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EVALUATION OF SOIL PROPERTIES IN SELECTED AREAS OF AGRARIAN COMMUNITIES OF AKWA IBOM STATE, NIGERIA

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***Abstract**: From the findings of this research, soil properties in selected areas of agrarian communities of Akwa Ibom state, Nigeria were evaluated. Hence, representative soil samples were obtained from four different locations at 0-20cm and 20-40cm depths. The samples were subjected to standard laboratory analytical methods to determine the physical and chemical properties of the soil, soil texture (Sand, silt and clay), pH, CEC, and exchangeable acidity at different study sites. The standard fertility ratings were used to interpret the results obtained. The soils had a pH range of 1.50-7.71at the surface. The results obtained showed that most of the soils were dominantly sandy loam, slightly acidic to strongly acidic with low exchange acidity, Cation exchange capacity was observed to range from low to moderate, indicating that the soils will support arable crop production. From the results of the present study it is recommended that the phosphorus and exchangeable potassium should be artificially supplemented to enhance the nutrients in the soil required for the growth and yield of the crop plants.*

Keywords: *Soil Properties, Agrarian Communities, Agriculture, Crops, Evaluation*

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INTRODUCTION

Agricultural practices require sustainable use and management of soil resources (Talha and Abba, 2019). The soils may easily lose their nutrients and qualities within a short period of time under poor management and land use. Soil, being the natural medium for plant growth, has a direct impact on yield and quality of crops and pastures growing on it. Improving the productivity of the agricultural sector of the country is greatly dependent on efficient utilization and management of soils (Kidder, 2013). Soils in many areas have been degraded irreversibly and has become incapable for supporting agricultural production. Spatial variability of physio-chemical characteristics concerns on the evaluation of the factors such as climate, and physio- chemical characteristics of soil (Roslan *et al.,* 2011).

Soil properties describe the physical and chemical characteristic behaviour of soils (Usman, 2017) which all together entails its fertility. The need for basic knowledge and assessment of changes in soil properties and their fertility status with time to evaluate the impact of various soil management practices has become necessary for sustainable agriculture in Nigerian savanna zones (Usman, 2020). Similarly, for sustainable soil nutrient management in these zones, there is also need for an understanding of how soil responds to agricultural practices over time.

Knowledge of soil properties in the savannah describe the inherent soil productivity and fertility to support crop production which should be evaluated for changes over time as a result of adverse weathers in the tropics. Soil fertility is a complex soil index which include physical and chemical characteristic, and it is an important component of overall soil productivity (Talha and Abba, 2019).

Soil fertility institute availability of nutrient status, and its aptitude to provide nutrients out of its own reserves and through exterior applications for crop production. According to report by Roslan *et al.,* (2011) soil fertility degradation is aided more by climate change and described it as one of the most important constraints to food security. Soil fertility degradation implies a decline in soil quality with an attendant reduction in ecosystem functions and services (Lal and Shukla, 2015).

The use of chemical fertilizers in supplementing the soil requirement has been increasing steadily, however, sustainable agricultural productivity depends largely on improved soil fertility management and hence, considered an important factor in production. Soil analysis is a reliable tool used in evaluating and predicting the fertility condition of a soil, thus employed as a diagnostic tool for management strategies in improving soil fertility for increased production (Talha and Abba, 2019).

Soil Analysis/Soil Testing

Soil testing is used to determine both the amount of each nutrient that is immediately available and the amount that can become available during the life of a crop. Various methods have been developed and the key to success is that the methods must be calibrated. Soil test calibration implies establishing relationship between soil test values and relative crop response (Noma *et al*., 2004). Soil sampling done properly forms the basis of a successful long-term soil and crop nutrient management plan. It is most useful before planting to predict lime or fertilizer needs (Brady and Weil, 2017). Also, it measures levels of specific nutrients in a soil. However, it cannot indicate whether plants growing in that soil are able to take up the nutrients. Soil test is the best way to assess soil pH (Kidder, 2013).

