International Journal of Organic agricultural Research & Development
Volume 19 (4) (2024)

ASSESSMENT OF PHYSICAL AND CHEMICAL PROPERTIES OF SOILS OF DIFFERENT LAND USE TYPE IN OGBOMOSO

Oparinde, M. D., Oyediran G. O., Olatunji O. O., Akande, S. A. and Esho, G. B.
Department of crop production and soil science, Ladoke Akintola University of Technology, Ogbomoso, Nigeria
Corresponding author: oparindeayomiotan@gmail.com

ABSTRACT

The study was conducted at Ladoke Akintola University of Technology (LAUTECH) in Ogbomoso, Nigeria. It examined the impact of different land use types (arable land, cashew plantation, woodlot and fallow land), on soil physical and chemical properties. Soil samples were collected randomly at the depth of (0-30 cm) in 3 replications, air-dried, gently crushed, and sieved through 2mm sieve and subjected to laboratory analysis. The samples were analyzed for particle size distribution, pH, exchangeable bases, effective cation exchange capacity, total nitrogen, available phosphorus, organic carbon, exchangeable acidity, electrical conductivity and base saturation. The results showed that soil texture is predominantly sandy loam, except for arable land. Total porosity values were high at cashew plantations, fallow land, and woodlots, while arable land had the highest bulk density. Soil reaction was moderately acidic, with high base saturation and organic carbon levels. The EC was slightly saline, and exchangeable minerals were moderate. The study concluded that annual applications of organic and inorganic fertilizers are necessary to maintain soil fertility and enhance productivity. Ultimately, a comprehensive soil survey of the region is warranted to investigate the profile characteristics of the soil, ascertain its specific mineralogical composition, and conduct a land evaluation, aspects which were not encompassed in this study.

Keywords: Land use types, Soil physical properties, Soil chemical properties content

INTRODUCTION

Soil functions as a dynamic substrate, providing vital nutrients, water, and structural integrity essential for the growth and development of vegetation. Nonetheless, the influence of soil characteristics on agricultural yield is complex and differs across geographical locations, climatic conditions, and specific types of crops. Soil characteristics arise from the interaction among five fundamental factors that influence soil genesis: parent material, topography, biotic organisms, climate, and temporal aspects. These interactions result in a variety of soils exhibiting different levels of productivity. As articulated by Law-Ogbomo and Nwachokor (2010), soil productivity is considerably affected by both the physical and chemical characteristics of the soil matrix. The intrinsic properties of soil govern its functional behavior, highlighting the necessity of comprehending the physical characteristics of soil, the factors that may alter these attributes, and the methodologies for managing them to enhance human endeavors.

Variations in soil characteristics are contingent upon anthropogenic land use practices. Specifically, agricultural methodologies exert influence on soil attributes and quality, shaped by diverse spatial and temporal variables, as observed by Vukicevich *et al.,* (2016).

Variations in soil characteristics are contingent upon anthropogenic land use practices. Specifically, agricultural methodologies exert influence on soil attributes and quality, shaped by diverse spatial and temporal variables, as observed by Vukicevich *et al.,* (2016). The agricultural sector indirectly affects soil properties through mechanisms such as enhanced erosion, diminished organic matter, compaction alterations, and complications including sealing, contamination, salinization, and desertification, as delineated by Stolte *et al.,* (2015).

The physical characteristics of soil may experience alterations due to factors such as the degradation of soil structure and texture resulting from diminished organic matter, erosion of finer particles, and exposure of the subsoil. These parameters elucidate the condition, movement, and transference of matter within the soil matrix. Illustrative examples of soil physical attributes include bulk density, porosity, particle size distribution, aggregate stability, soil texture, and soil structure, among others. Undoubtedly, soil structure, as one of the physical characteristics of soil, plays a critical role in various facets of agricultural processes.

Both soil structure and texture are crucial determinants that contribute to the overall health and functionality of soil within agricultural contexts, as well as its interaction with the subsoil. These modifications influence the presence and growth of plant species and affect the movement of water, dissolved nutrients, and chemical pollutants within and through the soil matrix (Brady and Weil, 2002).

The chemical characteristics of soil are influenced by the interactions occurring at the interfaces of soil colloids, their electrochemical properties, and the mechanisms by which ions and water molecules are organized and retained at these interfaces (Ufot, 2012). The chemical attributes of soil are closely linked to its inherent chemistry (Sainju & Liptzin, 2022). Notable chemical characteristics encompass mineral constituents, the cation exchange capacity of the soil, soil pH, organic matter content, heavy metal concentrations, percentage base saturation, and effective cation exchange capacity, among others. According to Brady and Weil (2002), organic matter serves as a pivotal factor in promoting the formation and stabilization of granular and crumb-like aggregates, as it supplies the necessary energy substrates that facilitate these processes. Havlin *et al.,* (2006) have indicated that cation exchange capacity constitutes one of the critical chemical properties of soil that affects nutrient availability and retention, representing the cumulative quantity of negative surface charges on minerals and organic matter that are available for attracting cations in solution.

When examining the relationship between soil nutrients and environmental conditions, it is imperative to consider land use and the type of vegetation present (Onweremadu, 2007). Various land use types exert significant influence on soil quality and the overall sustainability of soil resources within the ecosystem. Lister *et al.,* (2004) noted that an increase in herbaceous vegetation positively affects soil quality, including alterations in average bulk densities. Powlson *et al.,* (2011) documented changes in soil properties, particularly soil organic carbon, when land use transitioned from arable to forest, grassland, and perennial cropland.

The optimum productivity of any land use types depends on soil properties to adequately supply nutrient elements in required quantity and rate (Sainju & Liptzin, 2022). When the soil does not supply sufficient nutrients for normal plant development and optimum productivity, application of supplemental nutrients and good soil management practices are required. Thus, there is need to determine the soil properties under different land use types in order to identify the associated problems and make recommendations for soil management best practices.

MATERIALS AND METHODS

Description of Study Area

The climatic conditions of the study area are classified as tropical, exhibiting distinct dry and wet seasons accompanied by relatively high humidity levels.

The mean daily temperatures fluctuate between 25°C (77.0°F) and 35°C (95.0°F) nearly throughout the entire year. The annual average precipitation is approximately 1200 mm, with a variability ranging from 786.2 mm to 1513 mm. The rainy season is delineated from April to November and demonstrates a bimodal distribution on a monthly basis, with the initial peak occurring in June and the subsequent peak in September, interspersed with a lull during July and August. The dry season follows immediately after, commencing in November and concluding in February, coinciding with the occurrence of the harmattan phenomenon.

Soil sampling

A random sampling technique was employed to choose representative sites within the study area. Four land-use types were investigated for this study, they were; arable lands (al), cashew plantations (cl), woodlots (wl), and fallow lands (fl). Each land-use type is described as follows:

❖ Arable Land: The land has undergone continuous tillage (to a depth of 15 cm) annually for approximately two decades. It has been subjected to uninterrupted cropping with maize (*Zea mays*). The application of fertilizers (urea and NPK) is executed with regularity. Weed management is predominantly achieved through the utilization of herbicides. Pesticides are employed to mitigate pest populations. The prevalent weeds include guinea grass (*Panicum maximum*), prostrate globe amaranth (*Gomphrena celosioides*), tridax (*Tridax procumbens*), finger grass (*Chloris pilosa*), torpedo grass (*Panicum repens*), among others.

❖ Cashew (*Anacardium occidentale*) plantation: This plantation was established approximately 35 years prior to this study, although certain sections have undergone rejuvenation. Weeds are distributed sparsely, which may be attributable to the dense canopy of the cashew trees and the layer of leaf litter covering the soil surface. Notable weeds present include siam weed (*Chromolaena odorata*), silver bush (*Peperomia pellucida*), lesser round weed (*Hyptis brevipes*), etc. Manual slashing is employed as a method for weed control.

❖ Fallow Land: This land has remained undisturbed for a period exceeding 15 years. It is characterized by a variety of shrub species such as giant sensitive plant (*Mimosa invisa*), Mexican sunflower (*Tithonia diversifolia*), and tropical nettle weed (*Laportea aestuans*), among others.

❖ Wood lots: This area has existed approximately 35 years before this investigation. The dominant tree species identified in this locale are teak (*Tectona grandis*) and Kashmir tree (*Gmelina arborea*). The soil surface is inhabited by weeds such as siam weed (*Chromolaena odorata*), hemorrhage plant (*Aspilia africana*), blackjack (*Bidens pilosa*), etc. Manual slashing is also employed for the management of these weeds.

For each land-use category, soil samples were collected at a depth of 0-30 cm in replicates using a soil auger, with each sampling category yielding a representative composite soil sample of 1 kg, secured in plastic bags and appropriately labeled. Furthermore, undisturbed core samples were extracted from each sampled land-use type at the center of the designated plot, utilizing a cylindrical metal core sampler, resulting in a total of four (4) undisturbed soil samples. The configuration of the field/slope pattern, vegetation, the presence or absence of contaminants, and soil type were meticulously considered when determining sampling locations in each land use, ensuring the collection of representative samples from each field.

Sample Preparation for Laboratory Analysis

Before the required laboratory analysis was performed, the soil samples were prepared by removing unwanted materials, such as dead plants and organic piles. The soil samples was air-dried and crushed to pass through a 2-mm sieve. The prepared soils were put into plastic bags. The soil sample bags were properly labeled, indicating pertinent information, including the land use type and date of sampling, before transporting them to a laboratory for further sample preparation and analysis.

Laboratory analysis

The prepared soil samples were analyzed for certain selected properties which are necessary for proper scientific classification of the soils. The properties were determined as follows:

The soil particle size distribution was determined by the Bouyoucos hydrometer method (Gee and Or, 2002) and the textural class was determined using a textural triangle. The percentage of gravel content was calculated from the total soil weight as :

$$\%\ \text{Gravel Content} = \frac{\text{Weight of Gravel content}}{\text{Total Weight of Soil}} \times 100 \qquad \text{.......1}$$

Soil pH was determined potentiometrically using pH meter after equilibrium for 30 minutes. Soil organic carbon (SOC) was analyzed by the Walkley-Black method (Walkley and Black, 1934), as reviewed by Allison, (1965) using samples that were ground to pass through 0.05 mm sieve. The Maro-kjeldahl method was used to determine total nitrogen (TN) (Bremmer, 1965). Electrical conductivity (EC) was measured on a 1:2.5 ratio extract with an EC meter. Exchangeable acidity was determined by the titration method using 1.0 M KCl for extraction (Mclean, 1965). Effective cation exchange capacity (ECEC) is the summation of exchangeable bases and exchangeable aluminum. The determination of cation exchange capacity (CEC) was by the sum of cations method. Exchangeable Mn was determined using the ammonium acetate (NH_4O_{AC} at pH 7) extraction method, whereas available potassium was determined by the sodium acetate method, as described in Carter and Gregorich (2007). The Bray-1 method was applied to determine the available phosphorus

(Bray and kurtz, 1945). A flame photometer read the contents of exchangeable K^+ and Na^+, and exchangeable Ca^{2+} and Mg^{2+} was read with the help of atomic absorption spectrometry (AAS). Bulk density (ρb) will be determined using the core sampling method after drying the soil samples in an oven at 105 °C to constant weight for 24 h (Landon, 1991). The values of ρb and assumed average particle density (PD) of 2.65 g/cm^3 for mineral soils will be used to calculate the value of total porosity using the following formula

P = 1 - (ρb/PD) 100. Where, P = total porosity (%), ρb = the value of bulk density (g/cm^3), and PD = assumed particle density (g/cm^3). Percent base saturation (PBS) was calculated using the following formula PBS=(sum of exchangeable bases/ECEC)x100 (Hazelton and Murphy, 2007).

Statistical analysis

The data collected were subjected to analysis utilizing the Statistical Package for Social Sciences (SPSS). Statistical measures specifically the mean (X), were employed to construct tables and figures that facilitate comparative analysis of soil nutrients across the various land use types.

RESULT AND DISCUSSIONS

Physical characteristics

The composition of particle sizes establishes the textural classification of a soil, which in turn affects soil water retention capacity, aeration, and the retention of soil nutrients, among other factors. The textural classifications of surface soils in arable land are categorized as loamy sand, whereas those of cashew plantations, fallow lands, and woodlots are classified as sandy loam, as illustrated in Table 1. This finding indicates that the soil texture classifications within the analyzed land use are predominantly characterized by sandy textures, which constitute between 75% and 80%, succeeded by clay textures that comprise approximately 10% to 19%, with silt representing the minimal proportion across all land use, ranging from 6% to 10%, as detailed in table 3. The findings derived from this particle size distribution analysis suggest that the soils associated with arable land possess a greater potential fertility compared to those found in cashew plantations, fallow lands, and woodlots, primarily due to their loamy sand texture, which is attributable to the implementation of cultivation practices, fertilization, and various agronomic interventions.

The preeminence of sand in relation to other particle sizes across the entirety of the studied land uses is fundamentally indicative of the influences exerted by climatic conditions and the parent material on soil characteristics. Teshome and Yitayal., 2019, reported that clay and silt soils demonstrate a notable capacity to withstand soil erosion, rendering them less vulnerable to erosional risks. Consequently, it may be inferred from the results that the soils in these land use areas can be classified as less erodible.

The bulk density of 1.4 g/cm³ was observed in the cashew plantation, fallow land, and woodlot, respectively, while a density of 1.5 g/cm³ was recorded in the arable land use; this indicates a medium range and suggests that the soils within the study area possess adequate pore space, thus presenting no constraints for aeration. Furthermore, the investigation highlighted that the bulk density of the soils does not exceed the critical threshold of 1.63 g/cm³ (Teshome and Yitayal., 2019). Consequently, in the study area, issues related to compaction and drainage is minimal. This condition fosters a favorable environment for biological activity (Werner, 1997) and enhances infiltration. The maximum bulk density was identified in the arable land, potentially attributed to a reduced organic matter content coupled with an increased level of soil compaction resulting from intensive agricultural practices. The moderate density values indicate that bulk density is unlikely to impede root and water movement within these soils. Soil bulk density significantly influences the dynamics of water and air within the soil matrix and the development of crop roots, which ultimately impacts agricultural growth and yield.

The total porosity measurements obtained were 43% for the arable land and 47% for the cashew plantation, fallow land, and wood lot, respectively. The maximum total porosity values were observed in the cashew plantation, fallow land, and wood lot (47%), which can be attributed to elevated organic matter concentrations and reduced bulk density, as corroborated by Brady and Weil (2008), who indicated that the quantity of pore spaces and soil organic matter exhibits an inverse relationship with bulk density. Consequently, the total porosity measurements fall within the typical range of 30% to 70% (Hazelton & Murphy, 2007). All variables influencing soil pore spaces will inherently impact bulk density.

Chemical characteristics

The analytical findings from the soil samples in the land use examined, indicated a soil reaction of 5.8 for arable land, 5.7 for cashew plantations, 5.7 for fallow land, and 5.8 for woodlots, as delineated in Table 2. The majority of the soils within the examined land uses exhibit characteristics of acidity (moderately acidic), which may be attributable to the substantial rainfall conditions that facilitate the downward leaching of soluble basic cation nutrients. As reported by Teshome and Yitayal (2019), soil pH is markedly responsive to alterations in the natural environment, recurrent cultivation of identical plots, and the occurrence of intense rainfall. Furthermore, this phenomenon could be linked to the parent material from which the soils originated, resulting in the leaching of basic cations. Consequently, the soils associated with these land uses demonstrate diminished pH levels and a relatively acidic behaviour. Asadu *et al.,* (2001) have observed that the parent material exerts a substantial influence on soil pH.

The organic carbon content of soils across the various land uses fluctuates from moderate to high levels, specifically indicating that arable land contains 3.80%, cashew plantations exhibit 3.60%, fallow land shows 3.00%, and woodlots possess 3.40%. The highest organic carbon concentration was observed within the arable soil, a phenomenon likely attributable to the persistent application of organic fertilizers to that substrate. Research conducted by Fenton *et al.,* (2008) revealed that agriculturally productive soils typically exhibit organic content levels ranging between 3% and 6%.

The total nitrogen concentration was measured at 0.03% across all land use types, indicating a low value. The concentration of total nitrogen within the study region is below 0.1%, categorizing it as very low in nitrogen content. As delineated by Landon (2014), total nitrogen concentrations ranging from 0.1% to 0.2% are classified as very low.

The diminished nitrogen levels in this land use may be associated with the intrinsic properties of the organic materials and the leaching dynamics occurring within the soil. This result agrees with the findings of Tellen and Yerima (2018) who in a similar study reported that land-use types did not significantly influence total nitrogen. The results also corroborate the assertions made by Abdulkadir *et al.,* (2022), who reported indicated that the characteristics and origins of the soils, alongside the insufficient application of nitrogen-based chemical fertilizers, significantly impact the nitrogen content of the soil.

The concentration of available phosphorus in the cashew plantation was measured at 28 (mg/kg), while values for the woodlot and arable as well as fallow land regions were recorded at 27 (mg/kg) and 26 (mg/kg) respectively. This range is classified as moderate. The elevated phosphorus levels observed in the cashew plantation may be ascribed to the increased litter fall associated with this particular land use. The investigations conducted by Adepetu (1986) and Ataga and Omoti (1978) indicated that over 25% of the land area in South Western Nigeria exhibits low to medium levels of phosphorus within the plough layer of soil. These findings are consistent with the results of the present study, wherein the soils associated with various land uses are classified as medium in phosphorus content, aligning with the critical threshold for available phosphorus.

As illustrated in Table 2, the effective cation exchange capacity (ECEC) recorded values of 1.55 (Cmol/kg) in arable land, 1.66 (Cmol/kg) in cashew plantations, 1.55 (Cmol/kg) in fallow land, and 1.60 (Cmol/kg) in wood lot. The ECEC values noted across these land uses suggest a limited capacity for nutrient retention within the soils (Landon, 1991), attributable to the predominance of sand within each land use; it has been further emphasized that CEC as a characteristic of the soil's colloidal fraction principally arises from the clay and organic components. The observed diminished ECEC levels in the assessed land uses may also be ascribed to significant leaching of bases

(Msanya *et al.,* 2003) in conjunction with the reduced clay content (<36%) in the soil (Gachene and Kimaru, 2003). The soils under investigation exhibit a moderate availability of bases (Ca, Mg, and K). The anomalous trend exhibited by the ECEC values warrants further investigation into the mineralogical composition of the clay present across various land use types, as well as other factors influencing CEC. Research has established that cation exchange capacity exhibits fluctuations in relation to soil organic carbon (SOC) content (Kiflu and Beyene, 2013). The noted low ECEC values suggest that the application of all fertilizers, with the exception of phosphorus, should be conducted in split applications to mitigate nutrient losses resulting from leaching. Prior studies have demonstrated that the type of land use significantly impacts the CEC of soils (Muche *et al.,* 2015).

Calcium is imperative for the sustenance of optimal root development in agricultural crops (QDAF, 2015). The levels of exchangeable calcium within the soils are moderate, ranging from 0.70 (Cmol/kg) in arable land, 0.82 (Cmol/kg) in cashew plantations, 0.80 (Cmol/kg) in fallow land, and 0.85 (Cmol/kg) in woodlot, thereby indicating that the soils do not present any significant deficiencies. Calcium is frequently referred to as the "prince of nutrients" due to the necessity for soil colloids to achieve substantial saturation of calcium to facilitate plant absorption. This nutrient constitutes approximately 2% of the plant tissue. Calcium is utilized in the synthesis of calcium pectate, a robust structural component of cell walls. A deficiency in calcium results in stunted root development and stress manifestations in newly emerging leaves, as well as discoloration and distortion in overall plant morphology.

Magnesium is essential for the biosynthesis of chlorophyll and nitrogen metabolic processes in plants; it contributes to photosynthetic activities, enhances the mobility of phosphorus within plant tissues, and influences its uptake. The levels of magnesium were recorded at 0.30 (Cmol/kg) in arable land, 0.42 (Cmol/kg) in fallow land, and 0.40 (Cmol/kg) in both cashew plantations and woodlots, respectively, as delineated in Table 2

Potassium represents another critical nutrient requisite for achieving optimal crop yields. Plants typically contain an average of approximately 3% potassium in their tissue composition. functions as a corrective agent against the detrimental effects of nitrogen and is frequently necessary for crops that receive elevated nitrogen inputs (Sehgal, 1996). Plants utilize potassium in the form of K^+ ions, and its availability is contingent upon its spatial distribution within the soil matrix and its interaction with clay, humus, and soil moisture. The exchangeable potassium levels were documented at 0.18 (cmol/kg) in arable land, 0.19 (cmol/kg) in woodlots, and 0.20 (cmol/kg) in both cashew plantations and fallow land, respectively, which is considered low according to established critical limits, as illustrated in Table 2. The observed deficiency of potassium (K) in the study regions may be attributed to the low pH levels within the soil, which adversely affect potassium availability.

The sodium concentration measured was 0.04 (cmol/kg) in both arable and fallow land, and 0.03 (cmol/kg) in cashew plantation and woodlot, respectively, as detailed in Table 2. Given that the concentration of Na^+ in the soil did not surpass 1 cmol/kg, it is unlikely that Na^+ would adversely impact the soil characteristics of these regions. These findings corroborate the dominance of calcium over magnesium, potassium, and sodium, as previously noted by Idoga (1985) and Ogunkunle (1989).

The percentage base saturation values were notably high, with 78.7% in arable land, 87.3% in cashew plantation, 91.6% in fallow land, and 91.8% in the woodlot, as illustrated in Table 2. The elevated base saturation may be attributed to the presence of weathered minerals that liberate nutrients into the soil, along with their alluvial nature. This observation aligns with the findings of Landon (1991), which indicated that a relatively high base saturation of 70 to 80% is essential for the optimal performance of most cropping systems.

The recorded exchangeable acidity was 0.30 (cmol/kg) in arable land, 0.08 (cmol/kg) in cashew plantation, and 0.10 (cmol/kg) for both fallow land and woodlot, as presented in Table 4. These values are classified as generally low (<1.0 cmol/kg) and suggest that the soils exhibit minimal or no acidity-related challenges.

Raji and Mohammed (2000) documented an exchangeable acidity value of less than 1.0 cmol/kg and posited that the contribution of exchangeable acidity to potential acidity is negligible in the soils of the Nigerian Savannah.

Electrical conductivity serves as an indicator of relative salt concentrations or salinity, with excessive salt presence in the soil potentially disrupting root functionality and nutrient absorption (Hodges, 2014). The soils are characterized as very slightly saline, as evidenced by their low electrical conductivity values of 3 ms/cm, as shown in Table 2 below. Soil electrical conductivity may be influenced by variations in climatic conditions throughout soil development (Sebhatleab, 2014). By comparing these values against the critical threshold for salinization (4 ms/cm), it is evident that all land uses are not susceptible to salinity-related threats, thus enabling the soils to support a diverse range of crops.

CONCLUSION

The study which assessed the physical and chemical properties across four different land use: Arable land, Cashew plantation, Fallow land and Wood lot, within the premises of Ladoke Akintola University of Technology (LAUTECH) Ogbomoso area of Oyo State, Nigeria, shows that generally, the texture (loamy sand and sandy loam) of the soils are suitable for agricultural crop production. Although there are limitations due to the selected soil properties, the number of land-use considered, depth of sampling (0–30 cm), and years of establishment of the land-use types.

The soils pertinent to the various land uses demonstrate a moderately acidic pH, moderate organic carbon content, and sufficient phosphorus concentrations. In order to achieve sustainable agricultural production and preserve soil integrity within the region, it is imperative that farmers implement both organic and inorganic fertilizers on an annual basis to maintain the physical and chemical fertility of the soil. It is advisable to adopt minimum tillage practices, ensure continuous cover of the soil through living or non-living mulches, to enhance nitrogen levels, thereby preventing soil degradation and promoting the amelioration of soil physical conditions conducive to crop growth and development. Notably, the current structural attributes of the soils are deemed sufficient for agricultural production.

Ultimately, a comprehensive soil survey of the region is warranted to investigate the profile characteristics of the soil, ascertain its specific mineralogical composition, and conduct a land evaluation, aspects which were not encompassed in this study; such an endeavor would contribute significantly to a deeper understanding of the soil properties in the area and facilitate the development of more effective land use strategies tailored to the soils.

REFERENCES

Abdulkadir, A., Halilu, Y., and Sani S., 2022. Evaluation of Physical and Chemical Properties of Soils at Bichi Local Government Area, Kano State, Nigeria. *IRE Journals Volume 5 Issue 9 ISSN: 2456-8880*

Adepetu, J.A. (1986) Soil Fertility and Fertilizer Requirements in Oyo, Ogun and Ondo States of Nigeria. Produced by Federal Development of Agricultural Land Resources, 48.

Allison, L.E. (1965). Organic carbon. In Black, C.A. (ed). Methods of analysis, part 2. Agronomy 9: 1367-1378. *American Society of Agronomy, Madison, Wisconsin, U.S.A.*

Asadu, C.L.A., Ekwo, A.U. and Udigwe, T.K. (2001). Soil characteristics around Lake Opi in eastern Nigeria and land use recommendations. Agro Science Journal, 2(1), 76-90

Ataga D.O. and Omoti U. (1978). Phosphate sorption characteristics and the use of sorption isotherms for evaluating the phosphate requirements of the Oil Palm on some acid soils. Journal of the Nigerian Institute for Oil Palm Research, 5(20): 36 – 41

Brady NC, Weil RR (2008*)*. The Nature and Properties of soils. 13th Edn. *Pearson Education, Inc. ;965.*

Brady, N.C and Weil, R.R (2002): The Nature and Properties of Soils. Pretence-Hall, Inc., Upper Saddle River, New Jersey.

Bray, R.H and Kurtz, L.T. 1945. Determination of total organic and available forms of P in soil. Soil Science, *Baltimore, 59: 39-45.*

Bremmer, J.M. (1965): Total Nitrogen. In Black, C.A. (ed). Methods of Soil Analysis, part 2. *Agronomy 9:1149-1178. American society of Agronomy Inc., Madison, Wisconsin, U.S.A.*

Carter, M.R., and Gregorich, E.G., (2007). Soil Sampling and Methods of Analysis, CRC Press, Boca Raton, FL, USA.

Feton, F., Alber, C., and Ketterings, Q., (2008). Soil Organic Matter. Agronomy Fact Sheet. Fact sheet 41. *Cornell University Cooperative extension 2008*.

Gachene, C.K.K., Kimaru G., (2003) (Eds.). Soil fertility and Land productivity: A guide for extension workers in the Eastern Africa Region. *RELMA Technical handout Series 30. Nairobi, Kenya: Regional Land Management Unit (RELMA), Swedish International Development Cooperation Agency (SIDA). 2003;164.*

Gee, G.W. and Or, D. (2002) Particle Size Analysis. In: Dane, J.H. and Topp, G.C., Eds Methods Of Soil Analysis, Part 4, Physical Methods, *Soils Science Society Of America, Book Series No. 5, Madison, 255-293.*

Havling, J.L., Beaton, J.D., Tisdale, S and Nelson, W.L., (2006). Soil Fertility and Fertilizers. An Introduction to nutrient management . *7th ed. Prentice Hall of India private limited, New Delhi.110001*

Hazelton, P. A., and Murphy, B. (2007). Interpreting Soil Test Results, What Do All the Numbers Mean? *Commonwealth Scientific and Industrial Research Organization Publishing.*

Hodges S.C.Soil Fertility Basics (2014). Soil Science Extension North Carolina State University.; *Available at http//.plantstress.com/Articles/min_deficiency_i/soil_fertility.pdf. Accessed on 7th May; 2014.*

Idoga, S. (1985). The Relationship of Topography to Soils and Vegetation in the Northern Guinea Ecosystem, Nigeria. *MSc thesis Submitted to the Department of Soil Science, Ahmadu Bello University, Zaria, Nigeria. 182p.*

Kiflu, A., and Beyene, S. (2013). Effects of different land use systems on selected soil properties in South Ethiopia. *Journal of Soil Science and Environmental Management, 4(5), 100-107*

Landon J.R.(1991). Booker Tropical Soil Manual. A handbook for soil survey and agricultural land evaluation in the tropics and subtropics. *Longman Scientific and Technical Publishers, Essex.;474.*

Landon, J. R. (2014). Booker tropical soil manual: a handbook for soil survey and agricultural land evaluation in the tropics and subtropics. Routledge

Law – Ogbomo , K.E., and Nwachokor, M.A. (2010). Variability in selected soil Physic-chemical properties of five soils formed on different parent materials in south eastern Nigeria. *Journal of Agriculture and Biological science, 6(1):14-19.*

Lister, T.N., Burger, J.A. and Patterson (2004). Role of vegetation in mitigating Soil quality impacted by forest harvesting. *Soil Science of Society of American Journal, 68:263-271.*

Mclean, E.O. (1965) Aluminium in Methods of Soil Analysis. America Science Agronomy, Madison, Wisconsin, 978-998.

Msanya B.M., Kaaya A.K., Araki S., Otsuka H., Nyadzi G. I. (2003). Pedological characteristics, general fertility and classification of some benchmark soils of Morogoro District, Tanzania. *African Journal of Science and Technology, Science and Engineering Series. 2003;4(2):101-112.*

Muche, M., Kokeb, A. and Molla, E. (2015) Assessing the physiochemical properties of soil under different land use types. *Journal of Environ, Anal. Toxicol .5.309.*

Ogunkunle, A.O. (1989). Variation within a taxonomic unit; The Ibadan series example in South-Western Nigeria. *Nigerian Journal of Soil Science, 9, 9-20.*

Onweremadu, E.U (2007). Pedogenic calcium loss and uptake of calcium by Gmelina growing in an Iso-hyperthermic Kandiudult. J. *Plant Sci, 2:625-629*

Powlson, D.S., Whitmore, A.P and Goulding, K.W.T. (2011). Soil carbon Sequestration to mitigate climate change : A critical re-examination to identify the true and the false. *European Journal of Soil Science, 62: 42-55.*

QDAF (2015). Food for fruit – nutrition management in mangoes. Department of Agriculture and Fisheries: State of Queensland. *Retrieved on 14th, June, 2019 from http://www.australian-mangoes.squarespace.com/s/Food-for-fruit-Part-1-QDAF-2015.pdf.*

Raji BA, Mohammed K (2000). The nature of acidity in Nigerian savanna soils. *Sam. J. Agric. Res. 16:15-24.*

Sainju, U. M., & Liptzin, D. (2022). Relating soil chemical properties to other soil properties and dryland crop production. *Frontiers in Environmental Science*, *10*, 1005114. https://doi.org/10.3389/fenvs.2022.1005114

Sehgal, J. (1996). Pedology: Concepts and Applications. *Kalyani publishers. (1st ed) New Delhi, India*

Sebhatleab, M. 2014. Impact of land use and land cover change on soil physical and chemical properties: a case study of Era-Hayelom tabias, northern Ethiopia. United Nations University. Land Restoration Training Programme [final project]. http://www.unulrt.is/static/fellows/document/Sebhatleab2014.pdf

Stolte, J.; Tesfai, M.; Oygarden, L.; Kværno, S.; Keizer, J.;(2015). Verheijen, F.; Panagos, P.; Ballabio, C.; Hessel, R. Soil Threats in Europe; Publications Office Luxembourg: Luxembourg.

