus as sharp decline occurred during the second year in the amount of nitrogen and phosphorus left in the soil, although, it agrees with Schmidt *et al.* (2011), on the increased level of organic matter in the soil. Marked decrease was also recorded for other essential nutrients and micronutrient of the soil. It has been confirmed that manure has the capacity to supply both macro and micronutrients in the soil for optimum plant growth (Yohannes *et al*., 2017). Although, Yohannes *et al*. (2017), reported that combined application of organic and inorganic fertilizers provides excellent opportunities to overcome nutrient imbalances, besides sustaining soil health and enhancing crop production, however in this experiment, organic fertilizer alone using poultry manure proved better for onion. This is an indication of possibility of organic onion production if soil fertility management based to organic standard is applied.

Conclusion and Recommendations

The main focus of this experiment was to compare fertiliser effectiveness of mineral fertiliser NPK 15-15-15 with poultry manure. The result in general revealed better performance of the 100% poultry manure as fertiliser for onion production, compared with the NPK and other treatments used. Dry bulb yield and relative profit margin due to application of 100% poultry were better than that of other treatments. In general, the post-harvest soils fertility status were lower than that of pre-planting, but the poultry manure treatments generally improved soil fertility status at the second year of planting compared with the NPK fertiliser. The use of poultry manure as organic inputs in soils will not only help to improve the yield and profit margin, but will contribute effectively to safe disposal of the material which is often regarded as menace in the environment.

Moreover, the finding of this study is an indication of possible solution to soil fertility management for organic onion production.

Based on the results of the two-year experiment, application of 90kg K/ha poultry manure is recommended for onion production. This result should be investigated for onion production in a proper design for organic agriculture research.

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Awareness of Organic Food Products Among Households in Ibadan Metropolis, Oyo State, Nigeria

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Abstract
The future of organic agriculture in Nigeria to a large extent depends on the demand of organic products by the consumers. However, consumers may not demand for products that they are unaware of or have limited information about. In this study, the assessment of awareness of organic food products was carried out. Multistage sampling procedure was used to select 120 respondents used in the study. Primary data were collected on respondents' awareness of organic foods and socio-economic characteristics which were analysed using descriptive statistics (frequency, percentage, mean and standard deviation) and composite score analysis. The results showed that 55% of the respondents were female with an average age and household size of 49±12years and 4±1 person, respectively. Less than 50% of respondents were aware that organic foods are more natural with quality taste (43.3%) and no preservatives (49.2%), their production is environmentally friendly (43.3%) and their consumption promotes healthy lives (35.8%). The level of awareness among respondents was high with about 39.2% and 50% of respondents having high and moderate levels of awareness, respectively. The results of the disaggregation of level of awareness across selected characteristics revealed that level of awareness was higher among female (40.9%), young (50.0%), with secondary education (46.9%) and high-income (48.6%). The study therefore recommended that more enlightenment and education on the attributes and importance of organic food products especially among uneducated, male, low income earners and older members in our society.

Keywords: Synthetic chemicals, Organic food, Consumers, Genetically Modified Organism.

Sensibilisation Aux Produits Alimentaires Biologiques Parmi Les Ménages De La Métropole D' Ibadan, État D'oyo, Nigéria