Tellen, V.A., Yerima, B.P.K., 2018. Effects of land use change on soil physicochemicalproperties in selected areas in the North West region of Cameroon. Environ. Syst. Res. 7 (3), 1–29.

Teshome, Y., and Yitayal, Y. (2019). Agro-Ecological Assessment Of Physico-Chemical Properties Of Soil In Kulfo Watershed, South Western Ethiopia. Arba Minch University, Ethiopia. EJBSS 2(1), 141-163.

Ufot, U.O., (2012). Soils and the Environment. Shadow Publishers Limited, Owerri, Nigeria. *1st Edition.11 (11)*

Vukicevich, E.; Lowery, T.; Bowen, P.; Úrbez-Torres, J.R.; Hart, M.(2016) Cover crops to increase soil microbial diversity and mitigate decline in perennial agriculture. *A review.Agron. Sustain. Dev., 36, 48.*

Walkley, A.J., and Black, I.A. (1934) "An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method," *Soil Science, vol. 37, no. 1, pp. 29–38.*

Werner, M.R. (`1997). Soil quality characteristics during conversion to organic orchard management. Appl. *Soil Ecol., 5: 151-167.*

Table 1:Particle Size Distribution of soils of the study area

LAND USE	0 ------------- 30cm						
	% SAND	% CLAY	% SILT	GRAVEL CONTENT (%)	BULK DENSITY (g/cm^3)	TOTAL POROSITY (%)	TEXTURAL CLASS
AL	80	10	10	28	1.5	43%	Loamy sand
CP	76	15	9	35	1.4	47%	Sandy loam
FL	78	12	10	26	1.4	47%	Sandy loam
WL	75	19	6	34	1.4	47%	Sandy loam

AL= Arable land, CP= Cashew plantation, FL= Fallow land, WL=Wood lot

Table2:Chemical properties of soils of the study area

Land use	pH in H_20	Ca^{2+}	Mg^{2+}	Na^{2+}	K^+ Cmol /kg	Exch. acidity	ECEC	BS %	EC ms/cm	O.C %	Avail P mg/kg	T.N %
A L	5.8	0.7	0.3	0.04	0.18	0.33	1.55	78.7	3	3.8	26	0.03
C P	5.7	0.82	0.4	0.03	0.2	0.11	1.66	87.3	3	3.6	28	0.03
F L	5.7	0.8	0.42	0.04	0.2	0.13	1.55	91.6	3	3	26	0.03
W L	5.8	0.85	0.4	0.03	0.19	0.13	1.6	91.8	3	3.4	27	0.03

AL= Arable land, CP= Cashew plantation, FL= Fallow land, WL=Wood lot

MANAGEMENT PRACTICE, ADOPTION AND PRODUCTIVITY OF SMALL-SCALE COMMERCIAL AQUACULTURE PRODUCTION IN OGUN STATE, NIGERIA

ASHLEY-DEJO S. S., SULE S. O., OYETUNJI O. T., DUROJAIYE F. A., OJETAYO T. A. and AKINSETE O. T.
Department of Forestry, Wildlife and Fisheries, Faculty of Agricultural Production and Renewable Resources, College of Agricultural Sciences, Olabisi Onabanjo University, Ogun State, Nigeria.
Corresponding author email address: ashleydejosamuel@gmail.com,
Phone Number: +2348036584136

ABSTRACT

This study investigated the management practice, adoption and productivity of commercial aquaculture in Abeokuta, Ogun State, Nigeria. The study was conducted in Abeokuta, Ogun State. One hundred and fifty respondents (150) were selected using multi-stage sampling technique. It was observed that majority were married males, educated and within active economic age with mean household size of 4.83. The mean output per production cycle was 1,236.91±752.41 kg, and the most commonly reared fish species was *Clarias spp*. The most commonly practiced culture system was earthen ponds. Also, the result revealed that easy access to inputs is the most available factor of production, with a mean score of 1.66 ranked first, followed by conducive environment/climatic factors (1.63 ranked Second). Majority (55.3%) of the respondents fell within the medium adopter category, while 25.3% classified as high adopters while 19.3% of fish farms are classified as low adopters. This investigation reveals that education, experience, training, extension services, and participation in cooperative societies are critical factors that promote the adoption of scientific aquaculture management practices in commercial fish farms. The study also indicate that farmer needs competent knowledge, skills and techniques to maximize profit.

Key words: Adoption, Fish farming, Innovation, Techniques, Scientific.

INTRODUCTION

Aquaculture plays an important role in nation economic development, potentially offering valuables, skill-based employment opportunities and stabilizing the economy (Nuseibeh, 2023; Nwuba *et al.,* 2022). Aquaculture is the rearing of fish in an enclosed and fairly shallow body of water where all its life processes can be controlled. It is an important sector for the nation's economic development, at a time when government is seeking for ways to diversify the economy, from being purely oil based. It is a potential means of contributing to the food security of the nation, directly by producing fish for food and indirectly by generating employment for the teaming unemployed populace, save foreign exchange and generate foreign exchange through export of fish and fish products (Dey *et al.* 2010).

As human standard of living continues to improve, especially in developing countries, a number of economic activities have continuously become important sources of livelihood, providing the much-needed food and income. Thus, aquaculture sector plays a significant role in reducing protein deficiency and malnutrition, generating employment and earnings foreign exchange.

Fishing contributes about 5% of the per capita animal in-take and employs about 8 million people worldwide (Abulude and Kolawole, 2020). Fish is an important and indispensable source of animal protein which provide at least 50% of the mineral intake and essential animal protein for over hundred million of people from the poorest South Asian and African countries (Food and Agriculture Organization (FAO) (2019). The industry helps in improving the nutrition and health of families, increasing people's income, and acts as active agent of economic development and social change (Ifejika *et al*., 2008).

In Nigeria, fish production is from both external and internal sources. The internal sources, after captured fisheries the second most important is aquaculture. To fulfil the excess demand of growing population, aquaculture productivity needs to be increased. The aquaculture sub-sector is considered a very viable alternative to meeting the nation's need for self sufficiency in fish production. This is based on its high reliability in return on investment. Nigeria is blessed with numerous opportunities for large-scale aquaculture; although the opportunity seems to be over ride by challenges. The main input of fish production is feed account for about 70% of total production cost (Khan *et. al.* 2021, Ashley-Dejo *et. al.* 2017, Alam et. al. 2012). Another important input that moves-up the productivity of aquaculture is good quality fingerling.

Profitability and productivity are inseparable entities in commercial aquaculture (FAO, 2018). Therefore, analysis and understanding of these important factors for different fish culture systems, is paramount. Profitability and productivity in aquaculture cannot be overemphasized because the two factors largely depend on the level of investment in appropriate technologies and sufficient capital management. Thence, the larger the investment the higher the profit often associated with economies of scale (FAO, 2018).

One way to boost fish production is through the adoption of aquaculture technologies, improve self-sufficiency in fish production and contribute to food security in Nigeria. Rogers (2003) described the adoption process as a mental process through which an individual pass from learning of new idea. The decision to adopt or reject the new idea depends on farmers and their environment, the appropriateness and gains of such innovation. These factors are therefore pre-requisite for adoption of improved farm technology and cultural practices essential for the achievement of self sufficiency in the production of food. Peace Corps (1976) postulate that farmers must pass through five stages of adoption before the idea is accepted. If they are not aware of the ideas, they will not be interested; if they are not interested they cannot evaluate its usefulness; if they do not evaluate, they will never try it, and if they do not try it they would certainly not adopt it. These five stages of adoption are inseparable as a link of a chain. Adoption takes place after people have successfully passed through the five stages. Williams (1968), explained the adoption process with the following steps: awareness; interest; action; desire; conviction and satisfaction. Thus, this study investigated the management practice, adoption and productivity of commercial aquaculture in Abeokuta, Ogun State, Nigeria.

MATERIALS AND METHODS

Study area, sampling size and data analysis technique

The study area is Ogun State situated within the tropics and located in the rain forest belt. The state is located in the rainforest vegetation belt of Nigeria within longitude $2^0 45'$E and $3^0 55'$E and latitudes $7^0 01'$N and $7^0 8'$N in the tropics. The state is bounded in the West by the Benin Republic, in the South by Lagos State and the Atlantic Ocean, in the East by Ondo State and in the North by Oyo and Osun State. Multistage sampling procedures were used to select respondents for this study. In the first stage Abeokuta zone was purposively selected out of four Agricultural Development Zones in Ogun State. The selection was based on the intensity of fish farming activities. In the second stage, three (3) Local Government Areas (LGAs) were selected from the six (6) LGAs using simple random sampling. Snowball technique was used in the identification of 484 fish farmers and simple random sampling technique was used in the selection of 150 respondents. The data for this study were subjected to both descriptive (percentages, mean, frequency count, standard deviation) and inferential (multi-variance logistic regression) analysis using.

The explicit form of the multi-variance logistic regression model is expressed as shown below:

$Y = a + b_1X_1 + b_2X_2$ --------------- B_nX_n

Where

Y = Factors affecting adoption of scientific aquaculture management practices

a = Constant.

X_1 = Age

X_2 = Educational qualification

X_3 = Household Size

X_4 = Fish farming experience

X_5 = Training

X_6 = Extension services

X_7 = Participation in cooperative society

RESULT AND DISCUSSION

Socio-economic characteristics of the Respondents

Table 1 provides socio-economic characteristics of commercial fish farmers in the study area. Out of the 150 respondents, 83 (55.3%) were male, and 67 (44.7%) were female. In most cases, fishing activities were done by men, although women were more engaged in the processing and marketing activities. The findings were similar with the study conducted by (Ajabe *et al*., 2022).

This becomes prevalent because in most communities almost every adult female is likely to be married. This is verified from the result in this study as majority (67.3%) of the respondents were married with a mean household size of 4.83. The mean age of the sampled group was 39 years, this indicated that the respondents were relatively young. The mean age of farmers in Nigeria is usually between 45-48 years (Adeoye 2020; Ogunwale, 2000). More-so, this age range has been tagged productive age as well as active economic age (Ashley-Dejo and Adelaja 2022, Ashley-Dejo *et al.,* 2017). Literacy level was assessed through educational qualification, about 64.7% had tertiary education and only 7.3% had no formal education (Table 1). This implies that respondents in the study area had very high literacy levels which might positively affect the management practices and adoption level. Olaifa *et al,* (2022) pustulated that farmers with low literacy levels hardily adopt nor appreciate most of the improved technologies. Results showed that the fish farmers made an average income of N861,360 per production cycle. Fish farmers in the study area were experienced with an average experience year of 8 years this could made them capable of knowing how best to carry out the production exercise (Table 1). This finding is supported by results of (Ozoemena *et al,* 2022) who asserted that the more years acquired by producers, the more they know about the activities carried out. Such knowledge also translates to lowering cost of production, which consequently increase income generated from production and sales with majority of the respondents.

Factors contributing to management practice, adoption and productivity of fish production

The factors that contribute to management practice, adoption and productivity of fish production in the study area is presented in Table 2. The table shows that easy access to inputs is the most important factor, with a mean score of 1.66 and ranked first, followed by conducive environment/climatic factors (1.63). Other factors that ranked high include a ready market for output, closeness to the source of the market, and accessibility of extension agents. On the other hand, availability of basic/social amenities was the least available factor (Table 2). The finding was similar with Yusuf *et al*., (2022) who reported that access to fish farm input, climatic factor, closeness to source of market were ranked high among other factors considered in their study.

Adoption level of aquaculture management practice

The adoption level of aquaculture management practices by fish farmers in the study area is presented in Table 3. The table indicates that majority (55.3%) fell within the medium adopter category, while 25.3% are classified as high adopters while 19.3% are classified as low adopters. This suggests that most fish farmers have adopted management practices to a significant extent, with a considerable proportion classified as high adopters. The adoption of management practices is crucial for the growth and success of fish farming businesses. Management practices help fish farmers to optimize production, improve efficiency, and reduce risks. The findings from this study suggest that fish farmers have recognized the importance of adopting management practices in their operations and it supports the findings of Ashley-Dejo *et al*., 2016 whose research showed that higher proportions of fish farmers were aware, tried and adopted most of the improved aquaculture technologies with some of the fish farmers also discontinuing most of the previously adopted technologies.

Constraints to management practices adoption

Information on the constraints to the adoption of management practices and productivity of fish farmers in the study area is presented in Table 4. The table shows that inadequate capital, high cost of input, high cost of fish feed, land acquisition system, inadequate extension services, and pollution were the most serious constraints to the adoption of management practices and productivity of commercial fish farming. These findings suggest that access to capital, quality inputs, and extension services can facilitate the adoption of improved management practices and enhance the productivity of fish farming. The constraints identified in this study are consistent with previous research on the challenges facing the aquaculture sector in developing countries (Assefa *et al*., 2018; Little *et al*., 2018). Similarly, inadequate extension services have been identified as a significant constraint to the dissemination of knowledge and adoption of best practices in aquaculture (Assefa *et al*., 2018).

Regression analysis on the factors affecting adoption of scientific aquaculture management

The results of regression analysis examining the factors that affect the adoption of scientific aquaculture management practices in the study area is presented in Table 5. It was observed that several variables are significant predictors of the adoption of these practices.

Firstly, educational qualification has a significant positive effect on the adoption of scientific aquaculture management practices, with a coefficient of 1.63 and a p-value of 0.01. This finding is consistent with previous studies that have identified education as a critical factor in the adoption of modern farming practices (Akinwumi *et al*., 2018). Secondly, fish farming experience also has a significant positive effect on the adoption of scientific aquaculture management practices, with a coefficient of 1.89 and a p-value of 0.05. This finding suggests that farmers with more experience are more likely to adopt these practices, perhaps because they have encountered more challenges and realized the benefits of using scientific management approaches. Thirdly, training has the most significant positive effect on the adoption of scientific aquaculture management practices, with a coefficient of 11.74 and a p-value of 0.01. This result highlights the importance of training programs in promoting the adoption of modern farming practices (Rahman *et al*., 2017). Lastly, extension services and participation in cooperative societies also have significant positive effects on the adoption of scientific aquaculture management practices. These findings support the idea that access to information and social networks can facilitate the adoption of modern farming practices Akinwumi *et al*. (2018).

CONCLUSION AND RECOMMENDATION

This study examined the demographic characteristics, management practices, and productivity of small-scale fishers in commercial aquaculture. The results showed that the majority of the respondents were male, most of the respondents had tertiary education, and the average household size was 4.83. Additionally, adoption of management practices such as easy access to inputs, a conducive environment/climatic factors, a ready market for output, and closeness to the source of the market contributed to the productivity of commercial aquaculture farms. The study also found that earthen ponds were the most common type of culture system used. Adoption of scientific aquaculture practices was average. Also, education, experience, training, extension services, and participation in cooperative societies are critical factors that promote the adoption of scientific aquaculture management practices in the study area.

However, the availability of certain factors such as basic amenities and suitable government policies can pose a challenge to the success of the farms. Thus, there is a need for policymakers to provide an enabling environment for the growth of the aquaculture industry in terms of infrastructure, funding, and policy support. The study indicate that farmer needs competency in knowledge, skills and techniques involved in the efficient management of fish to maximize profit, provision of basic infrastructures, electricity and quality water supply, provision of extension services including education program to fish farmer.

REFERENCES

Abulude, I., & Kolawole, E. A. (2020). Extent of Arable Crop Farmers' Involvement in Non- Farm Activities in Ondo State. Available at SSRN 3709332

Adeoye, A. S. (2020). Assessment of gender roles in fish farming activities among rural farmers in Afijio Local Government Area of Oyo State, Nigeria. *Nigeria Agricultural Journal,* 51(2): 406-412.

Ajagbe, S., Ajagbe, R., Abdulazeez, F., Ojubolamo, M., Olomola, A., Oke, O., & Adekanmbi, T. (2022). Analysis of Socioeconomics and Feed Efficiency of Catfish Production in Oyo State, Nigeria. *Ife Journal of Agriculture*, 34(1): 67-75.

Akinwumi, J. A., Adepoju, A. O., & Daramola, A. O. (2018). Analysis of factors influencing farmers' adoption of cocoa production technologies in Osun State, Nigeria. *Journal of Agriculture and Environmental Sciences*. 7(2): 52-61.

Alam, M. F., Khan, M. A., & Huq, A. A. (2012). Technical efficiency in tilapia farming of Bangladesh: a stochastic frontier production approach. *Aquaculture International,* 20: 619–634. http://doi.org/10.1007/s10499-011-9491-3.

Ashley-Dejo, S. S., & Adelaja, A. O. (2022). Economics of catfish hatchery farmers and its contribution to household poverty alleviation in Nigeria. *Agricultura Tropica Et Subtropica*, 55: 19–29. https://doi.org/10.2478/ats-2022-0003.

Ashley-Dejo, S.S., Olaoye, O.J., & Adelaja, O.A. (2017). Analysis of profitability of small-scale catfish farmers in Oyo State, Nigeria. *Malaysian Journal of Animal Science*, 20(2): 11 – 24.

Ashley-Dejo, S. S., Omoniyi, I. T., Olaoye, O. J., Fakoya, E. O., & Adelaja, A. O (2016). Adoption of improved fish hatchery production technologies and information by fish hatchery farmers in Oyo State, Nigeria. *Nigeria Journal of Animal Production,* Volume 43(2): 399 - 411.

Assefa, Y., Gebremedhin, B., & Mohammed, A. (2018). Constraints to the adoption of fish farming technology in Ethiopia. African Journal of Agricultural Research

Dey, M.M., Kumar, P., Paraguas, F.J., Chen, O.L., Khan, M.A., & Srichantuk, N. (2010). Performance and nature of genetically improved carp strains in Asian countries. *Aquaculture Economics and Management*, 14(1): 3–19. https://doi.org/10.1080/13657300903566846.

Food and Agriculture Organization (FAO), (2019). FAO in Nigeria: Nigeria at a glance. Retrieved from http://www.fao.org/nigera/fao-in-nigeria/nigeria-at-a-glance/en/- new.

Food and Agriculture Organization, (FAO) (2018). Dietary Assessment: A resource guide to method selection and application in low resource settings, Food and Agriculture Organization of the United Nations, Rome, Italy. ISBN 978-92-5-130635-2, 172 pp.

Ifejika, P. I., Akinbile, L. A., Ifejika, I. I., & Oladeji, J. O. (2008). The socio-economics effects on adoption of aquaculture technologies among fish farmers in Anambra State, Nigeria. Journal of Agricultural Extension 11Khan, M. A., Begum, R., Nielsen, R., & Hoff, A. (2021). Production risk, technical efficiency, and input use nexus: Lessons from Bangladesh aquaculture. *Journal of the World Aquaculture Society*, 52(1): 57-72. https://doi.org/10.1111/jwas.12767.

Little, D. C., Newton, R. W., & Beveridge, M. C. (2018). Aquaculture: A rapidly growing and significant source of sustainable food? Status, transitions and potential. Proceedings of the Nutrition Society.

Nuseibeh, R. A. (2023). The Political Economy of Youth Exclusion. In Urban Youth Unemployment, Marginalization and Politics in MENA (pp. 43-81). Cham: Springer International Publishing.

Nwuba, L. A., Ude, E. F., & Ogbonnaya, H. F. (2022). Current Trends in Fisheries and Aquaculture. *International Journal of Agriculture, Food and Biodiversity*, 1(1), 64-69.

Ogunwale, A. B. (2000). The role of rural women in food production and income generation: A case study of small-scale fish farming in Ogun State, Nigeria. In T. F. Daramola (Ed.), Women in Agriculture: The Nigerian Experience (pp. 25-40). Heinemann Educational Books.

Olaifa, E. S., Osabuohien, E. S., & Issahaku, H. (2022). Enhancing fish production for food security in Nigeria. Materials Today: Proceedings, 65: 2208-2214.

Ozoemena, F., Agbo, J. U., & Eze, M. E. U. (2022). Economic Analysis of Fish Farming and its Contributions to Household Poverty Alleviation in Ebonyi State, Nigeria. *Escet Journal of Educational Research and Policy Studies*, 2(1): 20-32.

Peace Corps (1976): Contribution to Agricultural Development through Extension. USA

Rahman, S., Dey, M. M., Saha, M. B., & Ferdous, M. J. (2017). Impact of training on farmers' knowledge and adoption of shrimp farming technologies in Southwest Bangladesh. Journal of Agriculture and Rural Development in the Tropics and Subtropics

Roger, E. M. (2003). Diffusion of Innovations, 5th Edition, New York: Free Press.

Williams, R. L. (1968). A model of adoption behavior. Journal of the Market Research Society.

Yusuf, S. A., Ayanboye, A. O., Azeez, K. A., & Adesina, M. A. (2022). Food Insecurity and its Correlates: Empirical Evidence from Fish Farming Households in Nigeria. *Interdisciplinary Journal of Rural and Community Studies*, 4: 60-70.(01): 74-86.

Table 1: Socio-economic characteristics of the Respondents

Variable	Frequency	Percentage	Mean±SD
Gender			
Male	83	55.3	
Female	67	44.7	
Age (years)			
Less than 25	17	11.3	
25 – 35	44	29.4	
36 – 45	41	27.3	39.64±11.06
46 – 55	39	26	
56 and above	9	6.1	
Religion			
Christianity	119	79.3	
Islam	31	20.6	
Marital status			
Single	29	19.3	
Married	101	67.3	
Widowed	16	10.7	
Divorced	4	2.7	
Educational level			
No formal education	11	7.3	
Adult education	8	5.3	
Primary education	5	3.3	
Secondary education	29	19.3	
Tertiary education	97	64.7	
Household or family size			
Less than 4	31	20.6	
4 – 6	97	64.7	4.83±1.95
Above 7	22	14.8	
Do you attend any training program on fish farm management			
Yes	106	70.7	
No	44	29.3	
Reason for farming venturing into fish farming			
Subsistence	50	33.3	
Demand for fish	29	19.3	
Price	11	10.4	
Household consumption	16	10.7	
Years of Fish Farming Experience			
Less than 5	57	38	
5-10	51	34.1	8.05±6.121
11 and above	42	28	
Participation in cooperative society			
Yes	69	46	
No	81	54	

Source: Field survey, 2022

Table 2: Factors contributing to management practice, adoption and productivity of fish production

Factors	Available	Not available	Mean score	Rank
Easy access to inputs	99 (66.0)	51 (34.0)	1.66	1st
Conducive environment/climatic factor	95 (63.3)	55 (36.7)	1.63	2nd
Ready market for output	91 (60.7)	59 (39.3)	1.61	3rd
Closeness to source of market	90 (60.0)	60 (40.0)	1.60	4th
Accessibility of Extension agent	89 (59.3)	61 (40.7)	1.59	5th
Free from theft	75 (50.0)	75 (50.0)	1.50	6th
Affordability of inputs	72 (48.0)	78 (52.0)	1.48	7th
Absence of pest and plague	64 (42.7)	86 (57.3)	1.43	8th
Assess to fund	64 (42.7)	86 (57.3)	1.43	8th
Suitable Government policy	53 (35.3)	97 (64.7)	1.35	10th
Availability of basic/social amenities	41 (27.3)	109 (72.7)	1.27	11th

Source: Field survey, 2022

Table 3: Adoption level of aquaculture management Practice

Adoption level category	Adoption range (%)	Percentage of adopter
Non-adopter	0	0.0
Low adopter	1 – 33.33	19.3
Medium adopter	33.34 – 66.66	55.3
High adopter	66.67 – 1000	25.3

Source: Field survey, 2022

Table 4: Constraints to management practice adoption

Constraints	Very serious	Serious	Not Serious	Not a Constraint	Total score	Mean	Remarks
Land acquisition system in Nigeria	62(41.3)	36(24.0)	19(12.7)	33 (22.0)	427	2.85	S
Inadequate capital	71(47.3)	63(42.0)	6(4.0)	10 (6.7)	495	3.3	S
Inadequate extension services	40(26.7)	39(26.0)	28(18.7)	43 (28.7)	376	2.51	S
Low quality of fish seed	36(24.0)	57(38.0)	33(22.0)	24 (16.0)	405	2.7	S
Pollution	37(24.7)	49(32.7)	49(32.7)	15 (10.0)	408	2.72	S
Managerial problem	35(23.3)	35(23.3)	58(38.7)	22 (14.7)	383	2.55	S
Flooding	66(44.0)	39(26.0)	28(18.7)	17 (11.3)	454	3.03	S
High cost of input	86(57.3)	34(22.7)	25(16.7)	5 (3.3)	501	3.34	S
Predators	28(18.7)	48(32.0)	54(36.0)	20 (13.3)	384	2.56	S
Harvesting cost	29(19.3)	45(30.0)	43(28.7)	33 (22.0)	370	2.47	NS
Poaching	28(18.7)	32(21.3)	65(43.3)	25 (16.7)	363	2.42	NS
Insufficient water for production	29(19.3)	46(30.7)	45(30.0)	30 (20.0)	374	2.49	NS
Disease and pest infestation	35(23.3)	32(21.3)	63(42.0)	20 (13.3)	382	2.55	S
Poor performance of species of fish	42(28.0)	23(15.5)	58(38.7)	27 (18.0)	380	2.53	S
High cost of fish feed	96(64.0)	29(19.3)	19(12.7)	6 (4.0)	515	3.43	S
Lack of fisherman cooperative society	25(16.7	58(38.7)	41(27.3)	26 (17.3)	382	2.55	S
Inadequate information	50(33.3)	46(30.7)	32(21.3)	22 (14.7)	424	2.83	S

Source: Field survey, 2022

Table 5: Tobit regression for factors affecting adoption of scientific aquaculture management practices

Adoption	Coefficient	Standard error	P-value
Constant	37.73	15.63	0.02
Age	-0.26	0.34	0.53
Educational qualification	1.63***	0.63	0.01
Household size	1.26**	1.45	0.05
Fish farming experience	1.89**	0.89	0.05
Training	11.74***	4.51	0.01
Extension services	2.74**	0.34	0.03
Participation in cooperative society	8.63*	1.74	0.06
F-value		61.63	
P-value		0.00	

Significance level: *** for 1%, ** for 5% and * for 10%

Source: Field survey, 2022

SOIL SUITABILITY ASSESSMENT FOR SUSTAINABLE PRODUCTION OF CUCUMBER (*Cucumis sativus* L.) IN THE SOUTHERN GUINEA SAVANNA ZONE OF NIGERIA

Alabi K.O., Afe A.I. and Isaac J.A.
Department of Crop production, Faculty of Agriculture, Kwara State University, Malete, Ilorin. Nigeria.
Corresponding Author: alabioyebisi@gmail.com 08055741813

ABSTRACT

The problem of selecting the correct land for the cultivation of a certain crop is a long-standing and mainly empirical issue and nowadays, sustainability is one of the important issues in land use system. A Typic Plinthustalfs soil developed on Pre-Cambrian basement complex rocks was evaluated for its suitability for cucumber (*Cucumis sativus* L.) in the southern guinea savanna zone of Nigeria. Three mapping units that were established along the topo-sequence and three profile pits that were dug in 2017 were used for the experiment. Linear parametric and square root models were used for assessing the suitability of the soils for sustainable cucumber production. Land qualities considered in the study were climate, topography, wetness, soil fertility and soil physical properties. Except for the fertility status of the land, other qualities were not a constraint to the production of cucumber at study site. None of the pedon is highly suitable for production of cucumber by both linear and square root models with index of current productivity (IPc) that ranged between 18.7 and 70. Linear model indicated pedon 2 as currently not suitable with IPc of 18.7. Potentially, the index of potential productivity (IPp) ranged between 25 and 70 which rated pedon 1 and 3 as moderately suitable and pedon 2 as marginally suitable for cucumber production by both linear and the square root model. The limiting factors were mainly low levels of available macro-nutrients (N, P, K, Mg), low organic carbon (<0.54%), and low cation exchange capacity (<5.61cmol/kg) in all three pedons studied. Field trial also confirms the claim as application of both organic and NPK fertilizers significantly affect the yield of cucumber in all the pedons. In conclusion, it is therefore recommended that organic fertilizer should be applied for sustainable cucumber production on soils of the studied site.

Keywords: Soil suitability; Typic Plinthustalfs; Linear Parametric and Square root Models; Limiting factors; organic fertilizers; Macro-nutrients.

INTRODUCTION

The need for increase food production to feed the ever-increasing human population cannot be over emphasized. Hence it is of great importance to carry out land evaluation assessment in relation to crops that are planted in different regions of the Nation.

Land sustainability assessment is a method of land evaluation, which identifies the major limiting factor for planting a particular crop. Land suitability assessment includes qualitative and quantitative evaluation, it is important to step in the process of land use planning where resources are limited. The assessment is carried out separately for each categories of land use (Reshmideri *et.al,* 2009).

Land suitability assessment provides information on constraints and opportunities for land use and hence serves as guide for decisions on optimal utilizations of the land resources; whole knowledge is an essential prerequisite for land use planning and development. (Kappo *et. al*, 2004). These kinds of assessment identify the main limiting factors for the agricultural production and enable decision makers such as land users and agricultural support services to develop crop management that can overcome such constraints thereby increasing yield (Rabia, 2012). Soil assessment can tell farmers how suitable their land is in terms of soil limitations to specific land use and management practices.

Soil suitability classifications are therefore based on the knowledge of crop requirements, prevailing soil conditions and defined soil management. From the basic soil requirements of crop, a number of soil characteristics directly related to crop yield performance. (Jimoh, *et. al.* 2018). Soil suitability assessment for agriculture is a means to evaluate the ability of soil to provide optimal ecological requirements of a certain crop variety. This is a strategy for achieving food security as well as sustainable environment. Nutrients deficiencies and imbalance are the main constraints of crop production in Nigeria, and thus assessing the suitability of soil for agricultural production is very important in the production of crops to meet the ever increase in population.

The food sub-sector of Nigerian agriculture parades a large array of crops, amongst this crop is cucumber (*Cucumis sativus*).

It belongs to the cucurbitaceae family which comprised of 118 general and 825 species.

Information on soil-site suitability evaluation for cucumber production is not available for the study area. The present study was therefore undertaken to unfold this information. Therefore, the main objective of this study is to evaluate the soils of teaching and research farm, Malete, Kwara State, for sustainable production of Cucumber (*Cucumis sativus*)

MATERIALS AND METHODS

Description of Experimental Site

The study area was Kwara State University Teaching and Research farm, Malete. It is located in Southern Guinea Savanna ecological region of Nigeria. It lies between Latitude $08^0$71'N; longitude $04^0$44'E in Moro Local Government Areas of Kwara State at 360 m above sea-level and the relief is very gentle. The climate is characterized by distinctive wet and dry seasons with a mean annual rainfall of about 1150mm, with a double maximal pattern between April and October. The wet season begins in April and ends around October while the dry season begins in November and ends in March. In addition, the annual mean temperature ranges from 25 to 28.9^{0C}

The soil at the site is Sandy loam and slightly acidic (Alabi *et al*. 2017), Its land area forms part of the South-Western sector of Nigerian basement complex, a zone of basement reactivation. The natural vegetation has been destroyed due to farming activities and procedures such as ploughing, harrowing and ridging by man making it anthropogenic. Presently, the type of vegetation in the area is savannah woodland. The area is predominantly used for the cultivation of arable crops such as maize, groundnut and cowpea, perennial trees such as cashew and mango. The site also contains woody species such as baobab (Adansonia digitata), Neem tree (Azadractha indica) and acacia (*Acacia species*), grasses such as spear grass (*Cylindrica imperata*), Elephant grass (*Pennisetum purpreum*) and guinea gamba grass (*Andropogon gayanus*).

Field Survey and Sampling

Detailed soil survey was conducted in the area using rigid-grid method. Three mapping units and soil profiles that was already dug in the study area for its classification in 2017 was scraped, redressed and used and Surface samples were collected at 0-20 cm for laboratory analysis.

Laboratory analysis and procedure

Surface samples collected together with samples from pedogenetic horizons were air-dried. The samples were passed through a 2mm sieve to separate the large particles, stones and debris. Sample collected were analyzed for physical and chemical properties. Particle size analysis was determined using the hydrometer method modified by Gee and Or, 2002. Soil pH was determined electrometrically in 1:1 soil:water suspension. Organic carbon is determined by Walkey-Black method (1945) while Total Nitrogen was determined by the Micro-Kjeldahl method (Bremner and Mulvaney, 1982) and extractable P was determined by Bray and Kurtz, 1945). Exchangeable Ca, Mg, Na and K were extracted with 1M ammonium acetate (1M NH4OAc) solution buffered at pH 7.0, as described by Anderson and Ingram (1998). The exchangeable sodium (Na^+) and potassium (K^+) content of the filtrates were determined by Flame photometer while the exchangeable calcium (Ca^+) magnesium (Mg^+) were determined by EDTA titration method and were read with atomic absorption spectrophotometer (AAS). Micronutrients (Fe, Cu, Mn, Zn and B) of the soils was extracted by Mehlich-III multi-nutrient extraction method.

Land Evaluation Procedure

The pedons were first placed in suitability classes by matching their characteristics with the requirements in Table 1 below. The suitability class of a pedon is that which is indicated by its most limiting characteristics. This affirms the well famous "Law of Minimum" in agriculture, which states that crop yield will be determined by the plant nutrient in lowest supply (FAO,1984). Secondly each limiting characteristic would be rated for the parametric method. The index of productivity (IPp) for each pedon was calculated using the equation below:

$$IPc = A \times \frac{B}{100} \times \frac{S}{100} \times \frac{C}{100} \times \frac{F}{100} \text{.....................} 1$$

$$IP = A.\sqrt{\frac{B}{100} \cdot \frac{C}{100} \dots \frac{F}{100}} \dots\dots\dots (ii)$$

Where A is the overall lowest characteristic rating, B, C…F are the lowest characteristics rating for each land quality group.

The five land quality groups to be used in this study are climate, topography, soil physical properties, wetness and chemical fertility. Only one member in each group would be used because (IPP) and current (actual) index of productivity (IPC) would be calculated without putting the calcium (Ca) mole fraction and available phosphorous (Bray's P1) into the 'f' group, while the IPC would be calculated with the calcium mole fraction (exchangeable Ca^{2+} as a fraction of cation exchange capacity) and available phosphorous (Bray's P1) forming part of the 'f' group.

Agronomic Evaluation

The performance of cucumber was evaluated experimentally using a 3 × 3 factorial experiment. The factors were topo-sequence and types of fertilizer or soil amendments. There are three levels of each factor; namely, upper slope, middle slope and lower slope, application of farmyard manure, N P K and control replicated three times making twenty-seven Experimental plots.

Experimental Design and Land Management

The experiment was carried out using a randomized complete block design (RCBD) with 3 replications. Experimental plots consisted of 17m by 11m in each mapping unit. Farmyard manure was applied at two weeks before planting to allow for proper decomposition and mineralization. Plant spacing of 0.60 m × 0.30 m was used. Marketmore variety of cucumber was planted and 2 seeds were planted per stand given a plant population of 111,111 plants per hectare.

Data collection

Growth and Yield parameters collected include: Number of leaves, Vine length, Leaf area at 4,6 and 8 weeks after planting**,** Days to 50% flowering**,** Days to 50% fruit setting**,** Fruit length (cm), Fruit yield per plant, Fruit weight (g)**,** Yield per ha (ton)**.**

Statistical Analyses

Data collected was subjected to analysis of variance (ANOVA). Using DSAASAT and treatment means where significant, were separated using Duncan Multiple Range Test, at 5% level of probability.

RESULTS AND DISCUSSION

Soil Physical and Morphological Properties

Land Evaluation for Cucumber production

Suitability ratings of the land characteristics (Table-7) was constructed using the rating of limiting characteristics (Table-1) and land requirements for suitability classification for cucumber cultivation (Table-2) suitability ratings of the various land characteristics as well as their aggregate rating (potential and actual) were computed using the linear and square root parametric models presented in the write up

None of the pedons is highly suitable for Cucumber production by both linear parametric and square root model. Using linear model, the actual productivity (IPc) indicated pedon 2 as currently not suitable (18.7 (N) and pedon 1 and 3 as marginally suitable (37.5 -S3). The limiting factors were mainly low level of CEC, organic carbon and low micro nutrients. The evaluation of the potential suitability without considering fertility factors which are regarded as temporary limitation, using the linear model indicated that pedon 1and 3 are classified as moderately suitable and pedon 2 as marginally suitable for production of cucumber with the productivity index of IPp 70 and 50 respectively.

However, evaluation of the suitability using the square root model, both the actual productivity (IPc) and potential productivity (IPp) ranged from 50 to 70 which indicated pedon 1 and 3 as moderately suitable and pedon 2 as marginally suitable for cucumber production.

Agronomic Evaluation of suitability Mapping Units

The analysis of variance of the data collected on physiological growth and yield parameters for cucumber grown on different mapping units during 2021 planting seasons are presented in Table8. The result showed that the performance of cucumber differed significantly ($P<0.01$) in all measured parameters across the pedons.

NPK Fertilizer application had significant effect in terms of vine length and leaf area. However, in terms of fruit yield, application of manure, NPK and control are significantly different with manure ranking the highest followed by NPK. In terms of number of leaves both at 4 and 6 weeks, the control performing best followed by manure and NPK. The significant effect of NPK fertilizer over Organic manure in terms of Vine length and leaf area may be attributed to delay response in Organic manure in the release of nutrients for plant use. The significant effect of organic manure on the fruit weight and fruit yield over NPK may has resulted from the presence of micronutrients in the organic manure and this may have rectified the micro-nutrient deficiencies observed in the soils. Also, the slower rate of release of nutrients from the mineralization of the organic manure may have synchronized nutrient requirement by the cucumber with nutrient release, thereby minimizing nutrient loss by leaching. There is no significant difference at 50% days to flowering and 50% fruit setting with the application of organic manure, NPK and control.

With the application of NPK at 4weeks, leaf area is significantly different from control and manure while the upper, middle and lower elevations have significant difference. This is also similar to that of 6weeks where NPK is significantly different. Upper elevation is significantly different from middle and lower elevation. At 8weeks, application of organic manure and NPK, performed better than control with the upper elevation performing better than the lower and middle respectively.

In terms of fruit weight and fruit yield, the cucumbers in the upper slope pedon were significantly higher than plants in the middle and lower slope. Also, the upper slope pedon maintained a significantly higher average number of leaves per plant and in the average leaf area per plant. The yield at upper slope pedon was slightly higher than that of lower slope and middle slope had the lowest fruit yield.

Although there was no significant difference ($P<0.05$) in the 50% days to flowering and 50% fruit setting, with the application of either organic manure or NPK. But the middle slope pedon performed better than the upper and lower slope pedons (Table 8). There was interaction between soil amendment and slope positions.

DISCUSSION

Land suitability evaluation enables more accurate and useful predictions to be made for specific purposes. Soil characterization helps us understand soils better and provides useful information for the assessment and monitoring of the behaviour of soils.

The analysis of research work showed the constraint of these soils to sustainable cucumber production. The constraints include low level of macro nutrients (N, P, K) which are needed in large quantities by the plants especially for cucumber production, low organic carbon and low exchange capacity.

Constraints of soils identified can be managed through some of these management systems; The low levels of micro-nutrients, organic carbon and CEC could be managed through the application of both organic and inorganic manure. Among the different sources of organic manure which have been used in crop production poultry manure was found to be the most concentrated in terms of nutrients content (Yagock and Awoniyi; 1974, Lombin et al., 1992).

Lia and Mathur (1998) stated that inclusion of organic manure improves soil fertility and crop yield. Sarkar et al. (2003) reported that the combination of farmyard manure along the recommended inorganic fertilizer dose increased yield significantly. Incorporation of crop residues could also be suggested as this would control soil erosion, crusting and improve physical conditions of crop root zones (Tarawali et al., 2001, Odunze, 2006). Minimum tillage is also suggested as heavy mechanized land preparation will increase structural destruction.

CONCLUSION AND RECOMMENDATION

Three Pedons (upper, middle and lower slope) were established and classified as USDA soil order Alfisol and was classified further as sub-group Typic Plinthiustalfs (Plinthosol, cutanic, Hypereutic) still remain. None of the pedon is highly suitable for the production of cucumber by both linear and square root models. Pedon 2 was classified as currently not suitable but potentially marginally suitable for cucumber production by both models. The limiting factors were mainly low levels of available macro and micro-nutrients (low total Nitrogen, Available Phosphorus, CEC, Organic Carbon and organic Matter). Potentially (without considering soil fertility which is regarded as temporal limitation) by both Models, Pedons 1 and 3 are moderately suitable (S2) for the Production of cucumber.

Field trial confirms the claim that low level of fertility is the major factor limiting the Productive Potentials of the soils for cucumber production in the area. Application of manure and NPK had significant improvement on the growth and yield of cucumber. However, application of manure had the higher effect in terms of Fruit weight, fruit yield per ha and the other parameter taken in the upper slope segment than the middle and lower slope. In conclusion, the productive capacity of the soils for cucumber production can be achieved through the use organic fertilizers.

REFRENCES

Abdulkadir, A (2008). Soil type and their management in the southern lake area, Nigeria, proceedings of the 22nd National irrigation and sustainable Agriculture IAB, ABU, Zaria, Nigeria. pp 334-348

Abua, M.A., (2015). Suitability assessment of soil for cassava production in the coastal and inter land area of southern Cross River State, Nigeria. *Journal of Soil Science & Environmental management.* 6(5) 108-115

Alabi, K.O., Wahab A.A., Lawal O. O.,Aderolu I. A., and B.A. Senjobi (2017).Characterization and classification of soils of Kwara state UniversityTeaching and Research farm, Malete,Nigeria .*Journal of Science ,Technology, Mathematics and Education*, 13 (2): 100 – 106.

Amara Denis M.K., Patil P.L., Gali S.K., and Quee, D.D. (2016). Soil suitability assessment for sustainable production of vegetable crops in Northern semi-arid region of India.

Arora VPS, Bargali SS, Rawat JS (2011). Climate change: challenges, impacts, and role of biotechnology in mitigation and adaptation. Progressive Agric. 11: 8-15.

Aziza, L. Fardous A.H., Farjana, Y. and Hasibur, R.H. (2018) production and marketing of cucumber in some selected areas of Mymensingh district Agricultural research & tech open access journal. 15(5) 141-148.

Bargali SS, Singh RP, Mukesh Joshi (1993). Changes in soil characteristics in eucalyptus plantations replacing natural broad leaved forests. J. Vegetation Sci. 4: 25-28.

Bray, R.H., Kurtz, L.T. (1945): Determination of total organic and available forms of phosphorous in soils. Soil Science. 59:39-45.

Bremner, J.M. and Mulvaney, C.S (1982). “Nitrogen total,” in Methods of Soils Analysis part 2, A.L. Page and R.H. Miller, Eds., vol. 9 0f Agronomy Monograph, pp.595- 624, ASA, SSSA, Madison, Wis, USA. European Union (2015) FAO, 2008 Food and agricultural organization (2000).

Guntulu Kursun and Orhan Dengiz (2020). Assessment of land suitability for the production of major crops in Ayranci district of karaman province located at arid terrestrial ecosystem, *Eurasian Journal of Soil science.* 9(1) 24-33.

Jimoh, A.I., Aliyu, J. Sabo A.T., and Yusuf, O.Y. (2018) Land suitability evaluation of Kubanni flood plan for rice production in Zaria, Kaduna State, Nigeria. *Nigeria Journal of Basic and Applied science* '26(1)46-54.

Kappo A., Rilwani M.L and Muibi k. (2004) Land Suitability Assessment for cocoa cultivation in Ife central Local Government Area, Osun State, *International journal of scientific Engineering & Research* 3 (4) 139 -144

khadse GK, Gaikwad ST (1995). soil based agro-technology transfer: A case study Agropedology. 91-96.

Lombin LG, Adepetu JA, Ayolade KA (1992). Complementary use of organic manure and inorganic fertilizer in arable crop production. In Fed. Min of Sci. & Tech. Ed. Organic fertilizer in the Nigeria agriculture: Present and future. Proceeding of National organic Fertilizer Seminar. Zaria pp. 146-162

Mao, X., Mengyu, L, Xinyuan, W., Changming, L., Zhimin H., Shi, J., (2003) Effect of deficit irrigation on yield & water use greenhouse grown cucumber in the North China plain. Agric. Water management. 6, (3), 219-228.

NBSS&LUP (1994). Proceedings of National Meet on Soil-site suitability criteria for different crops, Nagpur, National Bureau of Soil Survey and land use planning, NBSS&LUP Publication. Feb. 7-8, 32p.

Nwafor, M, E.C. EHOR, O.J. CHUKWU and J.I. AMUKA (2011): cost effective Agriculture growth option for poverty reduction in Nigeria: Evidence and policy implications. AIAE Research paper 6 African institute for Applied Economics, Enugu.

Physical aspect of crop productivity' www.fao.org.Rome:food and agriculture organization of the united Nations (2018).

Rabia, A.H. (2012): A GIS based land suitability assessment for agricultural planning in Kilte Awulaelo district, Ethiopia. The 4th international congress of ECSSS, EUROSOIL 2012 'Soil science for the benefit of mankind and environment' held at Bari, Italy PP:1257, 2-6 June, Bari Italy.

Reshmidevi, T.V., Eldho, T.I., and Jana, R, (2009) A GIS – Integrated fuzzy Rule – Based inference system for land suitability Evaluation in Agricultural watersheds. Agr. Syst. 101(1-2):101-109

Sarkar, S., S.R. Singh., and R.P. Singh (2003). "The effect of Organic and Inorganic Fertilizer on Soil Physical Condition and the Productivity of Rice-Lentil Cropping Sequence in India." *Journal of Agricultural Science* 140 (4): 419-425.

Surajit Bera and Mobin Ahmad (2017). SITE SUITABILITY ANALYSIS USING REMOTE SENSING&GIS FOR RAIN WATER HARVESTING. *International Journal of Geology, Earth & Environment Sciences ISSN: 2277-2081 2017* Vol. 6 (2) May-August, pp. 101-110/

Tarawali SA, Singh BB, Gupta SC, Tabo R, Harris F, et al. (2002) Cowpea as a key factor for a new approach to integrated crop-livestock systems research in the dry savannas of West Africa. Intl Inst Tropical Agric, Ibadan, 2002, pp. 22-40

Uddoh T.B. (2008). 'Soil Texture and fertility constraint in low land suitability for oil-palm cultivation in humid tropical climate of Akwa Ibom State, Nigeria. '*Nigerian Journal of Soil Science*.18:175-182.

Wang, Y.H., Joobeur. T., Dean, R. A., Staub, J.E., 2007. Cucurbit genome mapping and molecular breeding in plants. Vegeta (5)

Willy H. Verheye (2009). Land evaluation, Land use and Land Cover. Vol (11).

Yagock JY, Awoniyi JO (1974). Organic manure, industrial waste and chemical fertilization of maize and sorghum. Samaru Agriculture Newsletter 16 (1): 37-39

Table 1 Soil–site suitability criteria (crop requirement) for Tomato/ Cucumber/Cabbage

Land quality	Soil-site characteristics	Unit	S1	S2	S3	N
Climate	Total Rainfall	mm	600-750	500-600 750-1000	450-500 >1000	
	Mean Temperature in growing season	ºC	25-28	29-32 20-24	33-36 15-19	<15 >36
	Rainfall in growing season	mm	>150	120-150	90-120	
	Length of growing season	Days	>150	120-150	90-120	
Topography (t)	Slope	%	1-3	3-5	5-10	>10
Wetness (w)	Soil drainage	Class	Well drained	Moderate	Imperfect	Poor
Soil physical properties (s)	Texture	Class	Sl,l,cl,scl	Sicl,sic,sc,c(m/k)	c (ss)	Ls,s
	Coarse fragment	Vol (%)	<15	15-35	>35	
	Effective soil depth	cm	>75	50-75	25-50	<25
Fertility (f)	pH	1-2.5	6.0-7.0	5.0-5.9 7.1-8.5	<5	
	CEC	cmol(p+)/kg	>15	10-15	<10	
	$CaCO_3$ in root zone	%	Non-calcareous	Slightly calcareous	Strongly calcareous	
Soil toxicity (n)	Salinity (EC)	dSm-1	Non-saline	Slightly saline	Strongly saline	
	Sodicity (ESP)	%	Non-sodic	Slightly sodic	Strongly sodic	

S1=Highly suitable (IP = 100-75%), S2=Moderately suitable (IP = 74-50%); S3=Marginally suitable (IP = 49-25); N=Not suitable (24-0%).
Source: Modified from NBSS&LUP, 1994

Table 2: Land requirement for suitability classes for cucumber cultivation

Land quality	Unit	S1	S2	S3	N
Climate (c):					
Mean temperature	^{0}C	25 – 28	29 – 32	33 – 36	>16
Total rainfall	mm	600 – 750	500 – 600	450 - 500	
Rainfall in growing season	mm	> 150	120 – 150	90 – 120	
Length of growing season	days	> 150	120 – 150	90 – 120	
Topography (t)					
Slope	%	1 – 3	3 – 5	5 – 10	>10
Wetness (w)					
Soil drainage	class	well drained	moderate	imperfect	poor
Soil physical properties (s)					
Texture	class	sl, l, cl, sclsicl, sic, sc, c (m/k)		c(ss)	ls, s
Coarse fragments	vol%	<15	15 – 35	>35	
Effective soil depth	cm	>75 50 – 75	25 – 50	<25	
Fertility (f)					
pH	1 – 2.5	6.0 – 7.0	5.0 – 5.9	<5	
CEC	cmol[p+]/kg	>75	10 – 15	<10	
$CaCO_3$ in root zone	%	non-calcareous	slightly calcareous	strongly calcareous	
Soil toxicity (n)					
Salinity [EC saturation extract]	dS m^{-1}	non-saline	slightly saline	strongly saline	
Sodicity [ESP]	%	non-sodic	slightly sodic	strongly sodic	

S1=Highly suitable (IP = 100-75%), S2=Moderately suitable (IP = 74-50%); S3= Marginally suitable (IP = 49-25); N=Not suitable (24-0%). Source: Modified from NBSS&LUP, 1994

Table 3: Soil chemical Characteristics of surface sample 2021

Sample No	pH 1:1 (H_2O)	Nitrogen %	Organic carbon %	Organic matter %	Sand %	Silt %	Clay %	Texture	Ca++	Mg++ cmo/kg	Na++ cmo l/kg	K++ cmo l/kg	Acidity	Available. P mg/kg	EC. E.C. cmo l/kg	Base saturation %
2A	8.4	1.75	0.39	0.67	80.64	6	16.34	S/L	2.47	1.08	0.49	0.65	0.8	9.31	5.49	85.43
2B	7	1.47	0.54	0.93	82.64	6	13.34	S/L	2.68	0.96	0.36	0.84	0.76	3.36	5.61	86.45
3A	6.5	1.05	0.19	0.33	82.64	6	11.36	S/L	2.11	0.78	0.27	0.76	0.74	7.49	4.66	84.12
3B	6.9	1.54	0.19	0.33	80.64	6	13.36	S/L	2.01	0.71	0.25	0.81	0.6	9.94	4.38	86.3
4A	6.7	1.61	0.36	0.62	80.64	6	13.36	S/L	1.96	0.48	0.27	0.63	0.6	10.36	3.94	84.77
Block 4	6.8	1.47	0.04	0.06	82.64	6	11.36	S/L	1.78	0.44	0.22	0.71	0.8	4.2	3.95	79.74
Crop Museum	7.4	1.54	0.04	0.06	80.64	6	13.36	S/L	2.01	0.38	0.24	0.62	0.84	5.81	4.09	79.46

Table 8: The analysis of variance of the data collected on physiological growth and yield parameters for cucumber

Soil Amendment	Fruit weight(g)	Fruit yield per hectare (tons)	Vine length at 6 weeks (m)	Vine length at 8 weeks (m)	Leaf area at 6 weeks (cm)	Leaf area at 8weeks (cm)	Number of leaf at 6 weeks	Number of leaf at 8 weeks	Day to 50% flowering	Day 50% fruit setting
Manure	462.01a	8816.9a	0.48b	0.73a	147.8b	213.52a	24.7b	28.2b	35.70a	43.08a
NPK	348.49b	7085.2b	0.57ab	0.68a	172.1a	213.7a	28.05ab	35.2a	35.70a	43.07a
Control	278.23b	5165.6c	0.61a	0.72a	142.08b	160.916b	29.7a	35.9a	35.71a	43.07a
LSD	93.12	660.80	8.972	6.409	16.73	7.966	3.82	2.105	0.9158	1.323
Elevation/Location										
Upper	690.02a	11299.1a	0.78a	0.904a	223.1a	270.39a	48.06a	58.49a	35.03b	42.09b
Middle	194.0b	4237.1c	0.40b	0.631b	116.22b	135.809c	15.51b	18.13c	37.03a	44.05a
Lower	204.73b	5531.5b	0.49b	0.604b	122.76b	181.9b	18.9b	22.8b	35.05b	43.08ab
LSD	93.12	660.80	8.972	6.409	16.73	7.966	3.82	2.105	0.9158	1.323
SOA x Location	*	*	*	*	*	*	*	*	NS	NS

EFFICIENCY OF DIFFERENT FERTILIZER ON PERFORMANCE AND UPTAKE FOR CUCUMBER PRODUCTION (*Cucumis sativus L.*) IN OGBOMOSO, OYO STATE

Adisa, Oladunni Adeleke, Owoade, Folasade Mary, Oladejo, Oluyomi Olarinre
Department of Crop Production and Soil Science, LAUTECH, Ogbomoso, Oyo State, Nigeria
Corresponding author: oaadisa61@lautech.edu.ng

ABSTRACT

A field experiment was conducted on the Teaching and Research Farm at Ladoke Akintola University of Technology Ogbomoso, Oyo State, Nigeria. The study investigated the impact of various fertilizer types and cucumber varieties on growth, yield, and nutrient uptake in cucumber production in Ogbomoso, Oyo State. The experimental design was a Randomized Complete Block Design (RCBD) with five fertilizer treatments (poultry manure, urea, Mack Pure organic, NPK, and control) and three cucumber varieties (Cucumber marketer, Seminis, and Amarisa super F1). Results showed that poultry manure and urea significantly ($P < 0.05$) enhanced growth and yield parameters, with poultry manure increasing leaf count and vine number, while urea improved fruit production and nutrient uptake, especially for nitrogen and phosphorus. The "Cucumber marketer" (V1) variety demonstrated the highest growth performance and nutrient uptake. Although fertilizer and variety independently influenced yield, their interaction was limited in enhancing fruit production. The study suggests that farmers seeking higher cucumber yields and sustainable soil nutrients should consider using poultry manure and urea, combined with high-performing varieties like "Cucumber marketer."

Keywords: Cucumber, Nutritional value, Fertilizers, Nutrient uptake, Weeks after planting (WAP)

INTRODUCTION

Cucumber (*Cucumis sativus L.*) is a high-value horticultural crop grown worldwide for its nutritional, culinary, and economic importance. Cucumber is a versatile vegetable with a wide range of uses in different areas such as culinary, medicinal, and cosmetic (Sabir *et al*., 2019). Its crisp, refreshing taste makes it a popular choice in salads, sandwiches, and as a garnish for drinks. However, cucumbers are more than just a tasty addition to your meals. They are also a good source of vitamins and minerals, making them a healthy snack option. Cucumbers contain vitamin C, vitamin K, potassium, and magnesium, among other nutrients (Higdon and Frei, 2019). Aside from being consumed as food, cucumbers have various other uses. They are a common ingredient in skincare and beauty products, thanks to their high water content and cooling properties. Cucumber slices can be placed on the eyes to reduce puffiness, and cucumber extract is a popular ingredient in moisturizers and facial masks (Khan *et al*., 2021). Cucumbers also have a long history of use in traditional medicine. They are believed to have diuretic properties, meaning they can help to flush excess fluids from the body. Cucumber juice is a common remedy for urinary tract infections and other conditions that cause inflammation in the body (Al-Asmari *et al*., 2022). In addition, cucumbers are a valuable ingredient in the production of pickles, a popular food item worldwide. Pickling cucumbers involves soaking them in a vinegar solution, which gives them a tangy, sour flavor. Pickled cucumbers can be eaten as a snack or used as a condiment to add flavor to sandwiches, burgers, and other dishes (U.S. Department of Agriculture, 2022).

Optimizing cucumber production, especially in regions with variable soil fertility, depends significantly on efficient nutrient management strategies (Abiodun and Ali, 2021). Fertilizers play a central role in this optimization process, as they provide essential nutrients that influence plant growth, yield, and nutrient uptake efficiency (Ibrahim *et al*., 2023). However, the choice and efficiency of different fertilizer types—organic, inorganic, and integrated approaches—can vary considerably in their impact on cucumber performance, depending on environmental and soil factors (Bello *et al*., 2022).

Organic fertilizers, often derived from plant and animal residues, have been shown to enhance so il health by improving its physical, chemical, and biological properties (Oluwaseun and Olufemi, 2020, Owoade *et al.,* 2017, Owoade and Abolarin 2020). These fertilizers release nutrients more slowly compared to inorganic fertilizers, which can improve nutrient retention and minimize leaching losses. In contrast, inorganic fertilizers, typically composed of concentrated nutrient compounds, are known for their rapid nutrient availability and higher immediate impact on plant growth (Olujide and Oyedepo, 2021, Owoade and Abolarin 2020). Integrated fertilizer management combines organic and inorganic fertilizers to maximize nutrient availability while promoting soil health, a balance that has shown promising results for yield and sustainability in cucumber production (Yakubu *et al*., 2023).

Understanding the efficiency of these fertilizer types is essential for designing optimal fertilization programs that enhance cucumber yield while ensuring environmental sustainability. This study, therefore, investigates the effects of different fertilizer types on cucumber growth performance and nutrient uptake. By identifying the most effective fertilizer practices, this research aims to provide recommendations that can help farmers maximize cucumber productivity while promoting sustainable agriculture practices. The objective of this study was to determined the efficiency of different fertilizer on performance and uptake for cucumber production (*Cucumis sativus L.*) in Ogbomoso, Oyo state.

MATERIALS AND METHODS

Experimental Site

The field experiment was carried out in Teaching and Research Farm, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, (Latitude 8° 10'N and Longitude 4° 25'E) in the Derived savannah agro-ecological zone of Southwestern Nigeria. It has a bimodal pattern of rainfall distribution which is characterized by peaks around July and September. The day temperature ranges between 25.8°C in August and 30.50 °C in March, with mean annual temperature of 27°C (Ewetola *et al.,* 2020). The experimental site was manually cleared; tilled and flat beds measuring 3 m x 3 m were constructed.

Experimental design

The experimental design was Randomized Complete Block Design (RCBD). There were 15 treatments and each treatment was replicated three times to give a total of 45 experimental units for the varieties of Cucumber planted. Five fertilizer treatments were used. Fertilizer treatment used are as follows: T1 (poultry manure), T2; (urea), T3; (Mack pure organic), T4 (NPK), and T5 (Control). Three varieties of cucumber used are: V1 (Cucumber marketer), V2 (Seminis), and V3 (Amarisa super F1) which was planted on bed and watered regularly.

Data collection and analysis

Data collection commenced five weeks after planting (5WAP). The growth parameters observed were number of leaves and vine number. Yield parameters were number of flower per plant, and number of fruits per plant. Nutrient uptake was calculated as Nutrient concentration in plant tissue multiply by Plant dry weight divided by one hundred. Each parameter measured was subjected to (ANOVA) Analysis of variance and means were separated using Least Significance Difference (LSD) at 5% probability level.

RESULTS AND DISCUSSION

Growth parameters

Number of Leaves

Table 1 shows the effects of different fertilizer types and cucumber varieties on the number of leaves per plant at various weeks after planting (WAP). At 5 WAP, Variety V1 had the highest leaf count with poultry manure, while the control treatment showed the lowest leaf count. At 6 WAP, leaf numbers increased across treatments, with V1 under urea showing the highest count. Poultry manure and urea continued to be effective, with significant differences observed among varieties and fertilizers. At 7 WAP, leaf numbers further increased, with V1 treated with poultry manure having the highest count. Poultry manure and urea maintained their effectiveness, with both variety and fertilizer showing significant effects.

Vine number

Table 2 displays the effects of different fertilizer types and cucumber varieties on the vine number of cucumber plants at 5, 6, and 7 weeks after planting (WAP). At 5 WAP, V1 had the highest vine count with NPK, while the control treatment yielded the lowest counts. NPK was the most effective fertilizer overall. At 6 WAP, vine numbers increased, with V1 responding best to poultry manure. Poultry manure led to the highest average vine number, while the control remained lowest. At 7 WAP, vine numbers continued to rise, with V1 under poultry manure showing the highest count. Poultry manure remained the most effective fertilizer overall. At 5, 6, and 7 weeks after planting (WAP), different fertilizers significantly influenced cucumber vine numbers across varieties (V1, V2, V3).

Yield parameters

Number of flowers

Table 3 shows the effects of different cucumber varieties and fertilizer types on the number of flowers produced at 5, 6, and 7 weeks after planting (WAP). At 5 WAP, Variety 1 (V1) had the highest average number of flowers across all fertilizer treatments, with 13.0 flowers on average, while Variety 3 (V3) had the lowest count (5.4). V1 also responded well to Mack Pure fertilizer, producing 21.0 flowers, the highest among all treatments. Among fertilizer types, Mack Pure led to the highest flower count (13.7 on average), while the control treatment (no fertilizer) resulted in the lowest (6.7). At 6 WAP, V1 continued to produce the highest number of flowers across treatments, particularly with Mack Pure (146.0 flowers). V2 and V3 showed much lower flower counts across all fertilizers, with V3 having the lowest count overall. Mack Pure again led to the highest average number of flowers (54.4), followed by Urea. The control yielded the fewest flowers (28.6). At 7 WAP, V1 consistently produced the most flowers, particularly under Mack Pure and NPK treatments. V3 remained the lowest in flower production. The general trend continued with Mack Pure and NPK fertilizers supporting the highest flower counts, while the control had the least effect.