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Résumé

L'avenir de l'agriculture biologique au Nigeria dépend dans une large mesure de la demande de produits biologiques par les consommateurs. Cependant, les consommateurs peuvent ne pas exiger des produits dont ils ne sont pas au courant ou sur lesquels ils disposent d'informations limitées. Dans cette étude, l'évaluation de la notoriété des produits alimentaires biologiques a été réalisée. La procédure d'échantillonnage à plusieurs degrés a été utilisée pour sélectionner 120 répondants utilisés dans l'étude. Des données primaires ont été collectées sur la connaissance par les répondants des aliments biologiques et des caractéristiques socio-économiques qui ont été analysées à l'aide de statistiques descriptives (fréquence, pourcentage, moyenne et écart type) et d'une analyse de score composite. Les résultats ont montré que 55% des répondants étaient des femmes avec un âge moyen et une taille de ménage de 49 ± 12 ans et 4 ± 1 personne, respectivement. Moins de 50% des répondants savaient que les aliments biologiques sont plus naturels avec un goût de qualité (43,3%) et sans conservateurs (49,2%), leur production est respectueuse de l'environnement (43,3%) et leur consommation favorise une vie saine (35,8%). Le niveau de sensibilisation des répondants était élevé avec environ 39,2% et 50% des répondants ayant des niveaux de sensibilisation élevés et modérés, respectivement. Les résultats de la désagrégation du niveau de connaissance selon certaines caractéristiques ont révélé que le niveau de sensibilisation était plus élevé chez les femmes (40,9%), les jeunes (50,0%), ayant fait des études secondaires (46,9%) et à revenu élevé (48,6%). L'étude a donc recommandé que plus d'éclaircissements et d'éducation sur les attributs et l'importance des produits alimentaires biologiques, en particulier parmi les hommes sans instruction, à faible revenu et les membres plus âgés de notre société.

Mots clés: produits chimiques synthétiques, aliments biologiques, consommateurs, organisme génétiquement modifié

Introduction

Consumers' concerns over health and environmental problems are causing the patterns of food intake to evolve. Also, interest in organically grown food is on the rise worldwide (Willer, Yussefi-Menzler and Sorensen, 2009). The increase in consumers' interest in organic food products has been attributed among other issues to the growing demand for foods that are free from pesticides and chemical residues (Sangkumchaliang and Huang, 2012). Organic foods consist of those products that are not treated with synthetic fertilizers, pesticides, herbicides and other synthetic chemicals during production, processing and storage.

Furthermore, organic food products do not contain genetically modified materials with the intent of reaching sustainable system of agriculture. In livestock, breeding, use of growth hormones are avoided, antibiotics and other chemicals to enhance the growth. (Mohammad, Fathelrahman and Ullah, 2016).

Consumers' awareness and knowledge as well as the consumption of organic food is much higher in developed countries than in developing countries (Briz and Ward, 2009). Consumers are more informed about the food they eat and more conscious of the link between them and their health status (Annunziata and Pascale, 2009). This has resulted to a significant increase in demand for organic food which has transformed the small industry into a well-developed market in the last two decades (Aygen, 2012). The use of inorganic chemicals in food production have been identified as a major source of health risk such as abdominal pain, dizziness, headaches, nausea, vomiting, as well as skin dermatologic conditions, cancer, depression and eye problems (Lumpkin, 2005).

Organic foods provide a variety of advantages and nutritional value for human health. People with allergies to foods, chemicals or preservatives often find their symptoms lessen or go away when they eat only organic foods. Thus, enhancing good health and promoting long life (Mgbenka, Onwubuya

and Ezeano, 2015). Organic agricultural products are environmentally friendly and are characterized by high quality. This makes their price higher than conventional agricultural products but with consumer's increasing income and health awareness, there has been a surge in the number of consumers in developing countries who are willing to try and buy them. (Liu *et al.,* 2019). Organic foods are gaining popularity in developed and developing countries. Some countries in the North American and European Union are reported with produce market comprising over 90% organic foods sales. A number of countries in Africa also reported an increase in farmlands devoted to organic produce; that is from 52,000Ha in 2000 to over 1 millionHa in 2014 (Willer and Lernoud, 2019). African countries like Uganda, Kenya, Tanzania, South Africa, Cameroon and Ghana have gone far ahead of Nigeria in production of certified organic food (Aiyelaagbe, Harris and Trenchard, 2010). Nigeria is yet to improve on her potential in terms of organic farming compared to other African countries. Even though it is an agricultural country with the record at one time or the other of being world leading producer of some crops. Organic farming in an organized manner is still new in the country as only few hectares of land have been cultivated in years pass (USAID, 2014).

In spite of the numerous advantages of consumption of organic food products, information on its awareness in Nigeria appears to be limited. Bello (2014) asserted that marketing and distribution of organic product in Nigeria is challenging.

Unlike in the developed countries where there is available market and consumers are readily available to purchase organic product even at a premium price. This problem could be as a result of low or no knowledge about organic foods consumption and their impact on consumers' health as well as the environments. In developing countries, awareness of organic food is the first step among consumers though it does not necessarily equate with its consumption (Briz and Ward, 2009).

Therefore, knowledge and awareness about organically produced foods will be critical to consumers' behavioural attitude and their choice of foods. As consumers' knowledge and awareness is an important drive to the growth of organic foods in the market, an investigation of consumers' awareness of organic food would help both consumers and marketers of organic foods. It would also assist government to design strategies for consumer education on the benefits of consuming organic products. Based on aforementioned, the main objective of the study is to assess level of respondents' awareness of organic foods.

Specifically, the study objectives are to:

i. assess the level of awareness of organic foods in the study area.
ii. disaggregate level of awareness of organic foods across the selected socio-economic characteristics.

Materials and Methods

This study was carried out in Ibadan metropolis, the capital and most populous city of Oyo state, Nigeria. Ibadan has a population of over 3 million and is the third most populous city in Nigeria after Lagos and Kano. The principal inhabitants of the city are the Yoruba tribe, as well as various tribes (Hausa, Igbo, Fulani, Ijaw, Tiv among others) from other parts of the country. The main economic activities engaged in by the Ibadan populace include agriculture, trade, public service employment, factory work, service sector/tertiary production etc.

Multi-stage sampling procedure was used to select respondents for the study. The first stage was the selection of four Local Government Areas (LGAs) out of 11 LGAs (Ibadan southwest, Ido, Akinyele and Ibadan North-east) from the metropolis using purposive sampling technique.

These four Local Government Areas were due to the presence of many organic farmers, location of Nigerian Organic Agriculture Network (NOAN) and the newly established organic store in these areas. The second stage involved a selection of three communities in each from the Local Government Areas using simple random technique. This gave a total of 12 communities in all. Lastly, 10 households each were selected

from the communities using a simple random sampling technique. In all, one hundred and twenty household were selected while one respondent was interviewed from each household to make a total sample size of 120. Primary data was obtained through the use of well-structured questionnaire and administered as interview schedule in case of low literacy level. Information was collected on socio-economic characteristics of respondents' awareness of organic foods and source of information on organic food among others.

Descriptive statistics was used to profile the socio-economic characteristics of the respondents. It was also used to describe the organic foods awareness variables. To measure respondents' awareness of organic foods, they were asked respond to 17 facts about organic food consumption as they were provided with response options of "Aware and Unaware". Some of these awareness items include; organic foods are more natural with quality taste, consuming organic food reduce cancerous tendencies, organic foods are free from radioactive irradiation and materials, organic foods have no contamination by residues and consumption of organic food promote adequate growth and development. The score was calculated by summing up the Yes/No responses of respondents as regards the 17 indicators of awareness used in this study. A binary scale that scores 1 for respondents with 'Yes' and 0 for respondents with 'No' was used. With 17 indicators, the maximum obtained score was 15 and a minimum of 4 score. The mean score and standard deviation were 9 and 2 points. The categorization into low, moderate and high awareness was then achieved by categorizing respondents with 0-7 points as having low awareness, respondents with 8-10 points were categorized as having moderate awareness while respondents with 11-15points were categorized as having high awareness.

Results and Discussion

Socio-economic characteristics of respondents

The socio-economic characteristic of respondents in Table 1 shows that 55% of the respondents were female. More than half (55%) of the respondents were ≤50years with an average age of 49 years. Majority (74.2%) of the respondents had household size of 4-6 persons with an average household size of 4 persons. Just a few (30.8%) earned ₦50,001 – ₦70,000 monthly income with an average income of ₦90,000 while a higher percentage (60%) of the respondents had primary education.