Number of fruits

Table 4 presents the effects of different fertilizer types and cucumber varieties on the number of fruits produced at different weeks after planting (WAP). At 5 WAP, Variety 2 (V2) consistently produced more fruits across all fertilizer treatments, with the highest count of 45 fruits under Urea treatment. Variety 3 (V3) followed closely, while Variety 1 (V1) produced the least number of fruits. The average effect of fertilizers on fruit number indicates that Urea generally promoted higher fruit production (24 fruits), while the control (no fertilizer) resulted in the lowest fruit count (6.7 fruits). Similar trends continue at 6 WAP, with V2 yielding the highest number of fruits across all fertilizer treatments, particularly under Urea and Poultry Manure. Variety 1 remained the lowest in fruit production. The mean fruit count shows that Urea still leads to the highest fruit yield (7.0), followed by Poultry Manure. Control yielded the lowest number of fruits again. By 7 WAP, V2 continued to outperform the other varieties, especially under Urea and Poultry Manure treatments. V1 remained the lowest producer. The general trend shows Urea and Poultry Manure as the most effective fertilizers for fruit production at this stage, with average fruit counts of 12.0 and 11.0, respectively. Control still yielded the fewest fruits (5.0). Significant differences in fruit production were found due to variety and fertilizer type, though the interaction between them was only significant at 6 WAP. This suggests that both variety and fertilizer type independently contribute to fruit yield, with limited synergistic effects.

Nutrient uptake

Table 5 displays the effects of different fertilizer types and cucumber plant varieties on the nutrient uptake (Nitrogen, Phosphorus, and Potassium) of cucumber plants. V1 (Cucumber marketer) had the highest mean nitrogen uptake across all fertilizer types (0.87), while V3 (Amarisa super F1) had the lowest (0.54). Among the fertilizers, urea consistently led to the highest nitrogen uptake across all varieties, with an overall mean of 0.90, while control treatments resulted in the lowest nitrogen uptake. The least significant difference (LSD) results suggest that differences in nitrogen uptake are not statistically significant among varieties, fertilizers, or their interaction. Phosphorus uptake was highest in variety V1 with a mean of 9.13, followed by V2 (Seminis) (7.05) and V3 (5.04). Among the fertilizer treatments, urea led to the highest phosphorus uptake with a mean of 12.06, while control treatments again resulted in the lowest uptake values. LSD results show a significant difference in phosphorus uptake among varieties and fertilizers, but not for their interaction, indicating that both variety and fertilizer type independently influence phosphorus uptake. Variety V1 recorded the highest mean potassium uptake (2.02), while V3 had the lowest (0.94). Urea and NPK 15:15:15 led to higher potassium uptake across varieties, while control treatments resulted in the lowest uptake values. Similar to nitrogen, the LSD test shows no significant differences for potassium uptake among varieties, fertilizers, or their interaction.

CONCLUSION

This study highlights the significant effects of fertilizer type and cucumber variety on growth, yield, and nutrient uptake in cucumber production. Poultry manure and urea were especially effective, with poultry manure enhancing leaf count and vine number, and urea promoting higher fruit yield and nutrient uptake. The "Cucumber marketer" (V1) variety showed the best performance overall. Both fertilizer and variety independently influenced growth and yield; however their interaction had a limited effect on fruit production.

RECOMMENDATIONS

Based on the findings made during the course of this research work, the following recommendations were made:

1. Use of Urea and Poultry Manure for improved yield and nutrient uptake.
2. Adopting Integrated Fertilizer Management to balance short- and long-term nutrient availability.
3. Promoting Sustainable Nutrient Management Practices to support productivity and environmental sustainability.

REFERENCES

Abiodun, M., and Ali, M. (2021). Optimizing cucumber production through nutrient management strategies in variable soil conditions. *Journal of Agricultural Sciences*, 12(3), 123–132.

Al-Asmari, A., Khan, M., and Ansari, A. (2022). Traditional uses and pharmacological potential of cucumber: A review. *Journal of Ethnopharmacology*, 282, 114598. https://doi.org/10.1016/j.jep.2022.114598

Bello, S. A., Yusuf, A., and Usman, T. (2022). Comparative efficiency of organic and inorganic fertilizers on cucumber (Cucumis sativus) yield and quality. *African Journal of Horticultural Science*, 17, 89–102.

Ewetola E. A., Onofua O. E., Ola O. D. and Akande A. O. (2020). Influence of saw dust and plastic mulch on soil physical properties, growth and yield of Okra (*Abelmoschus Esculentus* (L.) Moench. *Nigerian Journal of Horticultural Science*. Vol. 25 (2)1118-2733.

Higdon, J., and Frei, B. (2019). *Vitamin and Mineral Basics*. Linus Pauling Institute, Oregon State University. Available at: https://lpi.oregonstate.edu

Ibrahim, A. O., Abdulkadir, M., and Aliyu, I. M. (2023). Impact of fertilizer type on nutrient uptake and yield of cucumbers in arid soils. *International Journal of Horticulture Science and Technology*, 18(4), 203–212.

Khan, M., Rehman, A., and Alam, N. (2021). Uses of cucumber in skincare: An overview of its potential applications. *Cosmetic Science Journal*, 5(2), 33–42.

Olujide, A. O., and Oyedepo, T. O. (2021). Inorganic fertilizers and their immediate effects on cucumber yield. *Agricultural Chemistry Review*, 8(2), 101–109.

Oluwaseun, O. R., and Olufemi, A. K. (2020). Benefits of organic fertilizers in improving soil properties and crop production. *Soil and Environmental Science Journal*, 15(1), 29–39.

Owoade, F. M., Abolarin, A. O. and Ewetola, E. A. (2017). Effects of organic and inorganic nutrients sources on performance of *Aloe vera* and soil chemical properties. *Canadian Journal of Pure and Applied Sciences*, 11(3):4305-4311. https://www.cjpas.net.

Owoade, F. M. and Abolarin A. O. (2020). Efficacy of Sunshine and neem-based organic fertilizer on performance and chemical constituents of *Aloe vera* in the Southern Guinea Savanna Ecology of Nigeria. *LAUTECH Crop and Environmental Reviews* 1(2): 112-121. https://laucers.com

Sabir, S., Qureshi, R., and Rehman, M. (2019). Culinary, medicinal, and cosmetic importance of cucumber (Cucumis sativus L.): A review. *Journal of Medicinal Plants Studies*, 7(4), 62–67.

U.S. Department of Agriculture. (2022). *Cucumbers: Nutritional Profile and Pickling Process*. Available at: https://www.usda.gov

Yakubu, Y., Okeke, E., and Alhassan, M. (2023). Integrated fertilizer management for sustainable cucumber production: A field-based assessment. *Sustainable Agriculture Research*, 32(2), 143–152.

Table 1: Effects of varieties and fertilizers types on number of leaves of cucumber plants

	Fertilizer types					
Variety	**Poultry Manure**	**Urea**	**Mack pure**	**NPK 15:15:15**	**Control**	**Variety mean**
			5 WAP			
V1	9.0	8.0	7.0	5.0	5.0	7.0
V2	5.0	6.0	7.0	5.0	6.0	6.0
V3	7.0	4.0	4.0	5.0	5.0	5.0
FER TY Mean	7.0	6.0	6.0	5.0	6.0	
LSD Variety	ns					
LSD Fertilizer	1.2					
LSD V*F	ns					
			6 WAP			
V1	16.0	14.0	13.0	10.0	9.0	12.0
V2	11.0	9.0	11.0	8.0	9.0	10.0
V3	9.0	6.0	7.0	6.0	7.0	7.0
FER TY Mean	12.0	10.0	10.0	8.0	8.0s	
LSD Variety	2.2					
LSD Fertilizer	1.8					
LSD V*F	ns					
			7 WAP			
V1	20.0	21.0	20.0	13.0	12.0	17.0
V2	17.0	13.0	14.0	10.0	11.0	13.0
V3	15.0	11.0	10.0	9.0	10.0	11.0
FER TY Mean	17.0	15.0	15.0	10.0	11.0s	
LSD Variety	2.8					
LSD Fertilizer	3.6					
LSD V*F	ns					

Least Significant Difference at 5% level of probability, FER TY- Fertilizer types, WAS- Week after planting (Field survey, 2023)

Table 2: Effects of varieties and fertilizers types on vine number of cucumber plants

	Fertilizer types					
Variety	**Poultry Manure**	**Urea**	**Mack pure**	**NPK 15:15:15**	**Control**	**Variety mean**
			5 WAP			
V1	18.0	10.0	20.0	16.0	12.0	15.0
V2	17.0	17.0	13.0	18.0	13.0	15.0
V3	18.0	11.0	20.0	14.0	10.1	15.0
FER TY Mean	17.0	12.0	18.0	16.0	12.0	
LSD Variety	ns					
LSD Fertilizer	3.5					
LSD V*F	6.1					
			6 WAP			
V1	38.0	29.0	33.0	36.0	38.0	35.0
V2	28.0	35.0	29.0	29.0	27.0	30.0
V3	34.0	33.0	38.0	28.0	33.0	33.5
FER TY Mean	33.0	32.0	33.0	31.0	33.0	
LSD Variety	4.5					
LSD Fertilizer	ns					
LSD V*F	ns					
			7 WAP			
V1	62.1	48.0	49.0	62.0	54.0	55.0
V2	51.0	61.0	52.0	54.0	55.0	55.0
V3	49.0	63.0	59.0	58.0	58.0	57.0
FER TY Mean	54.0	57.0	53.0	58.0	55.0	
LSD Variety	ns					
LSD Fertilizer	ns					
LSD V*F	12.5					

Least Significant Difference at 5% level of probability, FER TY- Fertilizer types, WAS- Week after planting
(Field survey, 2023)

Table 3: Effects of varieties and fertilizers types on number of flowers of cucumber plants

	Fertilizer types					
Variety	Poultry Manure	Urea	Mack pure	NPK 15:15:15	Control	Variety mean
			5 WAP			
V1	20.3	5.3	21.0	9.0	9.3	13.0
V2	18.0	9.3	10.0	10.7	7.7	11.1
V3	6.0	4.0	10.0	4.0	3.0	5.4
FER TY Mean	14.8	6.2	13.7	7.9	6.7	
LSD Variety	5.7					
LSD Fertilizer	7.4					
LSD V*F	ns					
			6 WAP			
V1	118.3	78.7	146.0	111.3	67.0	104.3
V2	10.7	11.0	7.0	6.0	7.0	8.3
V3	11.7	6.7	10.3	8.0	11.7	9.7
FER TY Mean	46.9	32.1	54.4	41.8	28.6	
LSD Variety	26.3					
LSD Fertilizer	ns					
LSD V*F	ns					
			7 WAP			
V1	33.7	60.7	62.3	58.3	37.3	50.5
V2	12.3	11.0	7.0	6.0	4.3	8.1
V3	5.0	4.3	1.7	5.3	2.0	3.7
FER TY Mean	17.0	25.3	23.7	23.2	14.6	
LSD Variety	13.7					
LSD Fertilizer	ns					
LSD V*F	ns					

Least Significant Difference at 5% level of probability, FER TY- Fertilizer types, WAS- Week after planting (Field survey, 2023)

Table 4: Effects of varieties and fertilizers types on number of fruit of cucumber plants

	Fertilizer types					
Variety	**Poultry Manure**	**Urea**	**Mack pure**	**NPK 15:15:15**	**Control**	**Variety mean**
			5 WAP			
V1	13.0	2.0	7.0	3.0	2.0	6.0
V2	37.0	45.0	43.0	27.0	31.0	37.0
V3	31.0	26.0	21.0	20.0	18.0	23.0
FER TY Mean	27.0	24.0	24.0	17.0	17.0	
LSD Variety	8.0					
LSD Fertilizer	ns					
LSD V*F	ns					
			6 WAP			
V1	5.0	3.0	4.0	3.0	3.0	4.0
V2	4.0	14.0	13.0	9.0	11.0	10.0
V3	6.0	3.0	6.0	7.0	3.0	5.0
FER TY Mean	5.0	7.0	8.0	6.0	6.0	
LSD Variety	0.9					
LSD Fertilizer	ns					
LSD V*F	2.0					
			7 WAP			
V1	8.0	7.0	4.0	3.0	4.0	5.0
V2	14.0	19.0	17.0	12.0	11.7	15.0
V3	12.0	11.0	9.0	8.0	7.0	9.0
FER TY Mean	12.0	12.0	10.0	8.0	7.0	
LSD Variety	3.6					
LSD Fertilizer	ns					
LSD V*F	ns					

Least Significant Difference at 5% level of probability, FER TY- Fertilizer types, WAS- Week after planting (Field survey, 2023)

Table 5: Effects of varieties and fertilizers types on nutrient uptake of cucumber plants

	Fertilizer types					
Variety	**Poultry Manure**	**Urea**	**Mack pure**	**NPK 15:15:15**	**Control**	**Variety mean**
			Nitrogen			
V1	0.98	1.36	1.09	0.40	0.57	0.88
V2	0.68	0.82	0.53	0.58	0.63	0.65
V3	0.94	0.52	0.54	0.41	0.32	0.54
FER TY Mean	0.86	0.90	0.73	0.47	0.51	
LSD Variety	ns					
LSD Fertilizer	ns					
LSD V*F	1.09					
			Phosphorus			
V1	8.10	12.51	13.46	4.83	6.97	9.13
V2	6.27	7.65	12.31	10.78	7.16	8.84
V3	11.92	6.77	6.97	4.57	5.03	7.05
FER TY Mean	8.76	8.98	10.91	6.73	6.32	
LSD Variety	ns					
LSD Fertilizer	ns					
LSD V*F	ns					
			Potassium			
V1	2.69	3.12	2.69	0.67	0.95	2.02
V2	0.95	1.39	0.92	1.02	0.93	1.04
V3	1.47	0.81	0.91	0.69	0.84	0.94
FER TY Mean	1.70	1.77	1.50	0.79	0.91	
LSD Variety	ns					
LSD Fertilizer	ns					
LSD V*F	ns					

Least Significant Difference at 5% level of probability, FER TY- Fertilizer types, WAS- Week after planting (Field survey, 2023)

International Journal of Organic agricultural Research & Development
Volume 19 (4) (2024)

COST AND RETURN ANALYSIS OF YAM FARMERS RESILIENCE TO CLIMATE CHANGE IN BENUE STATE

Adebayo Matthew OLATUNJI[1], Lydia Titi OGUNNIYI[2], Mufutau Oyedapo Raufu[3] and Gbenga Emmanel FANIFOSI[4]
[1]Department of Agricultural Economics, Ladoke Akintola University of Technology Ogbomoso Nigeria,
Corresponding author: amolatunji@lautech.edu.ng

ABSTRACT

This study conducted a cost and return analysis of yam farmers' resilience to climate change in Benue State, Nigeria. The analysis focused on understanding the socio-economic characteristics of the farmers and how these factors influence their resilience and economic returns. The socio-economic data revealed that the majority of yam farmers were male (65.18%), aged between 36 and 65 years, with a mean age of 46 years. The majority (41.30%) completed primary education and (74.09%) were primarily engaged in farming as their main occupation. A budgetary analysis of the farmers' production revealed that yam farming is profitable, with a benefit-cost ratio (BCR) of 1.13, indicating that for every ₦1 invested in yam production, farmers gained a return of ₦1.13. The study further explored resilience factors through factor analysis and structural equation modeling, identifying assets, adaptive capacity, and agricultural practices as key variables significantly impacting resilience to climate change. Assets had the strongest relationship with productivity (p=0.002), followed by agricultural practices and technology (p=0.025) and social networks (p=0.078). Among the analyzed variables, only farm size showed statistical significance at the 0.05 level (p=0.012). For farmers with high resilience, the t-value of 50.97 and p-value of 0.000 indicated a very strong and significant positive relationship with productivity outcomes. The findings highlight that increasing adaptive capacity, enhancing social networks, and improving access to technology are crucial to strengthening farmers' resilience. These results underscore the need for policy interventions aimed at improving access to affordable inputs, mechanization, and resilient yam varieties to enhance productivity and climate change adaptation among yam farmers in Benue State.

Key words: Cost and return analysis, Yam production, Resilience, Climate change, Benefit-cost ratio (BCR), Adaptive capacity, Profitability.

INTRODUCTION

The production of yams is a major contributor to local food security, livelihoods, and national agricultural outputs in Benue State, Nigeria, which is referred to as the "Food Basket of the Nation." However, yam farming is seriously threatened by climate change, which could result in unreliable yields and higher production costs. Improving the region's food security and economic sustainability requires an understanding of the cost and return dynamics of yam producers' climate change resilience (Adepoju *et al*., 2017). This investigation sheds light on the economic feasibility of yam farmers' tactics and how they adjust to climate-related difficulties (Adebayo *et al*., 2022).

The production of yams is seriously threatened by climate change, which will affect yields, quality, and availability. In Benue State, the effects of climate change include more frequent extreme weather events, extended droughts, erratic rainfall patterns, and rising temperatures. The cycles of yam cultivation are disturbed by these environmental changes, which also lower soil fertility and raise the prevalence of pests and illnesses. Consequently, yam growers are exposed to increased production risks, and these climate-related disruptions require higher financial investments in cultivation inputs including fertilizers, irrigation systems, and insect control methods. As a result, assessing the profitability of yam growing under climate stress requires a cost and return analysis. (Etwire *et al*., 2022).

According to Ojewumi *et al.,* (2022), Benue State's yam growers are susceptible to climate-related stocks such as rising temperatures, altered rainfall patterns, and a rise in the frequency of extreme weather events. A thorough cost and return analysis take into account the money made from yam sales as well as the other costs that farmers incur, such as labor, seeds, fertilizer, and equipment. Climate-related issues have the potential to dramatically raise production costs in Benue State, where smallholder farmers primarily cultivate yams. In order to maintain yields in the face of changing climate conditions, farmers may need to invest in climate-resilient methods, such as better seed types and irrigation systems, which can increase their overall production costs (Soomiyol *et al.,* 2020).

Policy and programmatic responses must be informed by an understanding of the economic costs and benefits of yam producers' climate change resistance (Mason *et al.,* 2021). In Nigeria, recent research has emphasized the necessity of climate-resilient agriculture and the significance of climate change adaptation (Aiyelari *et al.,* 2022). A major contributor to the nation's yam production, Benue State is a crucial yam-producing region (Adebayo *et al.,* 2022). As a result, this study evaluated the response of yam growers in Nigeria's Benue State to climate change.

The specific objectives were to:

1. Describe the socio-economic characteristics of the respondents in the study area.
2. Estimate the cost and return analysis of yam farmers resilience to climate change in Benue state.

MATERIALS AND METHODS

Study area

The study was carried out in Nigeria's Benue State widely referred to as "the nation's food basket." This is ascribed to the abundance of land and agricultural resources that may be used to produce a wide range of crops, including rice, cowpeas, soy beans, cassava, and yam. The state experiences two distinct seasons: the dry season and the rainy season. Every year, the dry season begins in November and ends in March, whereas the rainy season begins in April and lasts until October. With 3 ADPs and 23 LGAs, Benue State is known as the nation's food basket. Benue is situated at an elevation of 97 meters above sea level in the Southern Guinea savannah agro ecological zone in the central belt of Nigeria, roughly between latitudes 6030°N and 8010°N of the equator and longitudes 6035°E and 8010°E of the Greenwich meridian. According to the 2006 population censors, Benue State has a total population of 4,253,641 (with 2,144,043 are male and 2,109,598 are female) out of which 2,169,357 are children (0-17years) (FMWA and SD, 2008). The state occupies a landmass of 32,518 square kilometers. The state comprised of several ethnic groups: Tiv, Idoma, Igede, Etulo, Abakpa, Jukun, Hausa, Akweya and Nyifon. The Tiv are the dominant ethnic group, occupying 14 local government areas, while the Idoma and Igede occupy the remaining nine local government areas. Benue state has a Guinea savannah kind of vegetation characterized with scattered trees and coarse grasses. The people of Benue state are mostly farmers, traders and artesian but majority are farmers. The farmers produce food crops such as yam, cassava, rice, soya beans, sweet potatoes, Irish potatoes, maize beans tomatoes and fruits. The cash crops produce include yam, orange tomatoes, and rice. (Morse, 2020).

Population and Sampling Procedure

The population for this study consisted of all registered yam farmers in selected local governments in Benue State. A three-stage sampling procedure was used to select the farmers. In the first stage, the study area was selected. The second stage was randomly selected of four local government under Agricultural Development Zones (ADPs) in the study area constituted farmer settlement and highly cultivation of yam tuber prominent. The second stages were randomly selected of the three Agricultural Development Zones (ADPs) in the state. In the third stage, two farming communities or villages were randomly selected from each Agricultural Development Zones (ADPs), totaling eight communities. This process led to a final sample size of 247 yam farmers. Approximately 24.7% of the total yam farmers in the selected local governments were chosen randomly for this study.

Source of Data and Method of Data Collection

Questionnaire was used to obtain the required information related to background information and socio-economic characteristics of farmer's combination of capabilities, adaptative responses, and transformation strategies in combating climate change; production cost and returns of yam farmers' productivity strategies were solicited through the questionnaire.

Analytical techniques

The analytical techniques that used for the study are include descriptive statistics as frequency count, percentage, mean and standard deviation were employed to analyze data collected and farm budgetary analytical technique was used to estimate the cost and returns of yam farmer production in the study area This includes use of the following variables: Gross margin (GM) is the difference between the total revenue earned and the total variable cost incurred GM = TR - TVC. Variable cost (VC) is the cost that varies with changes in output; it is a function of output level. Total cost is the total expenditure on the output that is, addition of both variable and fixed costs TC = TFC + TVC. Total revenue (TR) is the total income realized on output produced that is, quantity sold multiplied by price per unit. Net Revenue (also known as profit) is the difference between the total revenue and the total cost.

Mathematical representation of gross margin analysis is given as:

Where, GM = Gross Margin,

Π = profit

TR = Total Revenue

TVC = Total Variable Cost

TFC = Total Fixed Cost.

Also, Resilience index measurement and analysis (RIMA) Model were used to evaluate the resilience and coping strategies of yam farmers provides a detailed and multifaceted understanding of how yam farmers are managing the effects of climate.

The Resilience Index Measurement and Analysis (RIMA) Model was used to determine the level of resilience of yam farmers to climate change shocks and it will be represented as below:

$R_i = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7)$

Where R = Resilience; X_1 = Assets; X_2 = Social Networks; X_3 = Agricultural Practice and Technology; X_4 =Sensitivity; X_5 = Adaptive Capacity

RESULTS AND DISCUSSION

Socio-economic Characteristics of the Yam Farmers

The socio-economic characteristics are crucial factors in the choice of agricultural practices of farmers. Studies have shown that social and economic status of yam farmers played critical roles in the practices cost and return analysis of yam farmers resilience to climate change in Benue state **Eze, *et al.*, (2023)** characteristics of yam farmers. This study therefore described the socio-economic characteristics of yam farmers.

The study revealed that the average age of respondents was 46 years, with a notable portion (25.10%) between 36 and 45 years old, highlighting that the farming population is largely within the economically active age group.

Additionally, the findings showed that the majority of respondents were male (65.18%). This indicates a significant male dominance in yam farming, with men constituting nearly two-thirds of the farming population and in the surveyed area, men often have better access to farming resources such as land, inputs, and credit facilities but women, on the other hand, face limitations due to societal norms that restrict their ownership and control over these assets, reducing their involvement in yam farming.

In terms of education, most respondents (41.30%) had completed primary education, while a smaller percentage had secondary (25.91%) and tertiary (9.31%) education. This indicates that the respondents possess basic educational skills, which could aid in adopting improved farming practices and climate-resilient techniques while approximately 23.48% had no formal education, indicate the need for educational programs targeting farmers. Regarding marital status, the majority of respondents (53.45%) were married, suggesting that family-based farming operations are common, which contributed to stability and support within agricultural households.

The average household size was between 6–10 members for most respondents (39.68%), indicating that extended families are common, which help reduce labor costs and improve farm productivity. Farming was the dominant occupation, with (74.09%) of respondents engaged in it, indicated that, it measures the central role of agriculture in the study area. The study also revealed that farm size varied, with the largest group of farmers (27.13%) cultivating between 7–8 hectares. Larger farm sizes are associated with better productivity, which enhance economic viability and access to resources like loans and subsidies in the sturdy area. Experience-wise, the majority of respondents (27.13%) had over 20 years of farming experience, followed by 26.72% with 11–15 years. This indicates that farmers are seasoned and familiar with long-term climate patterns, which is essential for adapting to climate change and ensuring resilience in yam production.

Distribution on cost and returns of yam farmers' productivity

The budgetary analysis of benefit cost ration of cost and returns of yam farmers' productivity. AVC were observed as (₦132,331), AFC were (₦138447 per year) while TC (₦66,611,788) and TR (₦75,837,500), Therefore, the benefit cost ratio (BCR) indicates that:

$$\text{BCF} = \frac{total\ benefit(TR)}{total\ cost(TC)} = \frac{₦75837500}{₦66611788}$$

$$= ₦1.138499 \approx 1.13$$

This implies that in the study area, productivity was measured by the output per unit of input cost of production per unit of yam or yam seedlings, therefore on the average, for every ₦ 1 spent on yam production, the return is ₦1.13. This suggests that yam production is profitable since the BCR is greater than 1. The significant difference between the costs and returns favor to investment in yam production in the study area. Since the BCR > 1, it showed profitability, making yam production a viable investment. This report consonance with report by Anozie *et al.,* (2023) that yam production remains a viable investment due to favorable economic returns.

The cost of inputs, including labor, seeds, fertilizers, and transportation, represents a significant portion of the production costs. Recent studies have emphasized the need for improved access to affordable inputs and mechanization to reduce the high labor costs that yam farmers typically face. Furthermore, the adoption of improved yam varieties that are more resistant to pests and diseases can help increase yields while keeping production costs in check.

Factor analysis

The factor analysis conducted to identify the resilience structures among the strategic adoption variables for resilience to climate change to yam farmers based in Table 3 on five variables with eigenvalue of the indicators as: Assets (AST), Sensitivity (SST), Adaptive capacity (AC), Social safety network (SSN), and Agricultural practices and Technology (APT). It further revealed the observed number of 247 with retained factors of three numbers why the number of parameters is 18.

Furthermore, from the observed frequency 247, variable 1, variable 2 and variable 3 are significantly correlated with the eigenvalues of 0.30842, 0.18427 and 0.00691 with their proportion.

Also, variable 4, 5, and 6 with eigenvalue of -0.00691, -0.03697 and -0.08688 with their proportion are not significant. explaining a negligible amount of variance in the data. Therefore, having the independent vs saturated chi^2 of 21 = 24.35 and probability of chi^2 = 0.2766 approximately = 0.3. This implies that, assets (AST) correlate with the resilience index (RI). The LR test (Likelihood Ratio test) indicates that the model is a good fit, with a probability of 0.2766 (approximately 0.3).

Structural equation model

From structural equation model, in Table 4 shows that, there is log likelihood of 152.3345. The model vs saturated of chi^2 of 21 = 10620.80 with the probability of chi^2 = 0.0000. From the number of observed of 247, the table revealed that social safety network, adaptive capacity, assets and agricultural practices and technology were significantly influence resilience to climate change among yam farmers in the study area. The result showed social safety networks (SSN) increases the chance of yam farmers' resilience to climate change provided all other factors are held constant. SSN having the p-value = 0.078 indicated that the variable is significant at 10% level of confidence. Additionally, adaptive capacity (AC) having p-value = 0.025 was significant at 5% level. The result indicated that increasing adaptive capacity of yam farmers will increase the likelihood of being resilience to climate change in the study area. The coefficient of both assets and Agricultural practices and technology followed the same trend as AST has p-value of 0.002 and APT has 0.035. These variables are significant at 1% and 5% level respectively. However, this result implies that, adaptive capacity (AC) is highly significant under the resilience to climate change among yam farmers in the study area.

Distribution of respondent by estimation of the yield / output of the yam due to climate change

Table 4.8 presents the analysis of various variables that affect productivity (output) in yam farming.

The results indicate that gender, marital status, education, primary occupation, farm size, years of farm experience, association membership, and climate change awareness all have a significant impact on yam productivity. In contrast, age, with a t-value of (-2.23), does not show significance and negatively affects productivity, implying that as yam farmers age getting older, their output slightly decreases due to reduced physical capacity or adaptability. Similarly, household size, with a t-value of -0.26, was found to be non-significant, suggesting that the number of household members does not directly affect productivity. This could be due to the increased demand on available resources (such as food and income), which may limit the resources available for farming investments. Also, the result shows that, among the variables analyzed, only farm size in hectares showed statistical significance at the 0.05 level, with a p-value of 0.012. The positive coefficient indicates that larger farm sizes are associated with higher productivity.

Nevertheless, the results for resilience status are categorized into three levels: low, medium, and high resilience. The t-value of -1.70 for low resilience suggests that it is not statistically significant, meaning that as resilience decreases, yam productivity also declines, but the relationship is not strong enough to be conclusive. For medium resilience with a t-value of -0.98 and p-value of 0.330, the effect is not statistically significant, indicating that medium resilience does not have a reliable impact on yam productivity in this study. However, for high resilience, the t-value of 50.97 and p-value of 0.000 show a very strong and significant positive relationship with the outcome variable. This indicates that farmers with high resilience experience much higher productivity, as their ability to adapt to challenges significantly enhances their output. This work goes in-line with Batungwanayo *et al.,* (2023) and Norman, (2019) stated that, farmers with high resilience are more likely to experience better productivity outcomes, as their ability to adapt and cope with environmental and socio-economic stresses directly correlates with increased crop yields.

CONCLUSION

The cost-return study of Benue State's yam farmers' climate change resilience shows that, in spite of the difficulties posed by climate change, yam growing is still a lucrative endeavor. The economic viability of yam production is suggested by the benefit-cost ratio (BCR) of 1.13, which shows that for every ₦1 invested, a return of ₦1.13 is generated. However, substantial financial outlays are necessary to increase climate change resistance, particularly in the areas of irrigation, pest management, and enhanced seed types. In order to deal with the increased production risks brought on by erratic rainfall, rising temperatures, and pest infestations, yam farmers in Benue State have resorted to techniques including social safety networks, enhanced farming techniques, and diversification. Although these tactics increase farmers' resilience, they also increase production costs overall, which affects profitability.

The structural equation model further confirms that assets, social safety networks, adaptive capacity, and agricultural practices significantly influence the resilience of yam farmers. Adaptive capacity and social safety networks, in particular, play critical roles in mitigating climate-related risks. Despite these adaptive strategies, the farmers' sensitivity to climate shocks remains high, emphasizing the need for more robust interventions.

The analysis identifies key factors influencing yam productivity. Significant contributors include gender, marital status, education, primary occupation, farm size, years of farm experience, association membership, and climate change awareness. Among these, farm size has the strongest positive impact, with statistical significance (p=0.012), indicating larger farms yield higher productivity. In contrast, age negatively affects productivity but lacks significance, suggesting older farmers face reduced output due to diminished physical capacity. Similarly, household size shows no significant effect, potentially due to resource constraints for farming.

Regarding resilience, high resilience demonstrates a strong, significant positive impact (p=0.000), showing adaptive farmers achieve significantly higher productivity.

However, low and medium resilience are non-significant, though low resilience slightly hints at reduced productivity. These findings align with prior studies, emphasizing that high resilience enhances farmers' ability to adapt to challenges, resulting in better crop yields.

REFERENCES

Adebayo, A. A., *et al*. (2022). Yam production in Nigeria: Challenges and opportunities. Journal of Agricultural Science, 160(1-2), 1-9.

Adebayo, S. A., and Musa, F. K. (2020). "Yam Farming in the Era of Climate Change: Financial Challenges and Adaptation Strategies." *African Journal of Agricultural Research*, 18(6), 345-359.