A few (30.8%) of the respondent heard information on organic foods from the print and electronic media such as television, radio, newspaper etc. A few (21.7%) of the respondents heard information about organic foods from local organic markets. Only 13.3% and 14.2% of the respondents heard from local organic farmers as well as family and friends. This implies that more consumers get information on organic food products through electronic and print media. This result is similar to the findings of Al-Taie *et al.* (2015). The authors opined that electronic and print media as well as other communication channels could give adequate and up-to-date information on consumption of organic food products by households and individuals as new trendy lifestyles that can generate a form of prestige among consumers. Therefore, delivering information on the potential benefits and sources of organic food products using various delivery channels could promote more awareness among consumers.

Table 1: Socio-economic characteristics of respondents

Variable	Frequency	Percentage	Mean
Sex of respondents			
Male	54	45.0	
Female	66	55.0	
Age of respondents (years)			
≤30	8	6.7	49.08±12.5
31-40	17	14.1	
41-50	41	34.2	
>50	54	45.0	
Household size			
1-3	12	10.0	4±1
4-6	89	74.2	
>6	19	15.8	
Monthly income (₦)			
?30, 000	2	1.7	90,000±46,283.6
30, 001 – 50, 000	17	14.2	
50, 001- 70, 000	37	30.8	
70, 001 – 90, 000	27	22.5	
>90, 000	37	30.8	
Education of respondents			
No formal education	4	3.3	
Primary education	72	60.0	
Secondary education	32	26.7	
Tertiary education	12	10.0	
Source of information about organic foods			
Print/Electronic media	37	30.8	
Local Organic Farmer	16	13.3	
Local Organic Market	26	21.7	
Doctor's Recommendations	14	11.7	
NOAN Advertisement/awareness campaign	10	8.3	
Friends and Family	17	14.2	

Source: Field Survey, 2018

Respondents' awareness of organic food products

Table 2 shows that few of the respondents were aware that organic foods are more natural with quality taste and no preservatives (43.3%), their production is environmentally friendly (43.3%) and their consumption promotes healthy lives (35.8%). Less than 55% of respondents were aware that consuming organic foods reduce cancerous tendencies (52.5%) and they are free from radioactive irradiation and materials (54.2%).

More respondents were aware that consumption of organic food aids digestion (55%), they possess label (57.5%) with long lasting freshness (56.7%) and are recommended for certain patients to

reduce health risks (58.3%). A higher percentage of the respondents were aware that organic foods have no contamination by residues (70%), they are cultivated using natural manure (69.2%), costlier than conventional food (69.2%) and have high dietary quality (69.2%) while over 70% of the respondents were aware that consumption of organic food promote adequate growth and development (74.2%) and they are free from genetically modified organisms (72.5%). This implies that consumers are more aware that consumption of organic food promotes adequate growth and development. Hamilton and Hekmat (2018) identified healthiness as a major attribute and reason why people consume organic food.

Level of awareness about organic food products

Table 3 reveals that 50.0% of the respondents had moderate level of awareness while about 39.2% had high level of awareness. The result implies more people are aware of organic food products in the study area. This implies that more consumers are aware of organic food products. Al-Taie (2015) opined that the positive attitude of consumer to organic food products was due to their perception that it is healthier than the conventional alternatives.

Table 2: Distribution of respondents using the indicators of awareness

Awareness Indicators	Yes (%)	No (%)
Organic foods are more natural with quality taste	43.3	56.7
Consuming Organic food reduce cancerous tendencies	52.5	47.5
Organic foods are free from radioactive irradiation and materials	54.2	45.8
Production of organic foods are environmentally friendly thus reducing impacts of climate change	43.3	56.7
Consumption of Organic food promote healthy lives	35.8	64.2
Organic foods are recommended for certain patients to reduce health risks	58.3	41.7
Consumption of Organic food aids digestion	55.0	45.0
Consumption of organic food promote adequate growth and development	74.2	25.8
Organic foods have no contamination by residues	70.0	30.0
Organic foods have high dietary quality	69.2	30.8
Organic food products cost higher price than conventional food products	69.2	30.8
Organic foods are cultivated using natural manure	69.2	30.8
Organic foods should possess label (certification, date of expiration etc)	57.5	42.5
Organic foods have no preservatives	49.2	50.8
Organic food can be found all year round	50.0	60.0
Organic foods freshness last longer	56.7	43.3
Organic foods are free from genetically modified organism (GMO)	72.5	27.5

Source: Field survey, 2018

Table 3: Categorization of respondents based on level of awareness of organic food products

Level of Awareness	Frequency	Percentage
High	47	39.2
Moderate	60	50.0
Low	13	10.8

Source: Field survey, 2018

Disaggregation of level of awareness across selected socio-economic characteristics

Table 4 shows that higher percentages (11.1%) of respondents with low awareness were male while higher percentage of respondents with moderate (54.6%) and high awareness (40.9%) were female. This implies that females were more aware of organic foods than their male counterpart. This may be due to fact that women are always in charge of cooking and purchase of food items for households in a typical African family.

Level of awareness across age of respondents

Table 5 shows that higher percentage (12.9%) of respondents with low awareness were >50years. Majority of respondents with moderate (70.6%) and high (50%) levels of awareness were between 31-40 years and ≤ 30years, respectively. This implies that younger respondents are more aware of organic foods than older respondents.

Level of awareness across education of respondents

Table 6 indicates that a higher percentage (75%) of respondents with low level of awareness had no formal education while majority of respondents with high (46.9%) and moderate (58.3%) levels of awareness had secondary and tertiary education respectively. This implies that there was more awareness among respondents that were educated than those with no formal education.

Level of awareness across income of respondents

Table 7 shows that the highest percentage (100%) of respondents that had low awareness falls in the income category of ≤ ₦30,000 while respondents with moderate (62.9%) and high (48.7%) levels of awareness had income of ₦70,001– ₦90,000 and >₦90,000 respectively. This implies that people with more income were more aware than people with less income. This could either be because they have enough income to get information about organic foods or they have enough to buy organic foods at premium prices.

Table 4: Distribution of level of awareness across sex of respondents

Sex of Respondents	Level of Awareness (%)		
	Low	Moderate	High
Male	11.1	51.9	37.0
Female	4.5	54.6	40.9

Source: Field survey, 2018

Table 5: Distribution of level of awareness across age of respondents

Age of Respondents (years)	Level of Awareness		
	Low	Moderate	High
≤30	0.0	50.0	50.0
31-40	5.9	70.6	23.5
41-50	9.7	53.7	36.6
>50	12.9	48.2	38.9

Source: Field survey, 2018

Table 6: Distribution of level of awareness across education of respondents

Education Level	Level of Awareness (%)		
	Low	Moderate	High
No formal education	75.0	25.0	0.0
Primary education	12.5	48.6	38.9
Secondary education	9.4	43.7	46.9
Tertiary education	8.4	58.3	33.3

Source: Field survey, 2018

Table 7: Distribution of level of awareness across income of respondents

Income (₦)	Level of Awareness (%)		
	Low	Moderate	High
≤30, 000	100.0	0.00	00.00
30, 001 – 50, 000	11.8	58.8	29.4
50, 001- 70, 000	16.22	37.8	46.0
70, 001 – 90, 000	11.1	63.0	25.9
>90, 000	2.7	48.7	48.6

Source: Field survey, 2018

Conclusion and Recommendations

It can be concluded that consumers are more aware of organic food products and its relative importance to their healthy living. The level of awareness was also higher among young, female, educated and high-income earners. It is thus recommended that more enlightenment and education is required on the attributes, advantages and importance of organic food products especially among uneducated, male, low income earners and older members in our society.