Adepoju, A. O., and Salau, E. S. (2017) Explored the role of yam production in food security and livelihoods in Nigeria, emphasizing its significance in Benue State, the "Food Basket of the Nation."

Aiyelari, E. A., *et al*. (2022). Climate-resilient agriculture in Nigeria: A review. Sustainability, 14(11), 6411.

Etwire, P. M., *et al*. (2022). Impact of climate change on yam production in Ghana: A review. Journal of Agricultural Science and Technology, 22(3), 537-548.

Eze, S. C., and Okoli, I. C. (2023). "Cost-Benefit Analysis of Yam Production in Enugu State, Nigeria." *African Journal of Agricultural Research*, 18(5), 229-240.

Eze, S. O., and Onyeneke, R. U. (2023). "Assessing Profitability and Sustainability in Yam Production under Climate Change: A Case Study in Nigeria." *Journal of Sustainable Agriculture and Development*, 15(2), 89-104.

Soomiyol, T. S., and Fadairo, O. S. (2020). Challenges of agricultural production in Benue State: Impacts of climate change on yam farming. *Journal of Agricultural Development Studies, 8(2), 34–45.*

Ibrahim, M. H., and Adama, I. A. (2022). "Economic Analysis of Yam Production in North-Central Nigeria." *Journal of Agricultural and Environmental Economics*, 14(3), 221-234.

Mason, L. M., *et al*. (2021). Resilience and climate change adaptation among smallholder farmers in Africa. Journal of Rural Studies, 85, 245-253.

Ojewumi, M. E., *et al*. (2022). Climate change and yam productivity in West Africa: A review. Journal of Agricultural Science and Technology, 22(2), 349-362.

Ojo, M. A., Mohammed, U. S., and Adekunle, O. A. (2021). "Cost and Return Analysis of Yam Farmers in Benue State, Nigeria." *International Journal of Agricultural Economics*, 6(4), 134-146.

Olajide, O. S., and Akinbile, A. A. (2021). "Benefit-Cost Analysis of Yam Production in Southern Nigeria." *Nigerian Journal of Agricultural Economics*, 13(2), 112-125.

Table 1: Table of Resilience Indicators and Sub-Components

Indicators	Sub-components
Assets (AST)	Agricultural assets Non- Agricultural assets
Agricultural practices and technology (APT)	Fertilizers and chemical Technological inputs adopted in farming and marketing Agro forestry practices
Social Networks (SSN)	Agricultural associations Insurance Cooperative
Adaptive capacity (AC)	Diversification index Numbers of income sources Crop diversity Education Dependency ratio
Sensitivity	The degree to which the farmer is actually affected by climate-induce shock The degree to which the farmer has been affected by the shock in recent past

Table 2: Socio-economic characteristics of respondents

Variables	Frequency	Percentage (%)	Mean
Age			
36 – 45	62	25.10	46
46 – 65	61	24.70	
36 – 45	53	21.46	
18 – 25	39	15.79	
56 – 65	25	10.12	
> 65	7	2.83	
Total	**247**	**100.00**	
Gender			
Male	161	65.18	
Female	36	34.82	
Total	**247**	**100.00**	
Education			**Mean**
Primary Education	102	41.30	41
Secondary Education	64	25.91	
Non formal education	58	23.48	
Tertiary Education	23	9.31	
Marital status			
Married	102	53.45	
Divorced	64	25.35	
Widowed	58	15.35	
Single	23	5.85	
Total	**247**	**100.00**	
Household size			
6 – 10	98	39.68	
11 – 15	84	34.01	
1 – 5	51	20.65	
16 – 20	13	5.26	
Above	1	0.40	
Total	**247**	**100.00**	
Major occupation			
Farming	183	74.09	
Trading	41	16.60	
Artisans	13	5.20	
Civil service	9	3.01	
Others	1	1.06	
Total	**247**	**100.00**	
Farm size			**Mean**
7 – 6	67	27.13	7.6
2 – 4	63	25.51	
9 – 10	46	18.62	
5 – 6	45	18.22	
1 – 2	26	10.53	
Total	**247**	**100.00**	
Farm experience (years)			**Mean**
Above 20	67	27.13	23.8
11 - 15	66	26.72	
6 - 10	44	17.81	
16 - 20	38	15.38	
1- 5	32	12.96	
Total	**247**	**100.00**	

Source: Field Survey, 2019

Table 3: Factor analysis distribution by diversification

Variables	Eigenvalue	Difference	Proportion	Cumulative
Asset (AST)	0.30842	0.12415	1.5508	1.5508
Sensitivity	0.07693	0.08384	0.3868	2.8641
Adaptive capacity (AC)	-0.00691	0.03006	-0.0348	2.8293
Social Networks (SSN)	-0.03697	0.04992	-0.1859	2.6434
Agricultural practices and technology (APT)	-0.08688	0.15308	-0.4369	2.2066

LR test: independent vs. saturated: $\chi^2(21) = 24.35$
Prob > chi^2 = 0.2766 Approximately = 0.3
Source: Field survey, 2022

Table 4: Analysis of the Resilience index of the structural equation model

Variables	Coefficient	Std. Err.	z	P>|z|
Social Networks (SSN)	1.100392	0.1124657	1.73	0.078
Agricultural practices and technology (APT)	0.2515043	0.1124657	2.24	0.025
Asset	0.0388681	0.0125441	3.10	0.002
Agric. Practices & Technology	0.2285589	0.1085247	2.11	0.035
Sensitivity	0.0467692	0.1609785	0.29	0.772
Diagnostics				
Number of observed values = 247. Log likelihood = 152.3345				
LR test of model vs saturated: $chi^2(21) = 106020.80$				
Prob > chi^2 = 0.0000				

Source: Field Survey, 2022

Table 5: Distribution of respondent by estimation of the yield / output of the yam due to climate change

Variable (output)	Coef.	Std. Err.	t	P>|t|
Age	-.0812143	.0364202	-2.23	0.027
Gender	.0331302	.0455202	0.73	0.468
Marital status	.1093638	.0482264	2.27	0.024
Household size	-.0036529	.014034	-0.26	0.795
Education	.0137606	.0300248	0.46	0.647
Pry Occupation	.0777696	.0391479	1.99	0.048
Farm Size hectare	.0193911	.0076381	2.54	0.012
Year of farm experience	.0015298	.0042244	0.36	0.718
Association Membership	9990457	.5314408	1.88	0.062
Climate change awareness	.0202316	.0091388	2.21	0.028
Resilience status	**Coef.**	**Std. Err.**	**t**	**P>|t|**
Low resilience	-.1466157	.0862783	-1.70	0.091
Medium resilience	-.0572584	.0586711	-0.98	0.330
High resilience	12.83102	.251751	50.97	0.000

PHYTOCHEMICAL, PROXIMATE, AND PHYTONUTRIENT PROFILES OF SELECTED BOTANICALS FOR INSECT PEST CONTROL AND THEIR IMPACT ON CUCUMBER (CUCUMIS SATIVUS) FRUITS

Adeola Foluke Odewole[1], Timothy Abiodun Adebayo[1], Akinyemi Olufemi Ogunkeyede[2], OluwatimilehinAbosedeAfol[1]
[1]Department of Crop and Environmental Protection, LAUTECH, Ogbomoso, Nigeria
[2]Department of Environmental Management and Toxicology, Federal University of Petroleum Resources, Effurun, Delta State, Nigeria.
Corresponding author; email: aodewole@lautech.edu.ng; +234 803 049 8906

ABSTRACT

Plant secondary metabolites exhibit diverse biological activities, acting as repellents, feeding deterrents, and fumigants. Cucumber (*Cucumis sativus*), a widely consumed vegetable, faces insect pest infestations, affecting yield and quality. In this study, five plant extracts were applied as foliar sprays on cucumber plants for pest control: rhizomes of *Zingiber officinale*, seeds of *Piper guineense* and *Azadirachta indica*, and leaves of *Lantana camara* and *Tithonia diversifolia*. The quantitative and qualitative contents of phytochemicals present in the plant materials used were analyzed. On the other hand, the proximate and mineral compositions in the harvested fruits were analyzed using standard laboratory methods. Phytochemical analysis revealed alkaloids, saponins, tannins, terpenoids, phenolics, flavonoids, and steroids. Qualitative data revealed the presence of Alkaloids, Saponins, Tannins, Terpenoids, Phenolics, Flavonoids, and Steroids while quantitative data showed the quantity of each constituent in the plant materials used as +++: strongly present; ++: moderately present; +: fairly present; -: Absent. Proximate analysis showed that carbohydrate, moisture, protein, ash, and crude fiber contents varied between treatments with improved nutritional quality of botanically treated crops. Mineral composition, including Fe, Ca, K, and Na, was significantly higher in botanically treated fruits. These results confirm that the bioactive compounds identified in this study reinforce the pesticidal potential of these plants and their value as sources of natural insecticides botanical treatments enhance nutritional content and safety, aligning with previous studies that suggest such treatments positively impact pest management and crop quality. This suggests that botanicals not only serve as effective pest control agents.

Keywords: Botanical, Proximate, Cucumber, Minerals, Pest Control

INTRODUCTION

Cucumber (*Cucumis sativus*) belongs to the Cucurbitaceae family and is one of the most important vegetable crops cultivated in both tropical and subtropical regions (Weng, 2021). In 2020, global cucumber production reached 91.3 million metric tonnes (MMT), with China accounting for approximately 77% of the total production (70.3 MMT) -Weng, 2021. In West Africa, key cucumber-producing countries include Nigeria, Egypt, Ghana, and Niger. Egypt is the largest producer in Africa, producing around 488,723 tonnes, followed closely by Nigeria with 27,000 tonnes (Falade, 2002).

Cucumber fruits are highly beneficial to human health due to their abundant nutritional compounds, including vitamins A and C, minerals, flavonoids, and polyphenols (Septembre-Malaterre *et al*., 2018; Kostecka-Gugała *et al*., 2020). In addition to their nutritional benefits, cucumber has been shown to possess anti-carcinogenic, antioxidant, antibacterial properties, and low-calorie phytonutrients (Adesuyi *et al*., 2012; Kumaraswamy, 2016; Uthpala *et al.,* 2020). However, the high-water content and nutrient composition of cucumber make it highly susceptible to insect pest infestations, which can lead to rotting and make the fruits unfit for human consumption. Insects pose significant threats to cucumbers, especially during the fruiting stage. Pests such as *Phylotreta cruciferae* and *Epilachna vigintopunctata* attack the fruits, leading to reduced yield and quality (Odewole *et al*., 2018).

Various methods have been employed to manage insect infestations, but most conventional approaches are not environmentally friendly. The use of synthetic insecticides, for example, introduces problems such as food residues, soil and water pollution, and health risks (Srivastava and Joshi, 2021; Boudh and Singh, 2019). In contrast, plant-based insecticides offer an environmentally safe alternative. These botanicals are biodegradable, easy to produce, and do not leave harmful residues on crops (Odewole *et al* 2014;

Odewole *et al*., 2020). Several plant materials, including *Zingiber officinale* (ginger), *Azadirachta indica* (neem), *Piper guineense* (black pepper), *Lantana camara*, and *Tithonia diversifolia* have demonstrated effectiveness in controlling insect pests on cucumber (Odewole *et al*., 2020; Ranz, 2022; Ngegba *et al.*, 2022).

While botanicals have shown promise in pest control, the phytochemical and proximate compositions of treated cucumber fruits have not been empirically documented. This research aims to determine the quality and quantity of phytochemicals present in botanicals used for insect pest management, as well as to analyze the proximate and phytonutrient composition of cucumber fruits treated with these botanicals.

MATERIALS AND METHODS

Study Area

Field experiments were conducted during the cropping seasons of 2015 and 2016 at the Ladoke Akintola University of Technology (LAUTECH) Teaching and Research Farm, located in Ogbomoso, Nigeria (Latitude 08º 05'N, Longitude 04º 50'E, elevation 34.1 m). The region is characterized by a hot, humid tropical climate and falls within the Southern Guinea Savannah zone of Nigeria.

Collection of s**eeds of cucumber (Cucumis sativus) and** Plant Materials

Cucumber seed var. Point-set, used for this study were obtained from Agro Allied shop in Ogbomoso, Nigeria. The plant materials selected for insecticidal screening were mature leaves of *Lantana camara* and *Tithonia diversifolia*, as well as ripe seeds of *Azadirachta indica*. These were collected from the LAUTECH Teaching and Research Farm. Additionally, rhizomes of *Zingiber officinale* (ginger) and seeds of *Piper guineense* (black pepper) were obtained from local markets in Ilorin and Ogbomoso, respectively. The fresh leaves of *T. diversifolia*, *L. camara*, and *A. indica*, as well as dried seeds of *P. guineense* and *Z. officinale* rhizomes, were sourced from LAUTECH and the Waso market in Ogbomoso.

Plant Extract Preparation for Qualitative and Quantitative Analysis

The plant materials were first air-dried under a shaded environment and then ground into a fine powder using a steel-blade blender. The powdered samples were extracted using Soxhlet apparatus with acetone, petroleum ether, ethanol, and distilled water. Each solvent extract was concentrated by distilling off the solvent, followed by evaporation to dryness. The solvent-free extracts were then subjected to both qualitative and quantitative phytochemical analyses.

Source of cucumber fruits, plant application and application

The cucumber fruits used for the proximate analysis were harvested from experimental plots treated with botanical sprays after eight weeks (Odewole *et al.*, 2020). These plots were part of a study designed to evaluate the efficacy of botanical treatments in pest management under field conditions. The preparation and application of the plant extracts followed the method described by Odewole *et al.*, (2020).

Proximate Analysis

Proximate analysis was carried out following the AOAC (2005) method to determine the moisture, ash, crude fiber, lipid, and nitrogen content. Crude protein content was calculated by multiplying the nitrogen content by a factor of 6.25. All determinations were performed in triplicate, and the results were expressed as means of percentage values on a dry weight basis.

Phytochemical Screening

· **Qualitative Phytochemical Screening**: The presence of alkaloids, steroids, saponins, terpenoids, flavonoids, tannins, and glycosides in the plant extracts was tested using methods described by Sofowora (1993), AOAC (2005), Trease and Evans (2005), and Koruthu et al. (2011).

· **Quantitative Phytochemical Screening**: Quantitative estimations of specific phytochemicals were conducted using various methods. Terpenoid content was quantified using the oxidation method outlined by Harborne (1998). Tannin levels were determined spectrophotometrically according to the method of Gupta and Verma (2010). Flavonoid content was estimated using the ferric chloride colorimetric method (Mattila and Kumpulainen, 2002). Alkaloid determination was performed using the method described by Harborne (1998), while saponin content was quantified using the spectrometric technique outlined by Uematsu *et al*. (2000). The total phenol content of *Cucumis sativus* fruits was determined spectrophotometrically following the method of Wolfe *et al.* (2003). Cyanogenic glycoside content was assessed using the alkaline picrate method (Harborne, 1998). Steroid levels were measured according to the method described by Edeoga *et al.* (2005).

Statistical Analysis

Data from the phytochemical analysis were subjected to statistical evaluation using a completely randomized design (CRD). The results of qualitative and quantitative phytochemical screening were expressed as mean values ± standard error of the mean (SEM) for each treatment. Differences between treatments were analyzed using analysis of variance (ANOVA) at a significance level of $p \leq 0.05$. When significant differences were found, Duncan multiple range test was applied to compare the means.

RESULTS

The plant materials used in this study were sourced from the families Zingiberaceae, Asteraceae, Verbenaceae, Piperaceae, and Meliaceae (Table 1). The phytochemical screening of these botanicals revealed a variation in secondary metabolites across the different plant parts, including leaves, seeds, and rhizomes. Alkaloids were found to be strongly present in *Tithonia diversifolia*, *Lantana camara*, and *Azadirachta indica*, while they were moderately present in *Piper guineense* and only fairly present in *Zingiber officinale*. Saponins were moderately present in *T. diversifolia*, *P. guineense*, and *L. camara*, but were only fairly present in *Z. officinale* and *A. indica*. Tannins were strongly present in *T. diversifolia* and *L. camara*, moderately present in *P. guineense*, and fairly present in *A. indica* and *Z. officinale*. Cardiac glycosides were observed to be fairly present in *T. diversifolia* and *L. camara*, but absent in *Z. officinale*, *P. guineense*, and *A. indica*. Terpenoids were strongly present in *Z. officinale* and *T. diversifolia*, moderately present in *L. camara*, and fairly present in *P. guineense* and *A. indica*. Phenolics were strongly present in *Z. officinale*, *L. camara*, and *A. indica*, while they were fairly present in *T. diversifolia* and *P. guineense* (Table 2). Flavonoids were moderately present in *T. diversifolia* and *P. guineense*, but only fairly present in *Z. officinale* and *A. indica*. Steroids were moderately present in *T. diversifolia*, *P. guineense*, and *A. indica*, with a lower concentration in *Z. officinale* and *L. camara*.

Effect of Botanical and Synthetic Insecticide Treatments on the Proximate Composition of Cucumber Fruits"

Treated cucumber fruits show that **plant extracts** and **synthetic insecticide** both influenced moisture retention, with slight variation in values (91.60%, 92.5% and 92.0) between the two treatments (Figure 1). The carbohydrate content in cucumber fruits treated with botanicals ranged from 4.87% to 6.20%. All botanically treated samples exhibited higher carbohydrate values, ranging from 5.27% to 6.20%, compared to the synthetic insecticide-treated fruits (Karate), which had a carbohydrate content of 4.90%, and the control (unsprayed) at 4.87% (Figure 2). These results indicate that treatment with botanicals enhances carbohydrate accumulation in cucumber fruits. The ash content of treated cucumber fruits varied between 0.67% and 0.87%. The control group showed the lowest ash content (0.67%), whereas the botanically treated fruits exhibited higher values, ranging from 0.77% to 0.87% (Figure 3). This suggests that botanical treatments positively influence the ash content in cucumber fruits, which may be linked to increased mineral content. Crude fiber content in the cucumber fruits treated with botanicals ranged from 0.83% to 1.07%. This indicates that botanical treatments may also contribute to higher fiber content in the fruits.

The control group exhibited the lowest crude fiber content at 0.83%, while the botanicals used resulted in values ranging from 1.00% to 1.07%. Karate (synthetic insecticide) treated cucumber fruits showed a crude fiber content of 1.00% (Figure 4). Protein content in treated cucumber fruits ranged from 0.77% to 1.03%, with the highest protein levels observed in fruits treated with botanicals (1.00% - 1.03%). In contrast, Karate-treated fruits had the lowest protein content (Figure 5). Fat (ether) content in the cucumber fruits ranged from 0.10% to 0.20%, with Karate-treated fruits showing the lowest fat content. Figure 6 further illustrates that fruits treated with botanicals had higher fat content compared to Karate-treated fruits. Overall, the proximate composition of cucumber fruits treated with botanicals was higher than those in the control and Karate-treated groups, suggesting a positive impact of botanical treatments on the nutritional quality of the fruits.

Influence of Botanicals and Synthetic Insecticides on the Mineral Composition of Cucumber Fruits

Significant variations were observed in the mineral composition of cucumber fruits treated with botanicals and synthetic insecticides. Iron (Fe), the least abundant mineral in the samples, ranged from 1.20 to 1.47 mg/100kg. The control (unsprayed) had the lowest Fe content (1.27 mg/100kg), while cucumber fruits treated with botanicals showed higher levels, ranging from 1.20 to 1.47 mg/100kg (Figure 7). Potassium (K) content ranged from 6.33 to 8.00 mg/100kg. The synthetic insecticide-treated fruits contained 7.33 mg/100kg of potassium, while the control group exhibited 6.67 mg/100kg. Botanicals-treated cucumber fruits had the highest potassium content, ranging from 6.67 to 8.00 mg/100kg (Figure 8). Calcium (Ca) was the most abundant mineral, with concentrations ranging from 15.00 to 25.00 mg/100kg. Botanical treatments consistently resulted in higher calcium content (25.00–21.67 mg/100kg) compared to the synthetic and control treatments (Figure 9). Sodium (Na) content in the sprayed cucumber fruits ranged from 4.67 to 6.67 mg/100kg, with the control group showing the lowest Na content (4.67 mg/100kg). In contrast, the plant-treated fruits exhibited higher sodium levels, ranging from 5.67 to 6.67 mg/100kg (Figure 10). Overall, the results indicate that cucumber fruits treated with botanicals exhibited higher mineral content compared to those treated with synthetic insecticides and the control, highlighting the potential nutritional benefits of botanical treatments.

Quantitative Phytochemical Analysis of Tested Plant Materials

The seeds of *A. indica* exhibited the highest content of alkaloids and steroids, but the lowest levels of tannins (48.33) and flavonoids (86.66). *Z. officinale* rhizomes had significantly higher terpenoid content (1558.33) compared to the other plant materials, with the lowest values observed for steroids (81.66), saponins (68.33), and alkaloids (113.33). *T. diversifolia* leaves demonstrated the highest tannin content (1555.00) and cardiac glycosides (66.66) among the tested plants. *L. camara* leaves showed significantly higher glycoside (73.33) and phenol (74.23) contents than other plant materials. *P. guineense* seeds had the highest flavonoid (480.00) and saponin (375.00) content, with the lowest phenol content (31.96). Table 3 summarizes the phytochemical composition across all plant materials.

DISCUSSION

The qualitative phytochemical screening results from this study demonstrated that the detection of secondary metabolites in plant species depends on several factors, including extraction temperature, the solvent used, and the collection season. These findings align with previous studies, where variations in the phytochemical profiles of plant extracts were attributed to the solvent polarity and the extraction conditions used (Mugesh *et al.*, 2020; Adebayo *et al.,* 2021). All the plant species in this study showed variations in the abundance of alkaloids, saponins, tannins, terpenoids, phenolics, flavonoids, and steroids, regardless of the solvents used, highlighting the complex nature of phytochemical distribution in plants.

Quantitative phytochemical analysis revealed the presence of certain metabolites that were undetectable in the qualitative screening. For example, cardiac glycosides were absent in the qualitative analysis of *Z. officinale, P. guineense*, and *A. indica,* but were detected in the quantitative analysis. This observation supports the idea that more abundant metabolites may mask the presence of less abundant ones in qualitative screenings. Such discrepancies emphasize the importance of combining qualitative and quantitative approaches for a more complete phytochemical assessment (Ncube *et al*., 2012; Ademola *et al*., 2020).

Similar findings were reported by Babarinde (2012), who found that flavonoids were absent in the qualitative screening of A. *indica* but present in quantitative analysis.

Similarly, Dash *et al.* (2012) documented that phytochemical fractions of *Asteracantha longifolia* exhibited variations in the presence of aromatic amino acids, depending on the extraction method. These observations support the notion that the extraction method, including the solvent and temperature, significantly influences the detection of phytochemicals. The variability in the detection of secondary metabolites—represented as +++ (strongly present), ++ (moderately present), + (fairly present), and - (absent)—is likely due to differences in solvent polarity and extraction protocols. This has been corroborated by studies such as that of Vasantha *et al.* (2012), who evaluated the phytochemical profiles of Kedrostis foetidisima using different solvents (hexane, petroleum ether, chloroform, acetone, and methanol).

Their results indicated that the solvent polarity affected the detection of specific metabolites, with flavonoids and steroids being present in hexane and petroleum ether extracts, while other metabolites such as flavonoids, tannins, triterpenoids, phenols, steroids, and cardiac glycosides were primarily detected in chloroform, methanol, and acetone extracts. This emphasizes that a combination of solvents should be employed to ensure a comprehensive phytochemical analysis (Wang *et al.*, 2015).

Furthermore, the bioactive secondary metabolites identified in this study—such as alkaloids, flavonoids, steroids, tannins, saponins, terpenoids, and cardiac glycosides—are widely recognized for their therapeutic potential. These compounds have been extensively studied for their pharmacological activities, including antimicrobial, anti-inflammatory, antioxidant, and anticancer properties (Shan *et al.,* 2016; Tan *et al.*, 2018). Their presence in plant extracts suggests that these species may serve as valuable sources for drug discovery, particularly in the development of natural insecticides or other therapeutic agents.

For example, alkaloids and flavonoids, which were abundant in most of the tested species, are well known for their insecticidal and antimicrobial activities (Hossain *et al.*, 2020; Mamedov *et al.*, 2019). Steroids, on the other hand, have been implicated in anti-inflammatory and cytotoxic properties (Zhao et al., 2019). These findings support the notion that the medicinal properties of botanicals are often attributed to the synergistic effects of their diverse phytochemical profiles.

In addition to their therapeutic potential, the presence of steroidal compounds is particularly noteworthy, as these compounds are used in the synthesis of pharmaceutical steroids, including hormones such as estrogens and androgens (Santos *et al.,* 2017). Steroidal compounds are of immense interest in modern pharmacology due to their biological significance and their role in the production of numerous drugs used in treating hormone-related conditions (Bhatnagar *et al*., 2020). Therefore, the detection of steroidal compounds in some of the tested plants highlights their potential for further pharmaceutical exploration.

The results of qualitative phytochemical screening indicate that the detection of secondary metabolites in plant species is influenced by various factors, such as the extraction method, solvent type, temperature, and the season in which the plants were collected. All plant species tested demonstrated variations in the abundance of alkaloids, saponins, tannins, terpenoids, phenolics, flavonoids, and steroids, irrespective of the solvent used for extraction. Similar findings have been reported in various studies, emphasizing the complexity and variability in phytochemical extraction methods (Santos *et al.*, 2021; Ayoola *et al.*, 2020).

The quantitative phytochemical analysis revealed that secondary metabolites not detected in the qualitative screening were quantified successfully. For instance, cardiac glycosides, which were not detected in *Zingiber officinale*, *Piper guineense*, and *Azadirachta indica* during qualitative screening, were present in the quantitative analysis. This highlights that certain secondary metabolites may be masked by more abundant compounds during qualitative testing, a phenomenon also observed in earlier studies (Mugesh & Bansal, 2020; Amri *et al.*, 2021). These findings suggest that qualitative phytochemical analysis alone may not provide a complete picture of a plant's phytochemical profile. It is therefore recommended that quantitative analyses be performed to confirm the presence and abundance of specific metabolites, particularly when developing phytochemical-based insecticidal treatments.

This study supports earlier research by Babarinde (2012), who observed the absence of flavonoids in the qualitative screening of *Azadirachta indica* but their presence in quantitative analysis. Similar results were reported by Dash et al. (2012), who found discrepancies between qualitative and quantitative screenings of *Asteracantha longifolia* depending on the fraction of solvent used. These observations underscore the need for careful selection of extraction methods and solvents in phytochemical studies.

Additionally, the variation observed in the secondary metabolites (denoted by +++ strongly present, ++ moderately present, + fairly present, and – absent) could be attributed to the solvent polarity and extraction methods employed. Previous research by Vasantha *et al*. (2012) highlighted that different solvents, such as hexane, petroleum ether, chloroform, acetone, and methanol, yield different phytochemical profiles from the same plant species. This suggests that a single solvent may not be sufficient to extract all valuable bioactive compounds, and a combination of solvents might be necessary for comprehensive phytochemical screening.

Phytochemical studies of botanicals have long demonstrated the presence of bioactive compounds such as alkaloids, flavonoids, steroids, tannins, saponins, terpenoids, and glycosides (Omotayo & Borokini, 2012; Shan & Yao, 2016). These compounds are recognized for their insecticidal, antimicrobial, and therapeutic properties, and they are considered essential precursors in the synthesis of pharmaceutical and pesticide agents (Ahad *et al.*, 2021; Yang *et al*., 2019). In this study, all the plant extracts tested exhibited significant concentrations of these compounds, confirming their potential as natural insecticides and their relevance in drug discovery. It is important to note that some of the plants tested contained steroidal compounds, which are of considerable interest in pharmaceutical research due to their connection with sex hormones and other medicinal uses (Okwu, 2001; Odukoya *et al.*, 2020). Botanical and synthetic insecticide treatments both influenced moisture retention, with values ranging from 91.60% to 92.50%. This reflects the findings by *Oduor et al. (2019)*, who noted that plant-based treatments can help preserve moisture content in treated crops. Higher carbohydrate levels in botanically treated cucumber fruits (5.27–6.20%) compared to synthetic insecticide-treated and control groups align with research by *Ibrahim et al. (2018),* confirming that botanical insecticides can promote carbohydrate accumulation. Also, the increase in ash content (0.77–0.87%) with botanical treatments compared to the control (0.67%) has been similarly observed in *Aiyelaagbe and Adetuyi (2014),* who reported improved mineral retention in fruits treated with botanicals. Higher crude fiber content in botanically treated fruits (1.00–1.07%) corresponds with findings from *Adeyemi and Olayinka (2015),* who demonstrated enhanced fiber content in crops treated with plant extracts. Increased protein levels in botanically treated fruits (1.00–1.03%) this reflects similar results observed by *Akinnifesi et al. (2016),* showing that botanical treatments can enhance protein content in crops. Fat content in botanically treated fruits (0.10–0.20%) was higher when compared to synthetic insecticide-treated fruits was confirmed by *Omoloye and Adebayo (2017),* who reported improved fat accumulation in botanically treated crops.

Phytonutrient analysis reveals that botanical treatments significantly improved the mineral composition of cucumber fruits, especially in terms of potassium, calcium, and sodium, compared to synthetic insecticides and control treatments. This is in line with Ojo *et al*., (2020). This suggests that botanicals not only serve as effective pest control agents but also offer potential nutritional benefits by enhancing mineral content in treated fruits.

CONCLUSION

In conclusion, the results of this study highlight the significant variation in the phytochemical composition of the tested plant species, which could be attributed to the choice of extraction methods and solvents. While qualitative phytochemical analysis provides useful preliminary information, it is essential to complement it with quantitative methods to fully understand the phytochemical potential of botanicals.

Furthermore, the bioactive compounds identified in this study—including alkaloids, flavonoids, saponins, terpenoids, and steroids—reinforce the pesticidal potential of these plants and their value as sources of natural insecticides. This research aligns with previous studies (Odewole *et al* 2020; Mugesh & Bansal, 2020) and provides strong evidence that botanicals can offer viable alternatives to synthetic insecticides, especially when extracted using appropriate techniques. In addition, botanical treatments improve the nutritional quality of treated crops by enhancing their carbohydrate, ash, crude fiber, protein, and fat content. This suggests that botanicals not only serve as effective pest control agents.

REFERENCES

Adebayo, O. O., Omotayo, E. O., & Olayinka, A. I. (2021). Phytochemical screening and pharmacological potentials of medicinal plants. *Journal of Phytochemistry, 33*(6), 97-110.

Ademola, I. A., Adefolalu, A. O., & Adepoju, M. (2020). Phytochemical screening and antimicrobial activity of medicinal plants. *International Journal of Phytochemistry and Pharmacology, 12*(4), 234-243.

Adesuyi A. O., Elumm, I. K., Adaramola, F., B.And Nwokocha, A. G.M. (2012) Nutritional and Phytochemical screening of Garcinia kola. Advances .*Journal Food Science Technology*. 4(1):9-14.

Adeyemi, S. A., & Olayinka, O. S. (2015). Effects of botanical insecticides on the nutritional content of cucumbers. *Journal of Natural Products and Plant Resources, 5(3), 42-49.*

Ahad, B., Shahri, W., Rasool, H., Reshi, Z. A., Rasool, S., & Hussain, T. (2021). Medicinal plants and herbal drugs: An overview. *Medicinal and Aromatic Plants: Healthcare and Industrial Applications*, 1-40.

Aiyelaagbe, O. O., & Adetuyi, F. C. (2014). Mineral composition of botanically treated vegetables. *Journal of Agricultural and Food Chemistry*, 62(19), 456-462.

Akinnifesi, F. K., Ajayi, O. C., & Gudeta, S. (2016). Botanical pesticides and protein enhancement in horticultural crops. *Journal of Agricultural Science*, 9(5), 97-105.

Amri, A., Boudhrioua, N., & Ben Amara, I. (2021). Phytochemical variability in plants from different geographical regions. *Journal of Ethnopharmacology, 271*, 113697.

AOAC (2005) (Association of Official Analytical Chemists) Official Methods of Analysis.18th edition, Washington DC. VA:432-440.

Ayoola, G. A., Lawal, M. A., & Babalola, O. O. (2020). Phytochemical analysis of plant extracts and their applications. *Journal of Phytochemistry Research, 7*(3), 159-173.

Babarinde S.A. (2012) Evaluation of insecticidal Activity of some Botanicals against the Cowpea Bruchid (*Callosobruchus maculatus*) Fabricius (Coleoptera: Bruchidae). Ph.D Thesis submitted to Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

Babarinde, I. O. (2012). Phytochemical screening of *Azadirachta indica* for bioactive compounds. *International Journal of Biodiversity, 2012*, 1-6.

Boudh, S., & Singh, J. S. (2019). Pesticide contamination: environmental problems and remediation strategies. *Emerging and eco-friendly approaches for waste management*, 245-269.

Dash, A.K.,Dutla, G.K., Sahoo, G., Mishra, S. K., Sadar, K.K and Bisoi P.C (2012). Phytochemical screening, mineral and proximate composition of *Asterachha longifolia* leaf extracts a quality livestock feed. *Journal Medical Plant Research* 6 (21):3786-3792.

Dash, M., Swain, M., & Panda, A. (2012). Phytochemical analysis of *Asteracantha longifolia* hot water extracts: A comparison of methanolic and aqueous fractions. *International Journal of Pharmaceutical Sciences and Research, 3*(6), 1881-1885.

Dhiman K., Gupta A., Sharma N.S., Goyal A., (2012) A Review on the Medicinally Important Plants of the Family Cucurbitaceae.*Asian Journal of Clinical Nutrition*, 4(1): 16-26

Egunjobi, J. K.(1969) Some common weeds of West Africa, Bulletin of Research Division Ministry of Agriculture, Natural Resources Western State. Ibadan, Nigeria.

Ejele AE, Akujobi CO (2011). Effects of secondary metabolites of Garcinia kola on the microbial spoilage of *Cajanuscajan* extract. *International Journal of Tropical Agricultural Food Systems* 5(1):8-14.

Falade, M. J. (2002). Investigation on the entomological and benefitial insect pests associated with cucumber (*cucumis sativus*) production in South Western Nigeria. *Journal of entomology and Zoology Studies*, *10*(2), 57-61.

Godber J.S.(1990) Nutrient bioavailability in humans and experimental animals. *Journal of.food quality.* 13:21-26.

Haruna, S.S., Ahmed, O. and Abdullahi, S.K. (2016) Phytochemical, Proximate and Mineral Analysis of *Solanumaethiopicum* L. Fruit. *International Journal of Chemistry, Materials and Environment Research,* 3, 8-13

Hossain, M. A., & Saha, P. (2020). Antimicrobial and insecticidal properties of alkaloids and flavonoids from medicinal plants. *Journal of Medicinal Plants, 27*(4), 215-232.

Ibegbulem CO, Ayalogu EO, Uzohu MN (2003). Phytochemical, anti-nutritional contents and hepatotoxicity of zobo (Hibiscus sabdariffa) drink. *Journal of Agriculture and Food Science* 1(1):335-339.

Ibrahim, S. M., Abdalla, A. A., & Hassan, H. A. (2018). Influence of botanical insecticides on the biochemical composition of vegetables. *African Journal of Agricultural Research*, 13(7), 523-529.

Jitendra P., Kumar G.S., Deviprasad S.P., Shamimqureshi M.D. (2011). Phytochemical and anthelmintic evaluation of *Lantana camara*(L) var aculeate leaves against *Pheretimapo sthuma*. *Journal of Global Trends in Pharmaceutical Sciences* 2(1):11-20.

Kostecka-Gugała, A., Kruczek, M., Ledwożyw-Smoleń, I., & Kaszycki, P. (2020). Antioxidants and health-beneficial nutrients in fruits of eighteen Cucurbita cultivars: Analysis of diversity and dietary implications. *Molecules*, *25*(8), 179.

Kubmarawa D, Ajoku GA, Enwerem NM, Okorie DA (2007) Preliminary phytochemical and antimicrobial screening of 50 medicinal plants from Nigeria, *Afr. J. Biotechnol*. 6(14): 1690-1696.

Kumaraswamy L. A (2016) comparativestudy on antioxidant activities of three cultivars of *Cucumis sativas* (Linn). *International Journal of Research in Biotechnology and Biochemistry (16) (PDF) Health Beneficial Effects of Cucumber*. Available from: https://www.researchgate.net/publication/351580539_Health_Beneficial_Effects_of_Cucumber [accessed May 31 2023].

Liu T.X, Sparks A N, Chen W (2003). Toxicity, persistence and efficacy of indoxacarb and two other insecticides on *Plutella xylostella* (Lepidoptera :Plutellidae) immature in cabbage. *International Journal Pest Management.* 49:235-241.

Liu, R.H. (2004) Potential Synergy of Phytochemicals in Cancer Prevention: Mechanism of Action. *Journal of Nutrition*, 134, 3479S-3485S.

Lower, R. L. and Edward, M.D.(1986). Cucumber breeding, In: M.J. Basset, Edo Breeding Vegetables crop, AVI Publishing Co; pp 173-203.

Loy, J.B., (1990) Hull-less Seeded Pumpkin: A New Edible Snackseed Crop. In Janick, J. and Simon, J.E. (Eds) (1990) Advance in New Crops. Timber Press Portland.

Mamedov, F. R., & Gulzar, T. (2019). A review on natural flavonoids: Phytochemistry, pharmacological activities and therapeutic perspectives. *International Journal of Molecular Sciences, 20*(23), 5757.

Mei, H., Kwadwo, N.O., Nana, D.B. and Tao, S.U. (2021) *Solanum aethiopicum* L. The Nutrient Rich Vegetable Crop with Great Economic, *Genetic Biodiversity and Pharmaceutical Potential. Horticulture,* 7, 126-143.

Messien, C.M., (1998) The tropical vegetable garden. Principles for improvement and increasing production with application to vegetable Macmillian Publishers, London. UK. Pp. 218.

Mintah BK, Eliason AE, Nsiah M, Baah EM, Hagan E, Ofosu DB. (2012)Consumption of fruits among students: A case of Public University in Ghana. *African Journal of Food, Agricul-ture, Nutrition and Development.*;12(2):5979-5993.

Mugesh, G., & Bansal, A. (2020). Phytochemical investigations of medicinal plants: Advances and current trends. *Phytomedicine, 65*, 153115.

Ncube, N. S., & Aremu, A. O. (2012). Phytochemical analysis and antimicrobial activity of medicinal plants. *International Journal of Phytotherapy, 2*(1), 20-32.

Ngegba, P. M., Cui, G., Khalid, M. Z., & Zhong, G. (2022). Use of botanical pesticides in agriculture as an alternative to synthetic pesticides. *Agriculture*, *12*(5), 600.

Odewole A. F. Adebayo T. A. Babarinde S. A. &Awolokun G.S. (2020) Archives of Phytopathology and plant protection insecticidal activity of aqueous indigenous plant extracts against insect pests associated with cucumber (*Cucumis* *sativus* L.) in Southern Guinea Savannah Zone of Nigeria. *Archives of Phytopathology and Plant Protection* 1-17.

Odewole A. F, Adebayo T. A, Olaniran O. A., Akanbi W. B. & Onifade O. O. (2018) Preliminary study of insect pests of cucumber (*Cucumis sativus* L.) in Ogbomoso Agricultural Zone of Nigeria *Acta fytotechn zootechn*, 21(3): 108–112.

Odewole, A. F., Alao, F. O., Agboola, A. A., & Adedapo, B. F. (2014). Comparative efficacy of plant extracts with synthetic against insect pests of okra (*Abelmoschus esculentus* L. Monech). *International Letters of Natural Sciences*, (14).

Odukoya, O. A., Adeyemi, A. T., & Afolabi, A. I. (2020). Phytochemical and pharmacological analysis of steroidal compounds in medicinal plants. *Medicinal Chemistry Research, 29*(1), 56-67.

Oduor, C. O., Kiprop, E., & Mwaniki, S. (2019). Effect of plant extracts on the postharvest quality and shelf life of vegetables. *Journal of Horticultural Science*, 7(2), 89-95.

Oguntona T. (1998) In: Osagie, A. U. & Eka, O. U. (Eds). Nutritional quality of plant food Nigeria Post Harvest Research Unit. 133.

Ojo, J. A., Adekunle, P. A., & Akinpelu, A. O. (2020). Effect of botanical insecticides on the mineral composition of cucumber (*Cucumis sativus* L.) fruits. *African Journal of Agricultural Science,* 12(4), 89-98.

Okwu D. E (2005). Phytochemicals, vitamins and mineral contents of two Nigerian medicinal plants. *International Journal of Molecular Medicine and Advanced Science* 1(14):372-381.

Okwu, D. E. (2001) Evaluation of the chemical composition of indigenous spices and flavouring agents. *Global Journal of Pure Applied Science*, 7 (3): 455-459 (2001).

Omoloye, A. O., & Adebayo, S. A. (2017). Evaluation of fat content in cucumbers treated with plant-based insecticides. *International Journal of Horticultural Science*, 14(2), 78-85.

Omotayo, E. O., & Borokini, T. I. (2012). Phytochemistry and pharmacological properties of plant species with therapeutic potential. *Pharmacognosy Reviews, 6*(12), 1-16. https://doi.org/10.4103/0973-7847.10093

Ranz, R. E. R. (Ed.). (2022). *Insecticides: Impact and Benefits of Its Use for Humanity*. BoD–Books on Demand. Pp. 1-30.

Robinson, R.W., Decker,N. and Walter, P. 1997. Cucurbit. New York: CAB International.

Santos, A. A., & Silva, C. T. (2021). Recent advances in phytochemical characterization of bioactive compounds in medicinal plants. *Journal of Natural Products, 84*(8), 1942-1955. https://doi.org/10.1021/npd.2021.01.001

Santos, R. A., & Silva, A. R. (2017). Steroid compounds from medicinal plants. *Phytochemistry Reviews, 16*(2), 245-262. https://doi.org/10.1007/s11101-017-9474-4

Saxena M , Saxena J and Khare S (2012) A brief review on: Therapeutical values of *Lantana camara* plant. *International Journal of Pharmacy & life sciences* 151-154.

Septembre-Malaterre, A., Remize, F., &Poucheret, P. (2018). Fruits and vegetables, as a source of nutritional compounds and phytochemicals: Changes in bioactive compounds during lactic fermentation. *Food Research International*, *104*, 86-99

Shan, B., & Yao, C. (2016). Antimicrobial properties of plant flavonoids and their derivatives: A review. *Journal of Ethnopharmacology, 192*, 69-79.

Srivastava, R. M., &Joshih, S. (2021). Integrated pest management for cucurbits in cucumber (Cucumis sativus L.). *Cucumber Economic Values and Its Cultivation and Breeding*, Chapter 10, pp. 129-139.

Tan, H. S., & Zhang, L. (2018). Medicinal phytochemicals in plants: Their effects in diseases, and the scope of application. *Phytotherapy Research, 32*(3), 405-419.

Thoa D. K.(1998)"Cucumber Seed Multiplication and Characterization," AVRDC/ARC Training Thailand.

USDA (2009) National Nutrient Data base for standard Refrence

Uthpala T. G. G., Marapana, R. A. U. J., Lakmini K. P. C. , Wettimuny D. C. , (2020) Nutritional Bioactive Compounds and Health Benefits of Fresh and Processed Cucumber (*Cucumis Sativus* L.) *Sumerianz Journal of Biotechnology*, 2020, Vol. 3, No. 9, pp. 75-82

Vasantha, K., Priyavardhini, S., Tresina S.P. and Mohan, V.R. (2012). Phytochemical analysis and antibacterial activity of *Kedrostis feetidissima*. Bioscience Discovery 3(1):6-16

Wang, L., & Zhang, Y. (2015). Effect of solvent polarity on the extraction of phytochemicals from medicinal plants. *Journal of Agricultural and Food Chemistry, 63*(35), 7767-7775.

Waziri M. and Saleh I. A. (2015) Proximate Analysis and Phytochemical Screening of *Psidiumguajava* (Guava) and *Cucumissativus* (Cucumber) Grown in GashuaFadama Area of Yobe State, Nigeria *International Research Journal of Pure & Applied Chemistry* 6(2): 77-83.

Weng, Y. (2021). Cucumis sativus chromosome evolution, domestication, and genetic diversity: Implications for cucumber breeding. *Plant Breeding Reviews*, *44*, 79-111.

Yang, X., & Zhang, Q. (2019). Pharmacological properties and applications of terpenoids and flavonoids. *Journal of Phytochemistry and Pharmacology, 21*(2), 230-243.

Zhao, L., & Zhang, J. (2019). Steroidal compounds and their pharmacological applications. *Bioorganic & Medicinal Chemistry, 27*(10), 1455-1469.

Table1: Profile of Botanicals Used for the Control of Cucumber Insect Pests

Botanical Name	Common Name	Family Name	Part Used
Zingiber officinale	Ginger	Zingiberaceae	Rhizome
Tithonia diversifolia	Mexican Sunflower	Asteraceae	Leaf
Piper guineense	West African Black Pepper	Piperaceae	Seed
Lantana camara	Wild Sedge	Verbenaceae	Leaf
Azadirachta indica	Neem	Meliaceae	Leaf

Table 2: Qualitative Phytochemical Analysis of Tested Plant Species

Constituents	*Z. officinale*	*T. diversifolia*	*P. guineense*	*L. camara*	*A. indica*
Alkaloids	+	+++	++	+++	+++
Saponins	+	++	++	++	+
Tannins	+	+++	++	+++	+
Cardiac Glycosides	-	+	-	+	-
Terpenoids	+++	+++	+	++	+
Phenolics	+++	++	+	+++	+++
Flavonoids	+	++	++	++	+
Steroids	+	++	++	+	++

Key: +++ = Strongly Present; ++ = Moderately Present; += Fairly Present; =Absent

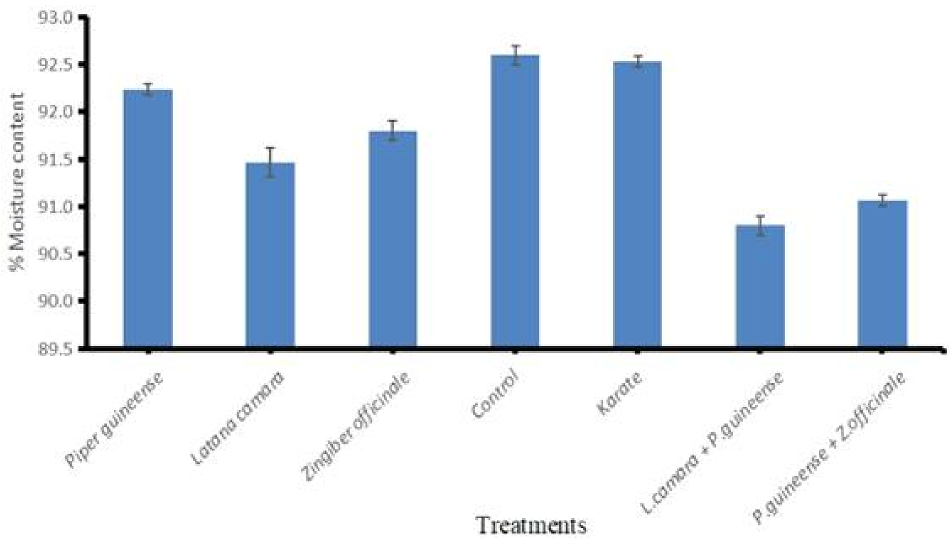

Figure 1: Composition of Moisture content in cucumber treated with plant extracts and synthetic insecticide

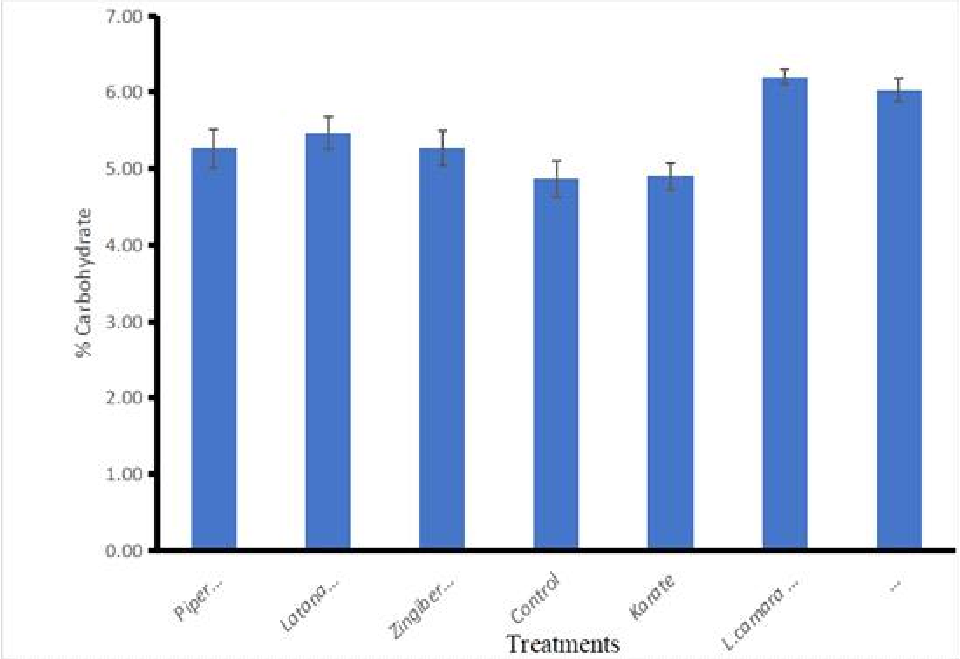

Figure 2: Composition of carbohydrate content in cucumber treated with plant extracts and synthetic insecticide

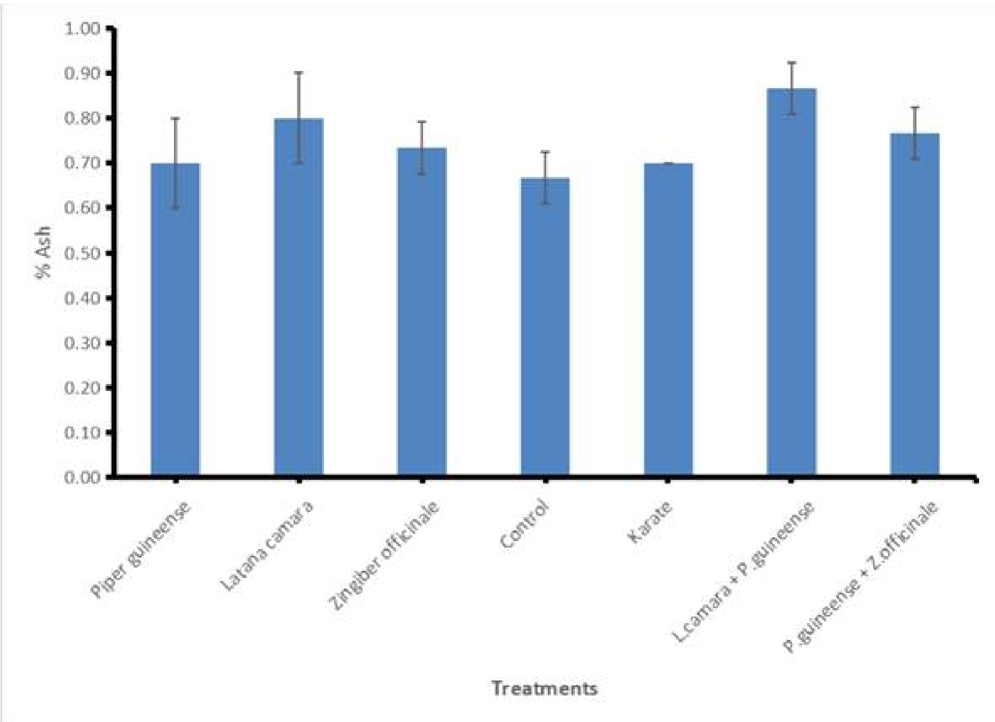

Figure 3: Composition of Ash content in cucumber treated with plant extracts and synthetic insecticide

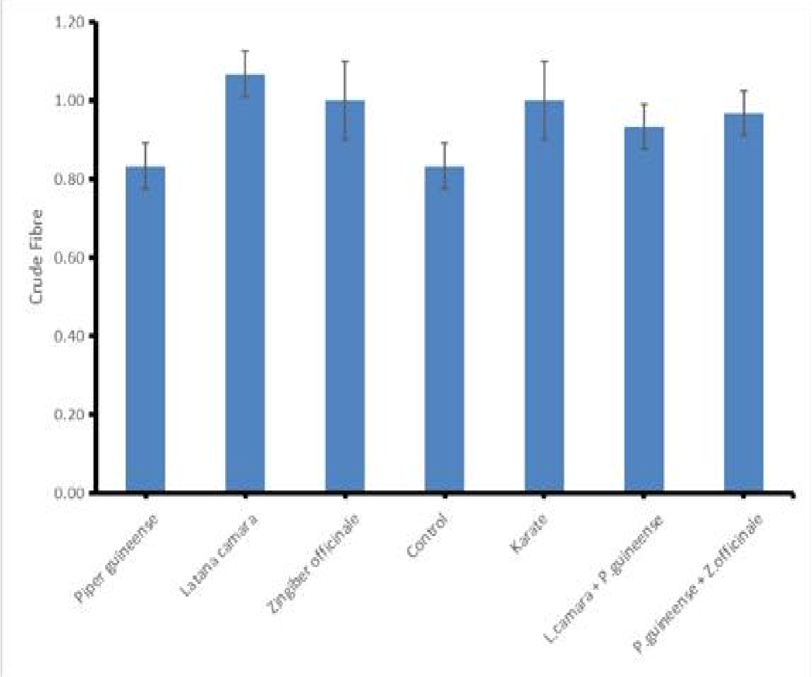

Figure 4: Composition of Crude fiber content in cucumber treated with plant extracts and synthetic insecticide

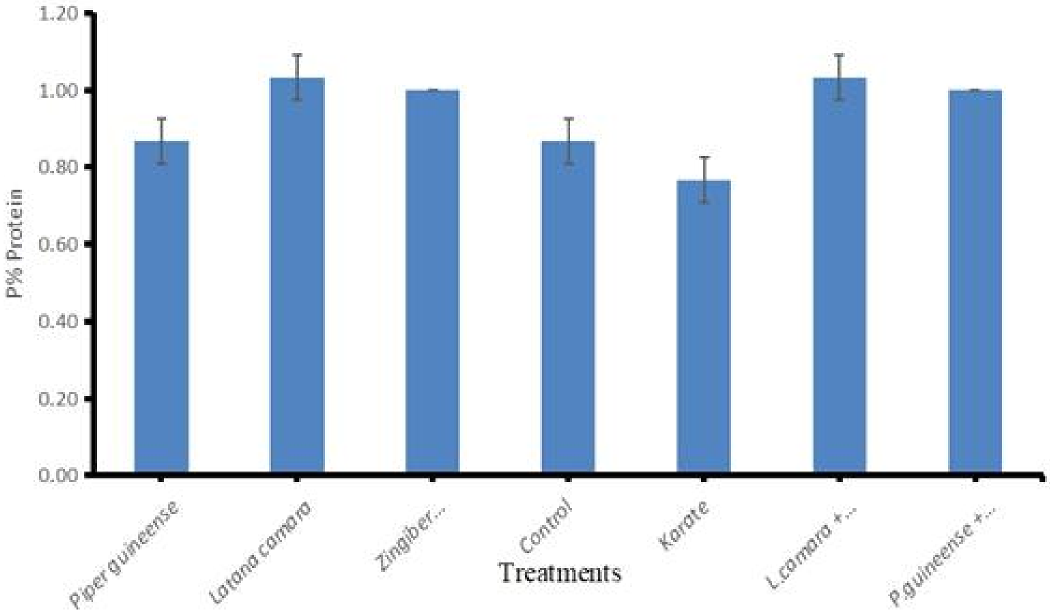

Figure 5: Composition of Protein content in cucumber treated with plant extracts and synthetic insecticide

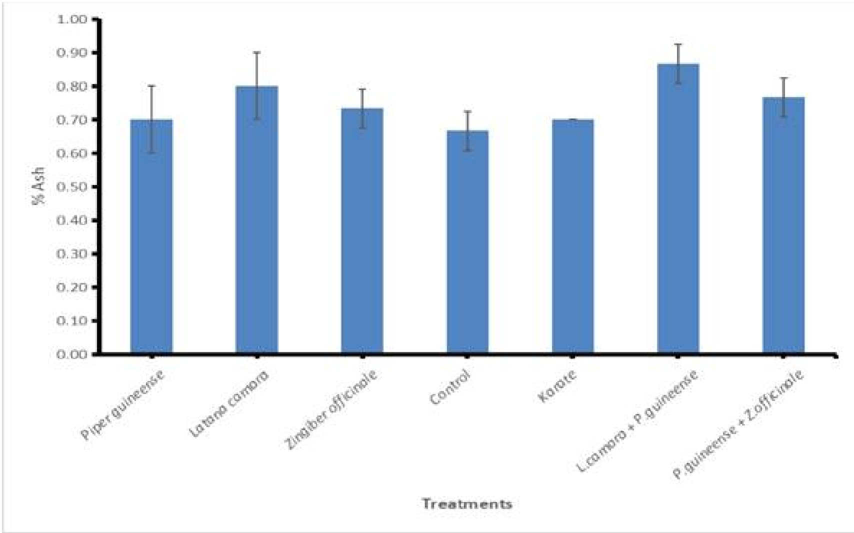

Figure 6: Composition of Ash content in cucumber treated with plant extracts and synthetic insecticide

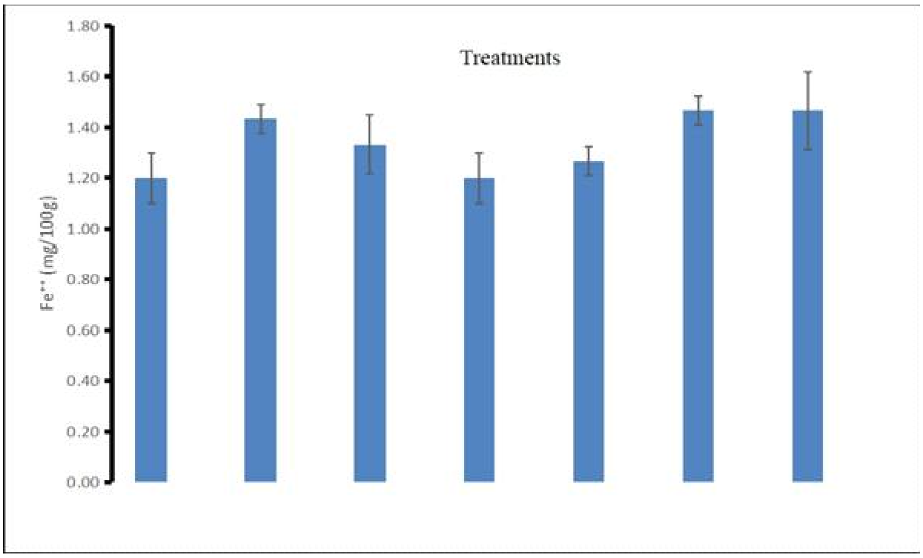

Figure 7: Phytonutrient's composition of Fe^{++} in cucumber treated with plant extracts and synthetic insecticide

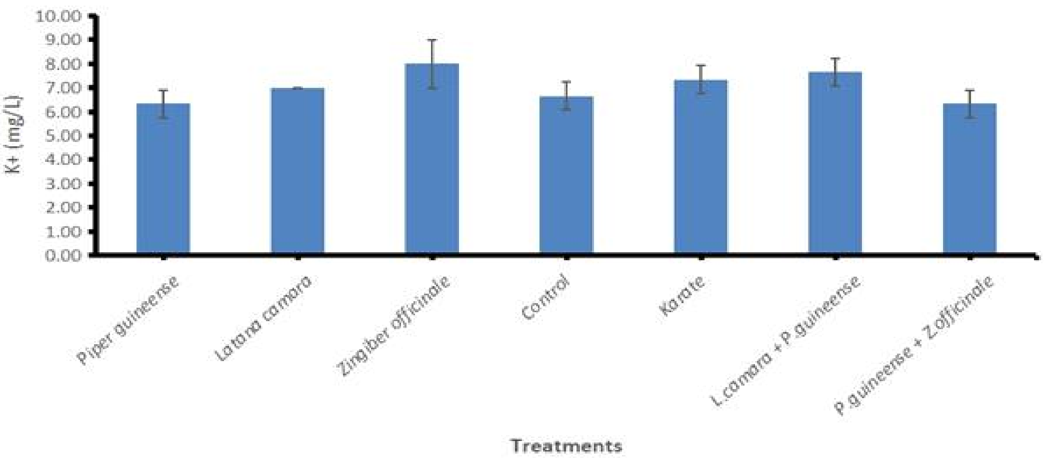

Figure8: Phytonutrients composition of K^{+} in cucumber treated with plant extracts and synthetic insecticide

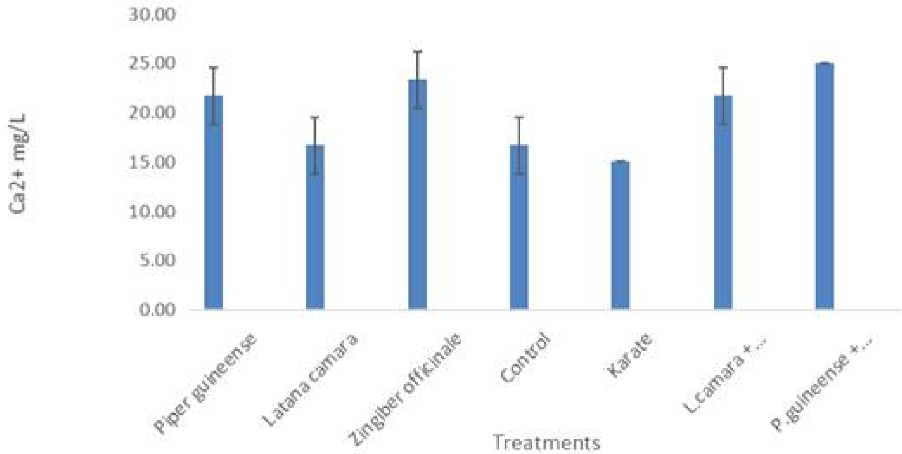

Figure 9: Phytonutrient compositiona of Ca^{2+} in cucumber treated with plant extracts and synthetic insecticide