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www.noara.bio

ABOUT NOARA

Network of Organic Agriculture Researchers in Africa (NOARA) is established to unite and coordinate African organic and ecological agriculture scientific and technical researchers within and outside Africa. NOARA is a membership Network that draws members from national, regional, continental and international organic agriculture organizations, associations, networks and companies within and outside Africa, but whose aims and goals are in support of organic and ecological agriculture.

NOARA Vision
Africa with zero hunger, poverty eradicated, improved livelihood and sustained ecosystem through innovative organic agriculture research/ une Afrique sans faim, sans pauvreté, avec de meilleurs moyens de subsistance et un écosystème durable grâce à une recherche innovante en matière d'agriculture biologique.

Mission
To establish and disseminate evidence-based scientific organic agricultural knowledge that can ensure healthy, ecological, fairness and care of organic agriculture actors in Africa for sustainable livelihood and ecosystem, leading to food security and sustainable development / Établir et diffuser des connaissances scientifiques en agriculture biologique fondées sur des données factuelles, susceptibles de garantir des moyens de subsistance durables et un écosystème sain, écologique, équitable et responsable aux acteurs de l'agriculture biologique, menant à la sécurité alimentaire et au développement durable.

NOARA OBJECTIVES

A. *Research and Training / Recherche et formation*
- Lead research agenda on organic and ecological agriculture in Africa / Programme de recherche principal sur l'agriculture biologique et écologique en Afrique
- Coordinate organic and ecological agriculture training and research in Africa / Coordonner la formation et la recherche en agriculture biologique et écologique en Afrique
- Support or initiate research activities that contribute to the social, cultural and economic productivity of Africa's smallholder farmers, processors and marketers, particularly, women and youths who have been largely marginalized / Soutenir ou lancer des activités de recherche qui contribuent à la productivité sociale, culturelle et économique des petits exploitants, transformateurs et commerçants africains, en particulier des femmes et des jeunes largement marginalisés

B. *Policy and Stakeholder Engagements / Politique et engagement des parties prenantes*
- Promote collaboration among organic and ecological agriculture researchers, practitioners, farmers and policy makers in Africa / Promouvoir la collaboration entre les chercheurs, les praticiens, les agriculteurs et les décideurs de l'agriculture biologique et écologique en Afrique.
- Improvement of ecological organic agriculture database for influencing policy development in Africa / Amélioration de la base de données sur l'agriculture biologique écologique pour influer sur l'élaboration des politiques en Afrique
- Advocate for mainstreaming of organic and ecological agriculture into agricultural research and innovation to enhance food security in Africa / Plaider pour l'intégration de l'agriculture biologique et écologique dans la recherche et l'innovation agricoles afin de renforcer la sécurité alimentaire en Afrique
- Engage organizations producing organic and ecological inputs in confirmatory and adaptive research for possible recommendation of their products to end users in Africa and beyond / Engager les organisations produisant des intrants biologiques et écologiques dans la recherche de confirmation et la recherche adaptative en vue de la recommandation éventuelle de leurs produits aux utilisateurs finaux en Afrique et au-delà.

C. *Conferences and Information Dissemination / Conférences et diffusion de l'information*
- Organize conferences and meetings for the exchange of information on organic and ecological agriculture / Organiser des conférences et des réunions pour l'échange d'informations sur l'agriculture biologique et écologique.
- Publish research and technical results on organic and ecological agriculture / Publier des recherches et des résultats techniques sur l'agriculture biologique et écologique
- Organize consortia of experts in addressing specific or emerging issues relating to organic and ecological agriculture in Africa / Organiser des consortiums d'experts pour traiter des problèmes spécifiques ou émergents liés à l'agriculture biologique et écologique en Afrique

D. *Advocacy and Awards / Plaidoyer et récompenses*
- Honour distinguished members as fellows of the network / Honorer les membres distingués en tant que membres du réseau
- Represent the interest of organic and ecological agriculture researchers beyond Africa / Représenter les intérêts des chercheurs en agriculture biologique et écologique en dehors de l'Afrique

NOTES TO AUTHORS

African Journal of Organic Agriculture and Ecology (AJOAE) – A journal of Organic Agriculture and Ecology is published biannually to create an effective medium for dissemination of information on organic agriculture research findings in all areas of agriculture, food sciences and Ecology.