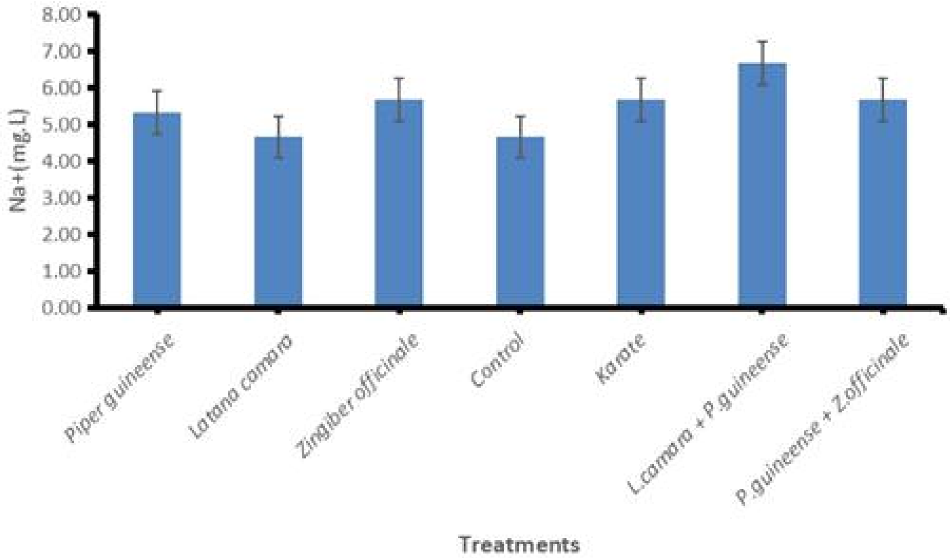

Figure 10: Phytonutrient composition of Na^{+} in cucumber treated with plant extracts and synthetic insecticide

Table 3: Quantitative Phytochemical Screening Analysis of Tested Plant Species

Constituent (%)	*Z. officinale* (Rhizomes)	*A. indica* (Seeds)	*L. camara* (Leaves)	*T. diversifolia* (Leaves)	*P. guineense* (Seeds)
Alkaloids	113.33e	1553.33a	1278.33b	970.00c	325.00d
Saponins	68.33e	120.00d	186.67c	220.00b	375.00a
Tannins	113.33d	48.33e	1470.00b	1555.00a	231.67c
Glycosides	26.66b	26.66b	73.33a	66.66a	13.33c
Terpenoids	1558.33a	161.67d	528.33c	1243.33b	151.67d
Phenols	69.46b	65.53c	74.23a	48.50d	31.96e
Flavonoids	195.00d	86.66e	278.33c	363.33c	480.00a
Steroids	81.66e	281.66a	133.33b	228.33b	185.00c

Means with the same letter (a, b, c, d, e) in each column are not significantly different at the 5% probability level using DMRT (Duncan's Multiple Range Test)

International Journal of Organic agricultural Research & Development
Volume 19 (4) (2024)

ANALYSIS OF GENDER ROLE IN MAIZE PRODUCTION IN IBARAPA EAST LOCAL GOVERNMENT AREA OF OYO STATE

[1] Oladiran S. S. [2] Ishie D. N. [2] Ogunleye T. B, Ayodeji I. O, and Adewole O. E
[1] Department of Agricultural Extension and Management, Federal College of Agriculture, Ibadan Oyo State, Nigeria
[2] Department of Agribusiness Management, Federal College of Animal Health and Production Technology, Ibadan Oyo State, Nigeria
Corresponding author's e-mail / Phone number: foodforthought2000@yahoo.com

ABSTRACT

The study determined the analysis of gender roles in maize production in Ibarapa East Local Government Area, Oyo State, Nigeria. Primary data obtained using structured questionnaire were collected from a sample of 120 farm families, five wards out often existing wards in the Local government area were selected. Data were sampled through multistage sampling techniques. Descriptive statistics such as percentage, mean scores and standard deviation were used for data analysis. The study revealed average age 44 years for female farmers and 40 years for the male farmers. Above average female respondents (66.7%) and male (65.0%) farmers were married. Female farmers had average household size of about 7 members while the male counterpart had household size of 6 members. Male farmers had more farming experience 13 years and cultivate more farmland 8acres than the female farmers 5acres.Women carried out most of the maize production activities and undertook general maize processing (92.3%) except for land clearing (70.1%), ridge making (58.7%), earthen in gup (83.7%), and storing of maize (79.2%). The study recommended that female maize farmers' associations should develop a high level of consciousness on policy issues or difference that affect them. Both male and female farmers should be encouraged to for m and join farming organizations or cooperatives. This will enable them serve as pressure group to ensure implementation of some strategies and policies by the government.

Keywords: Gender Analysis, Maize farmers production

INTRODUCTION

Agriculture is a prestigious, noble, and lucrative profession that should not be left in the hands of novices and the elderly using crude implements. Traditionally, farming has relied heavily on manual labor, with farmers using their physical strength and expending considerable energy (). However, with the advancement of agricultural technology, it is crucial for the government to invest in farm mechanization, provide access to credit, and establish modern storage facilities, among other improvements.

The topic of empowering in rural communities through increased incomes has garnered scholarly attention due to its vital role in enhancing and sustaining livelihoods, especially for women in agriculture (Yidana JA, Osei Kwarleng, 2013). Women represent a significant portion of the work force in many developing countries, comprising 43% of the global agricultural labor force (CreswellJ, 2003).

Various studies indicated that women's involvement in agriculture is driven by numerous factors, including the potential for income generation, secure employment, and meeting the livelihood needs of those engaged in agriculture.

The contributions of women significantly impact agricultural output and processing. The Food and Agricultural Organization (FAO) estimates that women produce 60–80% of the food consumed in most Sub-Saharan African nations and contribute to half of the world's total food supply today. Family food security is largely dependent on the work and creativity of women who grow, process, and prepared the food. In many developing nations, rural women work up to 16 hours a day to ensure food security and production while handling all domestic tasks.

Gender issues are increasingly important in Nigeria's agriculture sector. There is overwhelming evidence that women play a crucial role in agriculture, household maintenance, stability, and food security, even amid economic hardship. Nigeria's primary agricultural challenge is increasing food production and generating income from agricultural products. The role of women farmers in agricultural development cannot be overstated. Women are essential in planting, farming, harvesting, processing, and preparing agricultural products (Ajani, 2008; Tripp, 2004).

In Nigeria, the role of women in agriculture is largely influenced by geographic region, culture, and religion. Gender differentiated cropping patterns often persist among certain groups, such as the Igbo and Yoruba. For example, yams, considered a" prestige crop, "are traditionally regarded as a male crop, while "ephemeral crops" like cassavas, melons, beans, maize, and cocoyam are seen as female crops (Achebe and Teboh,2007; Ajani, 2008).

Maize is a significant food crop for both humans and livestock, providing energy, vitamins, and a small amount of protein (Hengsholtetal.,2018). In Nigeria, (Sadiq *eta l.,* 2013), likely due to its adaptability to different environmental conditions, leading to widespread cultivation across the country. Evidence shows a consistent production rate of maize in Nigeria (FAO, 2017). Both men and women make substantial contributions to maize-based farming systems and livelihoods, though gender roles in maize cultivation vary greatly across regions. On average, women constitute 43% of the agricultural labor force in developing countries, ranging from 20% in Latin America to 50% in East Asia and Sub-Saharan Africa (Quisumbing *eta l.*, 2014; FAO, 2011).

Interestingly, women and men manage complex post-harvest systems differently due to cultural contexts, social status, and other factors, leading to varying impacts. These differences can obscure the effects of development interventions on men and women. However, when gender is explicitly considered in studies, the effects become clear, revealing previously hidden implications (World Bank, 2010).

Since the 1970s, extensive literature has explored whether there are differences in male and female agricultural productivity or technical efficiency and whether women could be as productive as men with equal access to resources (Doss,2015). While findings have been mixed, studies applying production or profit functions generally find no significant differences in productivity or technical efficiency between men and women after accounting for access to inputs and the characteristics of plots, households, and farmers (Adelekeetal.,2008).

This study aims to address the gap in understanding gender roles in maize production in the Iseyin local government area of Oyo State. To achieve this goal, the study has outlined the following specific objectives:

i. describe socio-economic characteristics of the respondents

ii. identify gender roles in maize production

iii. identify the factors militating against gender roles in maize production

Hypothesis of the study:

Ho: Their no significant difference between male and female farmer's role in maize production practice in the study area.

Research Methodology

Description of the study area

The study was carried out in Ibarapa East Local Government Area of Oyo State, It is located in the southern part of Oyo state. It has its headquarters at Eruwa town, it is bounded in the north by Iseyin, in the east by Ido, in the west by Ibarapa central LGA and in the south by Ogun state. It has an area of 838km^2 and a population of 118,226 at the (2006) census. It is more or less a rural local government area with tremendous potentials for growth. The major farming activities carried out in this area are cassava, maize, coco-yam, vegetables, plantain, rice, groundnut, beans out of which maize, cassava, and cocoyam.The sales or prices of agricultural produce in this area are based on the season and market and the location of the individual farm. The area is also located a longlatitude $7^0 32^1$N and longitude $3^0 26^1$ East of Greenwich meridian.The town is situated in a distance of 57km, west of Ibadan, Oyo state capital.

A multistage sampling technique was used to select five wards out of the ten wards due to the predominant effect of climate on maize production in the local government, four villages were selected randomly from each ward and this gave rise to twenty villages and then six respondents farmers from each of the four villages making a total of one hundred twenty respondents. Data were collected by means of questionnaire. Descriptive statistics such as percentage, mean scores and standard deviation were used for data analysis, while inferential statistics such as independent t-test was use for comparison.

RESULTS AND DISCUSSION

Socio-Economic Characteristics of the Respondents

Result in Table 1 revealed that female farmers (51.8%) were slightly larger in population than the male farmers (48.2%). This suggests that maize production in the study area is a female dominated activity. This result contrasts many findings that always specify agricultural activities as male dominated profession (Zulkuni, 2010; Olagunjuetal., 2012). The result on age showed that the mean age of female farmers was 44years while that of male farmers was 40 years indicating that the respondents were in their youthful and active age, thus could actively participate in maize production as this age bracket is high productive in agricultural activities and accordingly, can put in their best for optimal production. Youthfulness could be an asset for innovativeness and assertiveness as it could endure the drudgery inherent in maize production.

This age range according to Aguillar, Carranza, Goldstein, Kilic and Oseni (2014) is characterized with energy which is required for maize production. More than half population of both male farmers (65.0%) and female farmers (66.7%) in the study area were married. This maybe informed by the need for families' income to provide food, education, healthcare and housing as the case maybe. Marital status demonstrates stability among farming families and tendency to adopt economic activities to raise income to finance family demand. Being married is a responsibility which requires income thus, married people often engage in different forms of economic developing activities. Higher proportion of married population construes a stable farming population in the study area with reduced chances of migration.This result agrees with the finding of Jamesetal (2013) who acclaimed that marriage confers some level of responsibilities and commitment on individuals who are married. The preponderance of married people in maize production in the study area could be ascribed to harmonizing proficiency of farm labor provision at household level.

The farm family pools her physical resources together to upkeep the production. The mean household size for male farmers and female farmers were 6 and 7 members respectively which were relatively large. A relatively large farm family is an indication for readily available of farm labour in a traditional farming setting which reduces labour cost in agricultural production. Large household size minimizes hired labour, lessens overall cost of production and ensures availability of labour. Large householdsize is needed in traditional farm family as it governs availability and amount of family labour for maize production. The larger the household size, the faster and more proficient the work is done and the many mouths to feed as well. This result concurs with Ndirituetal (2014) who concluded that households of 1-8 are mostly involved in maize farming in the study area. The average farm size cultivated by the male farmers was 8acres while that of the female farmers was 5acres. This indicates that the respondents cultivate less than 1 hectares, unchangeably could be smallscale farmers on subsistent production with family labour. This result described the respondents as small scale maize farmers. This situation could be indicative of increased land fragmentation, population pressure or non-use of machineries in production in the study area. The mean farming experience as shown in Table 1 revealed that the male farmers had 13 years of farming experience while that of the female farmers had 10 years of farming experience. This infers that the respondents were experienced in maize production and may be skillful and well-maintained in accessing agro based technologies, inputs and information due to previous experiences. Experience is a valuable asset, it could enable the farmer understand times and seasons easy access to input procurement, risk management, easy processing strategies among others. This result is in line with Oyelade and Anwanane (2013) who suggested that experience is a product of skillfulness; it contributes positively to efficiency of any business.

Gender roles in Maize Production

Farm activities performed by male and female maize farmers were presented in Table 2. The result revealed that male farmers were more involved in farm activities such as earthen ingup (83.0%), storing of maize (79.2%), landclearing (70.1%) and ridge making (58.2%); these activities are tedious or energy demanding.

However, female farmers were mostly involved in planting (68.6%), manual weeding (59.3%), supplying (72.8%), thinning (74.5%), manual harvesting (71.2%), winnowing (94.0%), threshing (78.0%) and general maize processing (92.3%); indicating that female farmers partook more in less tedious and more painstaking activities involved in maize production. Female farmers also underwent the drudgery of general maize processing in the study area. This result implies that women put up with disproportionate burden of the work load in farm activities. This finding agrees with FAO (2006) which reported that in Nigeria, women play dominant role in agricultural production and make up 60-80% of agricultural labour force depending on the region. The finding also supports the affirmation of Ajani (2008) who repeated that in most societies, food processing is the responsibility of women. Jamesetal,.(2013) affirmed that women are heavily involved in food processing by way of threshing, shelling and milling of grains.

FactorsMillitatingagainstgenderrolesinMaizeproduction

Findings in table 3 show that lack of extension services (χ=1.80), lack of access to technology (χ=1.60) and lnadequate facilities (χ=1.57) were the factors militating against male roles in maize production while illiteracy (χ=0.82) is the least factor, on the contrary, inadequate extensionservice (χ=1.57), lack of access to technology (χ=1.55) and inadequate credit facilities (χ=1.45) were factors militating against female roles in maize production. However, inadequate training (χ=0.47) was least factors militating against female roles in maize production. This implies that there is variance in their both gender millitating maize production in both male and female gender as stated by Aderinto (2007), which stated that inadequate extension service performance and low annual contact are very few.

Analysis showing the significant difference between male and female farmer's role in maize production practice

Results of test of hypothesis in table 4 shows that there is no significant difference between male and female farmers' involvement in production practices. This implies that male and female farmers in the study are engaged in similar roles for maize cultivation.

CONCLUSION AND RECOMMENDATION

Results revealed that respondents were young, married and had relatively large household size which is advantageous for maize production. The finding showed that women formed larger proportion of maize farmers in the study area. They mostly engage in time consuming and painstaking activities carried out in maize production which includes general maize processing, weeding, supplying, and fertilizer application while the men partook in energy consuming activities involved such as land clearing, ridgemaking, maize storage and marketing. It was recommended that female maize farmers associations should develop a high level of consciousness and sophistication on policy issues or difference that affect them. Both male and female farmers should been couraged to form and join farming organizations or cooperatives.This will enable them serve as pleasure group to ensure implementation of some strategies and policies. It will also help them in cheap procurement of some productive inputs and other activities which will be of help for them.

REFERENCES

Adeleke, O.A; Adesiyan I.O; Olaniyi A.O; Adelabu, O.K; & Matanmi,M.H.(2008). GenderDifferentialsintheproductivityofcerealcropfarmers:Acasestudy Of maize farmers in oluyole Local Government Area of Oyo state. *Agricultural Journal,3(3),193-198.*

Achebe, N., & B.Teboh.(2007). Dialoging women in Africa after gender?, eds. C. Cole, T. Manuh, and S. Miescher. Bloomington,Ind.,U.S.A.: Indiana University Press.

Aguillar,A.,Carranza, E., Goldstein, M., Kilic, T., & Oseni, G. (2014). Decomposition of gender differentials in agricultural productivity in Ethiopia. Agricultural Economics, 46(3), 311-344.

Ajani,O.I.Y. (2008). Gender dimensions of agriculture, poverty, nutrition, and food security in Nigeria. IF PRI Nigeria Strategy Support Program Brief 5. Washington, D.C.: International Food Policy Research Institute.

Creswell J (2003) Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. London: Sage Publications.

FAO. (2006). FAO STAT: Food and Agricultural Organization of the United Nation Food Production Data. Pp336.

FAO, (2011).Global food losses and food waste-extent, causes and prevention. FAO, Rome,Italy.

FAO, (2017).GIEWS-Global Information and Early Warning System: Country briefs, Nigeria. http://www.fao.org/giews/countrybrief/country.jsp?code=NGA

Hengsholt,E.,ShaliniU.,pollmann-LarsenM.,BjorgA.andMarineG.(2018)Tracking the 1.6 billion ton food loss and waste crisis; BCG Publishers.

James, P.O., Obinne, A. DE., & Ako, J.A. (2013). Indigenious Practices and gender Discrimination: Implication for the right of women. Proceedings of the 7th Annual Conference of Nigeria for Indigenous Knowledge and Development (NSIKAD) held at Raw Material Research and Development Council, Maitama District, Abuja, Nov 6-9 2013. Pp 136–144

Kassie, M., Ndiritu, S.W., & Stage, J. (2014).What determines gender inequality in household.

Metz, H.C.,ed. (1991). Nigeria: Acountrstudy. <http://countrystudies.us/nigeria/58.htm>. Accessed September 14, 2009.

Ndiritu S.W., Kassie, M., & Shiferaw, B. (2014). Are there gender differences in the adoption of sustainable agricultural intensification practices? Evidence from Kenya.

Oladeebo, J.O., & Fajuyigbe A.A. (2007). Technical efficiency of men and women upland rice farmers in Osun state, Nigeria. Journal of Human Ecology 22(2), 93–100.

Olagunju, F.I., Fakayode, S.B., Babatunde, R.O., & Ogunwole-Olapade, F. (2012). Gender Analysis of Sweet Potato Production in Osun State, Nigeria. Asian Journal of Agricultural Extension, Economics and Sociology, 2 (1), 1–13.

Oyelade,O.A., & Anwanane, N.B. (2013). Maize and Cowpea Production in Nigeria. Advances in Agriculture, Science and Engineering Research, 3(11), 1343–1358.

Peterman,A., Quisumbing, A., Behrman, J., & Nkonya, E. (2014). Understanding the complexities surrounding gender differences in agricultural productivity in Nigeria and Uganda. The Journal of Development Studies, 47(10), 1482-1509.

Peterman, A. (Eds.) (2014) Gender in agriculture: Closing the knowledge gap. Springer.

Sadiq, M.S., Yakassai, M.T., Ahmad, M.M., Lakpene, T.Y., and Abubakar, M. (2013).

Profitability and Production Efficiency of Small-Scale Maize Production in Niger State, Nigeria. IOSR Journal of Applied Physics (IOSR-JAP), 3(4): pp 19–23.

Quisumbing, A.; Meinzen-Dick, R.; Raney,T.; Croppenstedt, A.; Behrman, J.;

Yidana J A, Osei-Kwarteng M, Amadu Y (2013). The impact of cassava processing on the livelihood of women processors in Central Gonja district of the northern regionof Ghana. African Journal of Agricultural Research 8(49): 6524-6528.

Table 1:Socio-Economic Characteristics of the Respondents

	Malen=60			Femalen=60		
Variables	**Frequency**	**Percentage**	**Mean**	**Frequency**	**Percentage**	**Mean**
Age(years)						
30-40	23	38.3		23	38.3	
41-50	22	36.7	40years	25	41.7	44years
51-60	15	25.0		12	20.0	
Maritalstatus						
Single	9	15.0		13	21.7	
Married	39	65.0		40	66.7	
Divorced	10	16.7		6	10.0	
Widowed	2	3.3		1	1.7	
Yearsspentoneducation						
1-6	6	5.0		6	10.0	
7-12	33	55.0	13years	33	55.0	
13-18	21	23.3		21	35.0	12years
Householdsize						
1-4	13	21.7		6	10.0	
5-8	33	55.0	6members	33	55.0	7members
≥9	14	23.3		21	35.0	
Farmsize(acres)						
1-5	7	11.7		48	80.0	
6-10	51	85.0	8acres	12	20.0	5acres
≥11	2	3.3		-	-	
Sourcesofland						
Inherited	14	23.3		15	25.0	
Rent	18	30.0		3	5.0	
Gift	8	13.3		10	16.7	
Purchased	20	33.3		6	10.0	
Farmingexperince(years)						
1-10	17	28.3		48	80.0	
11-20	39	65.0	13years	11	18.3	10years
≥21	4	6.7		1	1.7	
Secondaryoccupation						
Civilservant	19	31.7		20	33.3	
Trader	18	30.0		25	41.7	
Artisan	23	38.3		15	25.0	
AccesstoCredit						
Yes	15	25.0		27	45.0	
No	45	75.0		33	55.0	
Sourceoflabour						
Family	22	36.7		14	23.3	
Hired	35	58.3		43	71.7	
Communal	3	5.0		3	5.0	

Source: Field survey, 2023

Table 2: Gender roles Performed by Men and Women in Maize Production

	Malen=60				Femalen =60			
FarmActivities	**Frequency**	**Percentage**	**Mean**	**Standard Deviation**	**Frequency**	**Percentage**	**Mean**	**StandardDeviation**
Landclearing	57	70.1	3.09	0.871	41	43.2	1.74	0.916
Ridgemaking	44	58.2	2.87	0.920	44	54.2	2.16	0.892
Plantingoperations	37	42.8	1.89	0.850	51	68.5	2.32	0.911
Manualweeding	38	52.8	2.66	0.938	50	59.3	2.25	0.870
FertilizerApplication	38	43.7	1.96	0.728	60	67.8	2.55	1.079
Earthening	52	83.7	2.97	1.063	30	25.5	1.27	0.549
Supplying	32	38.2	1.74	0.516	56	72.8	2.66	0.928
Thinning	45	50.1	2.37	0.823	48	74.5	2.75	0.728
Manualharvesting	44	40.0	1.68	0.651	64	71.2	2.49	1.063
Threshing	36	32.2	1.59	0.833	52	78.0	2.86	0.761
Winnowing	27	36.4	1.03	1.079	59	84.0	3.04	0.982
Marketing	33	30.0	1.38	0.762	55	72.5	2.66	0.865
Storingofmaize	57	79.2	3.16	1.080	35	38.3	1.21	0.870
Generalmaizeprocessing	49	58.2	1.09	0.860	56	82.3	2.93	0.938

Source: Field survey 2023

Table 3: Factors militating against gender roles in maize production

	Male					Female				
Factors	**VS**	**S**	**NS**	**Mean**	**Rank**	**VS**	**S**	**NS**	**Mean**	**Rank**
Inadequatecreditfacilities	24(40.0)	30(50.0)	6(10.0)	1.30	5	32(53.3)	23(38.3)	5(8.3)	1.45	3
Climate	22(36.7)	20(33.3)	18(30.0)	1.07	7	15(25.0)	27(45.0)	18(30.0)	0.95	7
Lackofaccesstoinfrastructalfacilities	36(60.0)	22(36.7)	2(3.3)	1.57	3	25(41.7)	29(48.3)	6(10.0)	1.32	5
Illitracy	9(15.0)	31(51.7)	20(33.3)	0.82	10	8(13.3)	29(48.3)	23(38.3)	0.75	9
Inadequateaccesstoproductioninformation	33(55.0)	19(31.7)	8(13.3)	1.42	4	29(48.3)	22(36.7)	9(15.0)	1.33	4
Inadequateaccesstoextensionservice	48(80.0)	12(20.0)	0(0.0)	1.80	1	38(63.3)	18(30.0)	4(6.7)	1.57	1
Landconstraints	11(18.3)	33(55.0)	16(26.7)	0.92	8	18(30.0)	31(51.7)	11(18.3)	1.12	6
Inadequatetrainingonmaizeproduction	9(15.0)	32(53.3)	19(31.7)	0.83	9	7(11.7)	23(38.3)	30(50.0)	0.62	10
Labourshortage	25(41.7)	22(36.7)	13(21.7)	1.20	6	9(15.0)	32(53.3)	19(31.7)	0.83	8
Lackofaccesstotechnology	37(61.7)	22(36.7)	1(1.7)	1.60	2	39(65.0)	15(25.0)	6(10.0)	1.55	2

Table4: Analysis showing the significant difference between male and female farmer's role in maize production practice

Variables	t-test	Df	P-value	Decision
Male roles-Female roles	0.647	10	0.520	NS

Source: Fieldsurvey, 2023

EFFECTS OF DIFFERENT GROWING MEDIA ON THE GROWTH AND YIELD OF CUCUMBER (*Cucumis sativus L.*)

Owoade F. M., Owolabi E. T., Adeleke M. A., Ayadi D. T. and Adigun T. S.
Department of Crop Production and Soil Science
Ladoke Akintola University of Technology Ogbomoso, P. M. B. 4000, Oyo State, Nigeria.
Corresponding Author: owolabiesther1604@gmail.com

ABSTRACT

This study investigates the effects of different growing media on the growth and yield of cucumber plants (*Cucumis sativus*), focusing on potential sustainable alternatives to traditional soil. The treatments include soil, coco peat, rice husk, sawdust, and combinations thereof (coco peat with rice husk, coco peat with sawdust, and rice husk with sawdust). A completely randomized design was used to minimize variability and enhance the reliability of results. Key growth parameters such as: the number of fruits, number of flowers, and fruit weight were recorded throughout the cucumber growth cycle to assess each medium's impact. The results indicated that the type of growing medium significantly influences the growth performance and productivity of cucumber plants. Among the treatment involved, combinations like coco peat with rice husk yielded favorable outcomes, enhancing both the number and weight of fruits compared to soil alone. The high-water retention capacity of coco peat, combined with the aeration provided by rice husk, likely contributed to these improved growth metrics. Conversely, single media such as sawdust showed limited support for optimal growth, underscoring the importance of a balanced medium for nutrient retention and moisture control.

This research trial showed the potential of non-soil media for cucumber cultivation, offering practical and sustainable options for growers, particularly in areas where soil quality is poor or where resources are limited. Additionally, it suggests that media combinations can improve yield, benefiting both commercial agriculture and small-scale farms. Based on these findings, recommendations for cucumber cultivation include the use of coco peat and rice husk mixtures to optimize growth and sustainability. Future studies may explore the long-term impacts of these media on soil health, nutrient content, and cost-effectiveness in various agricultural settings.

Keywords: Growth media, nutrient retention, performance, productivity

INTRODUCTION

Cucumber (*Cucumis sativus L.*) is an important commercial vegetable which is also used as salad, it belongs to the family Cucurbitaceae. Cucumber, is one of the most significant exotic vegetables and the fourth most extensively farmed vegetable in the world (FAO, 2020a). Because of its many health advantages, it is one of the most significant vegetables cultivated domestically in Nigeria. Cucumber can be consumed raw, processed into juice, served as a post-meal dessert, or mixed with other foods. Empirical research suggests that Nigeria's demand and output markets for cucumbers could boost agricultural productivity, economic empowerment, and food security (Anthony *et al*., 2021). Due to its economic and nutritional advantages, its production is still becoming more and more popular in Nigerian communities (Abdulkadir *et al*., 2020).

About ninety five percent of Cucumbers consist mostly of water. It is primarily grown in the summer and well-known for its juicy fruit. Seeds of this fruits contains essential oil which is helpful for brain development and body smoothness (Bhagwat *et al*., 2018). Chakraborty and Rayalu (2021) state that cucumbers aid digestion, hydration regulation, blood pressure and sugar maintenance, skin soothing, fat reduction, and weight loss. It contains low calories (16 calories per cup) and more fiber on the skin (Bhagwat *et al*., 2018). Cucumbers are good source of dietary fiber, magnesium, and potassium. It is well recognized that these nutrients can lower blood pressure, which lowers the risk of heart disease. Additionally, studies have shown that older adults with hypertension who regularly drank cucumber juice had a reduction in blood pressure. Our stomachs benefit from cucumber's cooling properties. Cucumbers' soluble fiber aids in reducing our rate of digestion. Additionally, the high-water content of cucumbers avoids constipation, softens faeces, and maintains regular bowel movements (Chakraborty and Rayalu, 2021).

Cucumber production in Nigeria has not been ranked; it is primarily grown in Jos, Plateau State, with a little amount being growing in Ohaji Egbema, Imo State, and a few other federation states. In Nigeria, although cucumbers are becoming more and more important, farmers still receive low returns from their crops because of deteriorating soil fertility brought on by repeated cropping and a lack of attention to soil amendment materials. Southern regions, where the crop is typically used more extensively, tend to have lower yields.

Nigerian farmers mostly use shifting cultivation (Lawal, 2014) to make sure the soil's basic nutrients are sufficient to sustain the growth of the crops they cultivate. However, there are drawbacks to using soil for agriculture, such as pests and diseases, competition between weeds and crops for nutrients and space, pollution of the environment, and an increase in the number of insecure people in the nation as a result of conflicts between farmers and herders. The aforementioned farming limitations have prompted a growing call for the use of alternate crop producing methods. The soilless cultivation reduces the soil related problems experienced in the conventional crop cultivation. The objective is to investigate the effects of different growing media on the growth and yield of cucumber.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the experimental site of the Department of Crop Production and Soil Science, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. Ogbomoso is located at 8°10'N and 4°10'E and the climate experiences cool and dry conditions from November to March and then warm and moist from April to October. The maximum and minimum temperature is 33 and 28°C, respectively. The humidity of this area is high (about 74%) all year round except in January when dry wind blows from the North. Annual rainfall is over 1000 mm (Olaniyi, 1997).

Treatments and experimental design

The treatments consist of seven treatments (T1: 100% Rice husk**;** T2: 100% Saw dust**;** T3: 100% Coco peat**;** T4: 50% Rice Husk + 50% Saw Dust**;** T5: 50% Coco Peat + 50% Rice Husk**;** T6: 50% Saw Dust + 50% Coco Peat**;** T7: 100% Soil) in Completely Randomized Design (CRD) and replicated three times. 400g each of coco peat, rice husk and sawdust were measured into different polythene bags. 200g each of coco peat and rice husk; 200g each of coco peat and sawdust; 200g each of rice husk and saw dust were also measured into separate polythene bags. The polythene bags were arranged on the land and spaced at 60cm.

Agronomic practices: Two seeds were sown per hole at a depth of 2cm. Supplying, thinning, weeding, staking and watering were equally carried out. 15g of Agrovet fertilizer (Foliar fertilizer) was mixed with 5 liters of water. 50 cl of the mixed fertilizer was applied to each pot at two weeks intervals using foliar application.

Data collection

Data were collected at two weeks interval. Data were collected on the vegetative parts two weeks after sowing while data were collected on the reproductive parts when flowers appeared and it was then collected again after two weeks. Vine length was measured using a ruler calibrated in cm from the base of the plant to the tip of the plant. Data on the number of leaves was obtained by visually counting the number of leaves on the plant. Leaf length was measured using a ruler calibrated in cm from the base of the leaf (where the leaf blade meets the petiole) to the tip of the leaf. Leaf breadth using a ruler calibrated in cm by measuring the widest part of the leaf (from edge to edge, perpendicular to the length). The number of flowers and was obtained by visually counting the number of flowers. The number of fruits was also obtained by visually counting the number of fruits.