Scope:
Contributions may be on Agricultural Economics, Agricultural Engineering, Agricultural Extension, Agroforestry, Animal science, Crop/Environmental protection, Crop science, Environmental Sciences, Fishery/Aquaculture, Pharmacy, Soil science, Veterinary Medicine, Wildlife Management.

Preparation of manuscripts
- Articles could be written in either English of French with moderate technical terminologies to facilitate wide readership.
- All manuscripts should be typed, Times New Roman (12), 1.5 spacing on A4 size (210 x 297mm) paper.
- The length of the manuscript should in general not exceed 12 pages (tables, figures and other illustrations inclusive).
- Leave ample margins, 2.54 cm to the left and 2.54 cm to the top and bottom of the page.
- The cover sheet should contain (a) Title of the article (b) Author (s) name, followed by a line at the tail end giving name and address to which all correspondence should be addressed.
- The manuscript should be organized as follows: TITLE, ABSTRACT (250 words max), INTRODUCTION, MATERIALS AND METHODS or METHODOLOGY), RESULTS, DISCUSSION (or RESULTS AND DISCUSSION), CONCLUSION AND RECOMMENDATION, ACKNOWLEDGEMENTS (where necessary) and REFERENCES.
- The main heading should be centered and capitalized; the secondary and tertiary headings should be typed in lower case letters to the left of the page.
- Use only international system of Unit (SI) and ensure that units are quantitative measurements, e.g. 3kg; when they are preceded by a capitalized noun, e.g. Table 8.
- Tables and figures should be numbered in Arabic numerals, cited in the text, sources indicated if not original (i.e. not made by the author), and on separate sheet(s).
- Each table and figure should have an explanatory legend, which should be typed at the bottom of the page.
- Reference citation in the text should follow the name, years system; all references cited must be listed in alphabetical order of the sole/senior/first author's names; each reference should be systematic as for journal; surname of the author(s) initials; year of publication (in parenthesis), title of paper, name of Journal (italicized), volume number, number of issue (if applicable) in Arabic numerals on the first and the last pages of the references, e.g. Olayemi A.A. (1991) ……"A Descriptive Analysis of Agriculture Cooperative Model in Rural Development". ***Journal of Rural Development and Administration.*** 23 (3):1-8.

For two authors" Joseph, K. and Aworh, O. C. (1991) "Composition, Sensory Quality and Respiration during Ripening and Storage of Edible Wild Mango ***(Invingia gabonensis)". International Journal of Food Science and Technology.*** 26:337-342.

For the citation of books, the author's name comes first followed by year of publication in bracket, title of book (underlined), edition and volume number (if any) page or pages, city of publication and publishers e.g.
Fredick, G. B. (1970). ***Principles of Educational and Psychological Testing.*** 468 pp. Illinois: The Dryden Press Inc.

For a chapter in a book, e.g. Pickering, D. C. (1978) "An overview of agricultural extension and its linkages with agricultural research". The World Bank experience. In: ***Agricultural Extension Worldwide: Issues, Practices and Emerging Priorities*** (eds.) Rivera, W. M. and Schram, W. G.) 320 pp. New York: Crom Helm.

Careful editing and scrutiny are required before sending manuscript to the editor as there may be no opportunity for alteration once an article is accepted for publication based on reviewers' comments.
Recommendations and excerpts from published articles will also be featured in NOARA bulletin for organic practitioners' uptake and utilization.

Contributors are to send their manuscripts, not previously published or being considered for publication elsewhere to: https://publications.noara.bio/

Thank you for choosing AJOAE.

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Table of Contents

AFRICAN JOURNAL
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ISSN: 2734-2913 (Prints);2795-2223 (Online)
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