Data analysis

Data collected were analyzed using Analysis of Variance (ANOVA). The significance of the treatments effects was determined using Mean Separation with Duncan's Multiple Range Test (DMRT) at 5% probability level.

RESULTS AND DISCUSSION

Number of leaves

The study revealed significant variations in cucumber leaf production across different growing media over time. Coco peat and its mixture with rice husk promoted vigorous early growth, producing the highest number of leaves

(4.67, 5.17) at 2 and 4 weeks after sowing (WAS) respectively. However, its declined by 8 WAS, likely due to nutrient depletion.

Rice husk, which initially had the lowest leaf count, showed remarkable improvement by 6 WAS and 8 WAS, indicating its suitability for later growth stages. Soil provided moderate but consistent growth, excelling in the later phases, while sawdust and its combinations consistently underperformed, suggesting they lack the necessary nutrients or structure for optimal growth. Overall, coco peat was most effective for early vegetative growth, while rice husk and soil supported sustained development in later stages, highlighting the importance of selecting appropriate growing media to enhance cucumber growth throughout its lifecycle. Coco Peat was the most effective growing medium for leaf production during the first 6 weeks, supporting vigorous early vegetative growth. (Table 1). Similarly, Eifediyi and Remison (2010) reported the growing media and fertigation increases the number of leaves.

Vine length

Vine length, a key indicator of cucumber plant health, varied significantly across different growing media throughout the study. Coco peat combined with rice husk consistently produced the longest vines at all sampling periods (9.67 cm at 2WAS, 15.03 cm at 8WAS), outperforming other media. Coco peat alone also showed strong performance, though slightly less effective than the combination. In contrast, rice husk + sawdust produced the shortest vines, indicating poor support for growth. Soil demonstrated modest but steady vine growth, though less effective than coco peat-based media. Overall, coco peat, especially when mixed with rice husk, proved to be the most effective medium for promoting vine length, emphasizing its potential for optimizing cucumber cultivation. (Table 2).

Leaf area

Leaf area growth determines light interception and is an important parameter in determining plant productivity (Gifford *et al*., 1984; Koester *et al*., 2014). The experiment showed significant differences in cucumber leaf area across various growing media, with coco peat consistently producing the largest leaf areas at all growth stages (17.90 cm² and 85.10 cm² at 2 and 8WAS). Coco peat + rice husk also performed well, especially by 8WAS, indicating a complementary effect that enhances leaf expansion. In contrast, rice husk consistently had the smallest leaf areas, demonstrating limited support for leaf development. Sawdust showed moderate but limited improvement over time, while soil maintained consistent, moderate growth throughout. Overall, coco peat, particularly when combined with rice husk, was the most effective medium for promoting leaf area, underscoring its ability to enhance photosynthesis and overall plant growth. (Table 3).

Number of flowers

The experiment revealed significant differences in cucumber flowering across various growing media, with rice husk producing the highest number of flowers (11.50), followed by coco peat + rice husk (8.50). Coco peat alone performed moderately well (6.80), similar to soil (5.00), indicating its ability to support flowering. Sawdust, both alone and in combination with rice husk or coco peat, produced the fewest flowers (1.00), suggesting poor nutrient availability and water retention. Rice husk's superior performance, especially when combined with coco peat, highlights its ability to balance water retention and aeration, essential for flowering. While coco peat and soil also supported moderate flowering, sawdust consistently underperformed, emphasizing the importance of selecting nutrient-rich and well-aerated media for optimal flower development in cucumber plants. (Table 4).

Number of fruits

The experiment demonstrated significant differences in cucumber fruit production across various growing media, with coco peat + rice husk producing the highest yield (11.17 fruits), significantly outperforming all other treatments. This combination likely benefits from coco peat's excellent water retention and rice husk's aeration, creating optimal conditions for fruit development. In contrast, rice husk (1.00) and sawdust (1.00), both alone and in combination, consistently produced the fewest fruits, indicating poor nutrient availability and inadequate support for fruiting. Coco peat alone (3.83) and soil (3.50) produced moderate yields, suggesting they are viable but less effective than coco peat mixed with rice husk. Interestingly, while rice husk supported flowering, it failed to sustain fruit production, likely due to nutrient deficiencies or limited water retention. Sawdust's consistent underperformance highlights its unsuitability for cucumber fruiting. Overall, coco peat + rice husk was the most effective medium, emphasizing the importance of selecting growing media that balance water retention, aeration, and nutrient availability to maximize cucumber yield. (Table 5). This result confirms the study of Luitel, Adhikari, Yoon, and Kang (2012) that plants grown in cocopeat produced the highest marketable fruit number per plant and yielded the greatest marketable yield per plant.

Fruit weight

The experiment showed significant differences in cucumber fruit weight across various growing media, with coco peat producing the highest fruit weight (82.00 g), significantly outperforming all other treatments. This highlights coco peat's superior water retention and nutrient-holding capacity, which create optimal conditions for fruit development. The findings align with Alifar, Ghehsareh, and Honarjoo (2010), who reported that the highest cucumber yield and biomass were achieved using coco peat in soilless culture. In contrast, coco peat + sawdust produced a lower fruit weight (33.50 g), suggesting that sawdust may reduce water retention or nutrient availability compared to pure coco peat. Rice husk, sawdust, soil, and their combinations failed to produce any fruit, likely due to poor nutrient availability, inadequate water retention, or suboptimal root development conditions. (Table 6). The results emphasize the importance of selecting nutrient-rich, well-aerated media like coco peat to maximize cucumber yield, while highlighting the limitations of soil, rice husk, and sawdust for fruit production.

CONCLUSION

This study shows that the type of growing medium used has a strong effect on how well cucumbers grow and produce yield. Coco peat, whether used alone or in combination with rice husk, consistently produced higher results in terms of number of fruits, flower production, and fruit weight. This highlights its potential as a highly suitable growing medium due to its favorable properties, such as improved aeration, nutrient retention, and water-holding capacity. Thus, selecting an appropriate growing medium, especially coco peat or its mixtures, is key to improving cucumber yield. These results can help farmers boost productivity and provide valuable insights for better horticultural practices.

However, it is essential to note that this study spanned a single growing season, which may not fully capture the long-term effects of the media on cucumber cultivation. Further studies over multiple growing cycles are recommended to assess the sustainability of using coco peat and its combinations.

RECOMMENDATION

Based on the results of the study, coco peat or a combination of coco peat and rice husk produced the highest yield, it is recommended to focus on this medium in cucumber cultivation. This medium could be promoted for its effectiveness in enhancing fruit yield and plant health, making it suitable for farmers aiming for optimal productivity.

REFERENCES

Abdulkadir SU, Mahmoud BA, and Kashere MA (2020). Effects of fertilizer management on growth and yield of Cucumber (Cucumis sativus L). In Proceedings of 38th Annual Conference of Horticultural Society of Nigeria, Hall of Fame, University of Nsukka, Nigeria: 79-82.

Alifar, N., Mohammadi Ghehsareh, A., and Honarjoo, N. (2010). The effect of growth media on cucumber yield and its uptake of some nutrient elements in soilless culture. *Journal of Science and Technology of Greenhouse Culture-Isfahan University of Technology*, 1(1), 19-25.

Anthony L, Alabi OO, Ebukiba ES, and Gamba V (2021). Factors influencing output of rice produced and choice of marketing outlets among smallholder farming households in Abuja, Nigeria. Sarhad Journal of Agriculture, 37(1): 262-277.

Bhagwat, A.,Srinivasa, V., Bhammanakati, S. and Shubha, A. S. 2018. Evaluation of Cucumber (Cucumis sativus L.) Genotypes under Hill Zone of Karnataka. International Journal of Current Microbiology and Applied Sciences, 7 (09): 837–842.

Chakraborty S and Rayalu S (2021). Health Beneficial Effects of Cucumber.Intechopen Book Series. DOI:10.5772/intechopen.96053.

Eifediyi, E. K. and Remison, S.U. 2010. Growth and yield of cucumber (Cucumis sativus L.) as influenced by farmyard manure and inorganic fertilizer. Journal of Plant Breeding and Crop Science. 2(7): 216–220.

FAO (2020a). Vegetable crops in Nigeria at a glance. Food and Agriculture Organization of the United Nations, Rome, Italy.

Gifford, R. M., Thorne, J. H., Hitz, W. D., and Giaquinta, R. T. (1984). Crop productivity and photoassimilate partitioning. *Science* 24, 801–808. doi: 10.1126/science.225.4664.801

Koester, R. P., Skoneczka, J. A., Cary, T. R., Diers, B. W., and Ainsworth, E. A. (2014). Historical gains in soybean (*Glycine max* Merr.) seed yield are driven by linear increases in light interception, energy conversion, and partitioning efficiencies. *J. Exp. Bot.* 65, 3311–3321. doi: 10.1093/jxb/eru187

Lawal, M. (2014). Shifting Cultivation Farming and Its Impacts on Wildlife Species in Oyan Community, Odo-Otin, Osun State, Nigeria

Olaniyi J.O, (1997). Evaluation of growth and yield of cabbage in a savanna area of southwestern Nigeria. MSc thesis, Department of Agronomy, University of Ibadan, Ibadan, Nigeria. 68 Pp.

Table 1: Number of leaves of cucumber planted with different growing media

	Weeks after planting			
Treatments	**2**	**4**	**6**	**8**
Rice husk	2.23c	2.50b	6.63ab	7.83a
Sawdust	3.67abc	4.67ab	2.83bc	3.17abc
Coco peat	4.50ab	6.50a	9.67a	2.67abc
Rice husk + Sawdust	2.67bc	3.67b	1.17c	1.17c
Coco peat + Rice husk	4.67a	5.17ab	4.83abc	5.50abc
Coco peat + Saw dust	2.83abc	3.00b	4.33bc	2.33bc
Soil	3.00abc	5.00ab	2.33bc	7.67ab

Mean with the same letter within the same column are not significantly different from each other at 5% probability level

Table 2: Vine length (cm) of cucumber planted with different growing media

		Weeks after planting		
Treatments	**2**	**4**	**6**	**8**
Rice husk	4.88c	4.07b	5.31d	7.11c
Saw dust	5.15c	4.75b	7.45c	8.67c
Coco peat	7.73b	7.08a	9.92b	12.37b
Rice husk + Saw dust	4.10c	3.58b	6.35cd	7.01c
Coco peat + Rice husk	9.67a	8.70a	11.69a	15.03a
Coco peat + Saw dust	4.20c	4.37b	6.78c	7.68c
Soil	5.00c	5.05b	7.52c	8.79c

Mean with the same letter within the same column are not significantly different from each other at 5% probability level

Table 3: Leaf area (cm³) of cucumber planted with different growing media

	Weeks after planting			
Treatments	**2**	**4**	**6**	**8**
Rice husk	3.20c	1.50c	14.70d	16.50d
Saw dust	6.20bc	8.00c	24.60bcd	26.50cd
Coco peat	17.90a	42.80a	58.80a	85.10a
Rice husk + Saw dust	3.60c	5.90c	20.20cd	19.50d
Coco peat + Rice husk	11.10b	16.80b	36.40b	45.50b
Coco peat + Saw dust	5.30bc	9.00c	33.00bc	30.70bcd
Soil	5.50bc	17.90b	30.60bc	38.70bc

Mean with the same letter within the same column are not significantly different from each other at 5% probability level

Table 4: Number of flowers of cucumber planted with different growing media

Treatments	No of flowers
Rice husk	11.50a
Saw dust	1.00b
Coco peat	6.80ab
Rice husk + Saw dust	1.00b
Coco peat + Rice husk	8.50a
Coco peat + Saw dust	1.00b
Soil	5.00ab

Mean with the same letter within the same column are not significantly different from each other at 5% probability level

Table 5: Number of fruits of cucumber planted with different growing media

Treatments	No of fruits
Rice husk	1.00b
Saw dust	1.00b
Coco peat	3.83b
Rice husk + Saw dust	1.00b
Coco peat + Rice husk	11.17a
Coco peat + Saw dust	1.00b
Soil	3.50b

Mean with the same letter within the same column are not significantly different from each other at 5% probability level

UTILIZATION OF SOCIAL MEDIA FOR ACCESSING INFORMATION ON CLIMATE CHANGE ADAPTATION STRATEGIES AMONG COCOA FARMERS IN ONDO STATE

[1]Orisamika, A. O. and [2]Akintonde, J. O.
Ladoke Akintola University of Technology, Ogbomoso, Nigeria
Department of Agricultural Extension and Rural Development, Ladoke Akintola University of Technology, Ogbomoso, Nigeria
Correspondence contact detail: ayodeleomobolanle2@gmail.com, joakintonde@lautech.edu.ng

ABSTRACT

Social media refers to the internet-based digital tools for sharing and discussing information among people. Information on climate change needs to be assessable to farmers at the lowest cost through video, audio and multimedia outlet. climate change has emerged as one of the most devastating global environmental threats because it is projected to be major of the most important indices to agriculture, health, and water. Therefore, this research examined the utilization of social media for accessing information on climate change adaptation strategies among cocoa farmers in Ondo State, Nigeria. The data for this research was collected using structured interview schedule. Multi-stage sampling technique was used to select 160 respondents (cocoa farmers) from the study area. Descriptive statistics tool such as frequency counts, percentages, weighted mean score and ranking were used to analyze the objectives of the study while Pearson Product Moment Correlation (PPMC) was used to analyze the hypothesis. The result further revealed that majority (68.1%) of the respondents indicated targeting raining season for planting, planting of improved cocoa varieties 66.9% as the climate change adaptation strategies information accessed via social media platforms. The result revealed that WhatsApp had the highest weighted mean score of 3.94. The study also found out that high cost of facilities and high cost of operation (cost of subscription) constitute the major constraint to the use of social media platforms. It could be concluded that WhatsApp were frequently used for accessing information on climate change adaptation strategies among the cocoa farmers. Thus, Stakeholders involved in agriculture should strengthen network infrastructure in rural areas to improve connectivity, addressing one of the primary constraints identified by the study and enabling more seamless access to vital information on climate change adaptation strategies.
Keywords: utilization, social media, climate change, frequency, cocoa.

INTRODUCTION

Agriculture dominates the nation's economy. It is by far the most important sector of Nigeria's economy engaging about 70% of the labour force (Abudu *et al.,*2016). Agricultural land holdings are generally small and scattered, families often practice subsistence agriculture using simple tools and shifting cultivation. These small farms produce about 80% of the total foods. About 30.7 million hectares (76 million acres) or 33% of Nigeria land area are under cultivation Increasing smallholder productivity is one of the greatest challenges of the century, this is worrisome due to the growing populations, growing demand for food, rising poverty, economic stagnation, worsening environmental degradation, and climate change. The agricultural sector in most developing countries is becoming increasingly knowledge intensive. As researchers at the global, regional, and national levels continue to generate new information, agricultural systems is becoming more complex with farmers' access to reliable, timely and relevant information sources becoming more critical to their competitiveness (Thomas and Laseinde, 2015).

Information is power and agricultural information is pertinent to unlocking the potential of the agricultural sector, especially agricultural information dissemination. The world population is increasing, estimated to grow from 7.7 billion in 2019 to hit a record of 8.5 billion people by 2030, 9.7 billion by 2050 and 10.9 billion by 2100 (United Nations Department of Economic and Social Affair, 2019), with projected increases likely to come from sub-Saharan Africa. Social media provides the platform for effective agricultural information dissemination, communicating measures and practices and to utilize opportunities, address challenges facing agricultural sector in developing countries. Social media is important in the dissemination and creation of awareness on agricultural technologies and development knowledge in real time (Ifejika, Asadu, Enibe, Ifejika & Sule, 2019). However, reaching farmers with only traditional extension system is a big challenge and may continue to prove abortive considering the barriers to effective agricultural extension in developing countries which seeks to create opportunities to connect more farm families with extension agents.

The evolution of social media (SM) provided a visible solution to this challenge. Social media refers to the internet-based digital tools for sharing and discussing information among people. It refers to the user generated information, opinion, video, audio, and multimedia that is shared and discussed over digital networks (Andres and Woodard, 2013). Social media enables blogging, tagging, discussion, networking, and so on. The various platforms include Facebook, Twitter, YouTube, Instagram, Google, WhatsApp, Blog, LinkedIn etc. Social networks are seen as an important mechanism for the spread of information and technology (Baerenklau, 2005 and Young, 2009). Also, it has also been considered to be an effective tool in disseminating agricultural information among farmers and they constitute the most powerful media for disseminating information quickly enabling farming community to make informed decisions regarding their farming activities, especially in the rural areas of developing countries (Kakade, 2013 and Lwoga, 2010). The overall objective of the study was to determine the frequency of use of social media for accessing information on climate change adaptation strategies while the specific objectives were to; describe the socio-economic characteristics of the respondents; examine the information on climate change adaptation strategies accessed through social media, examine the frequency of use of social media for accessing information on climate change adaptation strategies, investigate the constraints in the use social media in accessing climate change adaptation strategies information. The hypothesis was tested and stated as: there is no significant relationship between socio-economic characteristics of the respondents and frequency of use of social media.

MATERIALS AND METHODS

The study was carried out in Ondo State, Nigeria. Its capital is Akure with latitude 7.100005 and longitude 4.841694. It is bounded to the East by Edo and Delta state, to the west by Ogun state and Osun state, to the north by Ekiti and Kogi state, and to the south by the Bight of Benin and the Atlantic Ocean. Some important cities and towns include Ondo, Owo, Ikare, Akungba-akoko, Ilaje, Ile-Oluji, and Owena. Ondo state lies in the equatorial rainforest belt and the rainfall around this area varies from 1800mm 2100mm per annum. It has distinct wet season from April to late October and dry season from November to March; the area has a mean annual temperature of 26.2^{0}C, the humidity is high between July and December and low between December and February. The main occupation of the people is farming, and the farms are semi commercial units, which largely rely on rainfall as the main source of water supply. In addition, farming household structure is basically of two types; the nuclear type called farm family, and the extended type called the farming household. People of the state are mostly farmers, producing such food crops as yam, maize, cassava, cowpea and cocoyam. The cash crops grown include cocoa, kolanut and palm produce.

Multistage sampling technique was used for selecting the respondents (Cocoa farmers) for the study. Ondo state is divided into three (3) agricultural zones and eighteen (18) blocks for administrative convenience by the Ondo State Agricultural Development Programme (OSSAPADEP). In Ondo state, the agricultural zones are Owo/Akure zone (6 blocks), Ondo zone (7 blocks) and Idanre/Owena zone (5 blocks). The first stage involves purposive selection of Ondo and Owo agricultural zones of the state due to dominance of cocoa farmers. The second stage involved random selection of Odigbo and Ile-Olugi/Okeigbo blocks from Ondo agricultural zone and Akure and Owo blocks from Owo agricultural Zone. The third stage involved random selection of two cells from each of the selected blocks. From Odigbo block, Ominla and Oloruntedo were selected, Bamikemo and Ojowo were selected from Ileolugi/Okeigbo block, Oba-ile and Eleyewo were selected from Akure block and Isuada and Ogbese were selected from Owo block. Finally, 50% of the cocoa farmers were selected at random from the selected cells through a snowball sampling technique. A total of 160 cocoa farmers were selected out of 314 from the selected cell.

Data collected were analyzed with descriptive statistics such as frequency, percentages and mean, the dependent variable was determined by frequency of use of social media and inferential statistical tool such as Pearson Product Moment Correlation (PPMC) was used to analyze the hypothesis.

RESULTS AND DISCUSSION

Socio-economic Characteristics of the Respondents

Results on table 1 revealed that the mean age of the cocoa farmers was 42years. The implies that the respondents sampled were still in their active age. Younger farmers may be more digitally savvy and thus more inclined to use social media platforms for information gathering. They may also be more receptive to new technologies and innovations on climate change adaptation. However, older farmers might face barriers such as limited access to technology, lower digital literacy, or traditional methods of information dissemination preference. This result is in line with Aromolaran *et al.,* (2017), where the mean age of the farmers used in his study was 49 years. The mean years spent in school was 11years. The findings showed that most of the respondents sampled in the study area were literate. Higher levels of education are generally associated with greater digital literacy and access to technology, including social media platforms. Farmers with more years of schooling are likely to be more proficient in using social media for information gathering, including accessing climate change adaptation strategies. This type of individuals are expected to have a better understanding of climate change and its impacts on cocoa. Chikezie (2012) posits that education is an important socio-economic factor that influences a farmer 's decision because of its influence on the farmer 's awareness, reception and the adoption of innovation that can increase production. The average household size was 6 members which are fairly large.

This result indicated that large households might have reasons to increase their level of cocoa production and need to access social media platforms for required information to combat the effects of climate change on cocoa production The mean years of farming experience was 29 years indicating that respondents had vast experience in cocoa production, and this is expected to influence their frequency of use of social media for accessing information on cocoa production as well as information on climate change adaptation strategies due to the wealth of experience they have gathered over time on cocoa production. The result agreed with (Adah et al., 2007) who stated that the higher the years of experience of a farmer the greater such farmer's ability to manage general and specific factors that affect his/her business.

Climate change adaptation strategies information accessed through the social media platforms

Result in Table 2 identified climate change adaptation strategies information accessed through the social media platforms among the respondents in the study area. The result revealed that majority (68.1%) of the respondents indicated to have accessed via social media information on targeting rainy season for planting leading to either late or early planting as the climate change adaptation strategies, planting of improved cocoa varieties 66.9%, changing planting date 64.4%. Others include pest management 60.6%, crop diversification 60.0%, harvest and storage 56.3%, application of fertilizer 42.5%, weed control 38.1%, post-harvest processing 37.5%, diversification to non-farm activities 33.8%, soil conservation measures 26.3%, use of irrigation system 25.6%, and tree planting 20.6%. The result implied that various information on climate change adaptation strategies on cocoa production were accessed via social media platforms by the respondents in the study area. Access to information on climate change adaptation strategies via social media platforms may empower cocoa farmers to make informed decisions and implement effective strategies. It can enhance their awareness, knowledge, and adoption of relevant practices, ultimately contributing to their resilience against climate change impact on cocoa production.

Rank order of frequency of use of available social media platforms

On the frequency of use of available social media platforms, it was measured on four-point rating scale of often, sometimes, rarely and never and weighted mean score (X) was computed and ranked. The result revealed that WhatsApp had the highest weighted mean score of 3.94, followed by Facebook with weighted mean score of 2.63. Other frequency of use of social media platform are in following order: Email (X = 2.19), Messenger (X=2.08), Instagram (X = 1.96), YouTube (X =1.86), Twitter (X=1.47), Telegram (X=1.40), Linkedin and Snapchat (WMS=0.94) respectively while Zoom was the least with weighted mean score of (0.07). The above result implied that WhatsApp and Facebook were frequently used social media platforms among the respondents for accessing information on climate change adaptation strategies on cocoa production. The frequency of social media platforms usage among cocoa farmers could influence their access to information on climate change adaptation strategies. Higher usage implies that the respondents are likely to encounter relevant information, but it also depends on the relevance of the content, needs and preference.

Constraints facing social media usage for accessing climate change adaptation strategies information

Result in Table 8 identified the constraints faced by respondents in the usage social media for accessing climate change adaptation strategies information in the study area. The result revealed that majority (96.9%) of the respondents identified high cost of device and high cost of operation (cost of subscription), 81.9% identified unreliable power supply, 71.3% identified interrupted network while 66.3% of the respondents identified poor familiarization. The result implied that cocoa farmers in the study area usually experienced challenges in obtaining information due to numerous constraints and they can hinder social media platforms utilization. The findings agree with. Sokoya *et al.,* (2012) who claimed that poor quality of available ICTs and erratic electricity power supply were constraints limiting the use of social media as a source of information.

Test of Hypothesis

The result of the analysis in Table 5 revealed that age (r = 0.791**; P = 0.000), year spent in school (r = 0.705**; P = 0.000); primary occupation (r = 0.517**; P = 0.000) and year of experience (r = 0.644**; P = 0.000) showed significant relationship with the frequency of social media for accessing information on climate change adaptation strategies. The aforementioned socio-economic variables (age, year spent in school, primary occupation and year of experience) have decisive influence on the frequency of use of the identified social media among the respondents in the area. Therefore, the null hypothesis is rejected, hence alternative hypothesis was accepted:

Ho_3: There is significant relationship between the selected socio-economic characteristics of the respondents and the frequency of use of social media for accessing information on climate change adaptation strategies.

For the above hypothesis, age was positive and significant level of 1%. The positive relationship suggests younger farmers are more likely to frequently utilize social media platforms to stay informed on climate change adaptation techniques on cocoa farming. This could be due to the fact that younger farmers are frequently and always with their phones and other gadgets where they can easily access information. Year spent in school was positive and significant level of 1%. The positive relationship indicated that individuals that are literate tend to use social media more often to gather general information and other information that are related climate change and recommended strategies to curb its effects also primary occupation was positive and significant at 1%. The positive relationship implied that individuals whose primary occupation involves cocoa farming are more likely to utilize social media platforms to stay informed on cocoa production and how climate change effects can be best ameliorated through the adoption of accessed recommendation social media. Year of experience was also significant at 1%. The positive relationship indicated that cocoa farmers with certain years of experience in cocoa farming are more likely to have reasons to access information on climate change adaptation strategies through social media with the intention to sustainably increase income and hence profit on cocoa production. Farmers with adequate years of experience would prefer to search and gather information on climate change and its effects on cocoa production. Hence, these farmers would adopt and utilizes available recommendations/strategies to curb these effects.

CONCLUSION AND RECOMMENDATIONS

Based on the findings of the study, it was ascertained that WhatsApp, Facebook and Messenger as the most widely used social media platforms among the respondents for accessing climate change information, with WhatsApp emerging as the most used social media platform. Key climate change adaptation strategies accessed through social media included adjusting planting schedule and adopting improved cocoa varieties. However, the study also highlighted several constraints to social media usage, such as high cost of social media gadget, technical issues, and poor network connectivity. Finally, socio-economic variable such as age, educational level, and farming experience were found to significantly influenced their use of social media in accessing climate change adaptation strategies in the study area. Thus, Stakeholders involved in agriculture should strengthen network infrastructure in rural areas to improve connectivity, addressing one of the primary constraints identified by the study and enabling more seamless access to vital information on climate change adaptation strategies.

REFERENCES

Annate, O.E. (2016), cocoa production and processing technologies, CRS press, Taylor and Francis Group, LLC.

Diekmann T.T, Loibl and Batte R. M, (2009). Economic impact of climate change on crop production in Ethiopia: evidence from cross-section measures. Journal of African. Economies 18, 529– 554.

Ifejika, P.I., Asadu, A.N., Enibe, D.O., Ifejika, L. I., &Sule, A. M. (2019) Analysis of social media mainstreaming in E-extension by Agricultural Development Programme in North Central zone, Nigeria. *Journal of Agricultural Extension and Rural Development*, 11(1), 78 – 84

Kakade, P. (2013); Climate change adaptation strategies used by Limpopo Province farmers in South Africa. J. Agric. Sci. 2012, 4, 39–47.

Kalusopa, M. (2005). Economic Impact of Climate change on agriculture in Cameroon. Policy Research paper No 4364 World Bank, Washington, D. C. pp. 51-55.

Olaniyi, N. (2013). Difficulties in Adapting to Climate Change by Farmers in Enugu State, Nigeria. J. of Agric.Extension.14 (2): 106-122.

United Nations Department of Economic and Social Affair (2019). How certain are the United Nations global populations projections? Populations facts December 2019, No 2019/6

Watson, R. T., M. C. Zinyowera, and R. H. Moss. 2014. *The Regional Impacts of Climate Change: An Assessment of Vulnerability*. Cambridge, U.K.: Cambridge University Press.

Table 1: Distribution of Respondents by Socio-economic Characteristics (n=160)

Age (years)			
≤ 30	8	5.1	42
31-40	96	59.6	
41-50	39	24.7	
Years spent in school			
≤ 6	43	26.9	11
7-12	45	28.2	
Household size			
≤ 5	60	37.6	6
6-10	89	55.6	
Above 10	11	6.9	
Years of experience			
≤ 10	22	13.8	
11-20	36	22.6	29
21-30	28	17.5	
Above 30	74	46.1	

Source: field survey, 2024

Table 2: Distribution of respondents according climate change adaptation strategies information accessed through the social media platforms (n=160)

Climate change adaptation strategies information	***Frequency**	**Percentage**
Changing planting date	103	64.4
Diversification to non-farm activities	54	33.8
Planting of improved coca varieties	107	66.9
Crop diversification	96	60.0
Application of fertilizer	68	42.5
Tree planting	33	20.6
Targeting raining season of plant, leading to other later or early planting	109	68.1
Use of irrigation system	41	25.6
Weed control	61	38.1
Pest management	97	60.6
Harvest and storage	90	56.3
Soil conservation measures	42	26.3
Post-harvest processing	60	37.5
Soil conservation measures	41	25.6
Planting of drought resistant cocoa varieties	99	61.9

Source: Field survey, 2024
***Multiple responses**

Table 3: Distribution of respondents according to frequency of use of available social media platforms (n = 60)

Social media platforms	Frequency (percentage)					
	Often	Sometimes	Rarely	Never	X	Rank
WhatsApp	153(95.6)	5(3.1)	2(1.3)	-	3.94	1st
Facebook	115(71.9)	30(18.8)	15(9.3)	-	2.63	2nd
Twitter	34(21.3)	30(18.8)	73(45.6)	23(14.4)	1.47	7th
Email	40(25.0)	110(68.8)	10(6.3)	-	2.19	3rd
Zoom	3(1.9)	1(0.6)	-	157(98.1)	0.07	11th
Snapchat	30(18.8)	10(6.3)	40(25.0)	80(50.0)	0.94	9th
Messenger	30(18.8)	120(75.0)	2(1.3)	8(5.0)	2.08	4th
Linkedin	30(18.8)	10(6.3)	40(25.0)	80(50.0)	0.94	9th
Instagram	17(10.6)	90(52.3)	41(25.6)	12(7.5)	1.96	5th
YouTube	28(17.5)	100(62.5)	12(7.5)	20(12.5)	1.86	6th
Telegram	27(16.9)	41(25.6)	60(37.5)	32(20.0)	1.40	8th

Source: Field survey, 2024
X: Weighted Mean Score

Table 4: Distribution of respondents according to constraints facing social media usage for accessing climate change adaptation strategies information (n=160)

Constraints	*Frequency	Percentage
Unreliable power supply	131	81.9
High cost of facilities	155	96.9
Interrupted network	110	68.8
Poor familiarization	106	66.3
Inadequate operational knowledge	114	71.3
High cost of operation (cost of subscription)	155	96.9

Source: Field survey, 2024
*Multiple responses

Table 5: Relationship between the selected socio-economic characteristics of respondents and frequency of use of social media for accessing information on climate change adaptation strategies

Variable	r-value	P-value	Remark	Decision
Age	0.791**	0.000	Significant	Reject Ho
Year spent in school	0.705**	0.000	Significant	Reject Ho
Primary occupation	0.517**	0.000	Significant	Reject Ho
Year of experience	0.644**	0.000	Significant	Reject Ho

**Correlation is Significant at 5%