The measure of soil pH is an important parameter which helps in identification of chemical nature of the soil (Shalini *et al*., 2003) as it measures hydrogen ion concentration in the soil to indicate its acidic and alkaline nature of the soil. Soil pH is determined by the concentration of hydrogen ions ($H^{\cdot}$). It is a measure of the soil solution's (soil water together with its dissolved substances) acidity and alkalinity, on a scale from 1 to 14. Acidic solutions have a pH less than 7, while basic or alkaline solutions have a pH greater than 7. By definition, pH is measured on a negative logarithmic scale of the hydrogen ion concentration [$H^{\cdot}$], i.e., pH = -log [$H^{\cdot}$].

METHODOLOGY

Soil Sampling and Preparation

Four local government areas (LGA) were randomly selected. In each LGA, sampling were carried out within the cultivated farms using bucket auger. Soil samples were collected at 0 – 20 cm (surface soil) and 20 – 40 cm (sub-surface soil) depth. Bulk auger samples were reduced to five (4) for each transect by bulking sample spots 1 and 2, 3 and 4, 5 and 6, 7 and 8, to make a composite sample, making a total of 60 composite sample from all the research locations. The samples were packaged and separately stored in cotton soil sample bags according location. The samples were then air dried, crushed gently using mortar and pestle and sieved through 2mm sieve to remove the coarse sand for particle size and chemical analysis. 60 undisturbed soil core samples were accordingly be collected for bulk density analysis.

Laboratory Soil Analysis

Soil samples were analyzed following standard laboratory procedures. The parameters analyzed included: Particle size analysis by hydrometer method, bulk density was determined using core sampler method (Bandyopadhyay *et al.,* 2012). Total soil porosity was calculated by assuming particle density 2.65 g cm^{-3} using the following equation. Total soil porosity was determined using an expression = 1 - (bulk density/2.65) × 100. pH in H_2O at 1:2.5 soil: water/solution ratio and 0.01 M calcium chloride suspensions using a pH meter with glass and reference electrodes (Bates, 1954). Walkley and Blacks (1934), chromic acid oxidation method was used in determining organic carbon. Exchangeable Cations (Ca, Mg, K, Na) was extracted by Ammonium Acetate (1N NH4 OAC) method, Ca and Mg was determined by Atomic Absorption Spectrophotometer (AAS) and K and Na by using flame photometer, exchange acidity (Al^{3+} + H^+) was by KCl displacement method then followed by titration with standard $NaOH_2$. Cation exchange capacity (CEC) and base saturation was determined by calculation and electrical conductivity by EC meter, Available phosphorus was extracted with 0.03 M ammonium chloride in 0.025 M hydrochloric acid (Bray and Kurtz, 1945).

Data Analysis

All data obtained from the laboratory analysis were subjected to Analysis of variance (ANOVA) using Statistical Package for Social Sciences (SPSS) v. 25.0.

RESULTS

Table 1: Physical properties of sampled soils of the four Local governments.

Sample Location	**Depth (cm)**	**Sand g/kg**	**Clay**	**Silt**	**Texture**
		Soil Properties			
LG 1	0-20	806.0	58.0	25.0	S
	20-40	689.0	60.0	21.0	SL
LG 2	0-20	752.0	62.0	20.0	S
	20-40	586.0	59.0	24.0	SL
LG 3	0-20	652.0	58.0	22.0	SL
	20-40	585.0	61.0	21.0	S
LG 4	0-20	632.0	60.0	22.0	SL
	20-40	586.0	58.0	20.0	SL

S = Sand Soil, SL = Sandy Loam.

Table 2: Exchangeable Acid and Cation Exchange Capacity of the four selected Local Government areas.

Location	EA	CEC
LG 1		
Range	4.06-6.06	0.34-0.84
Mean	5.22	0.80
SD	1.32	0.24
C V	24.86	26.66
LG 2		
Range	1.50-16.74	0.45-0.67
Mean	5.64	0.54
SD	3.12	0.28
C V	57.88	18.36
LG 3		
Range	3.21-8.47	0.61-0.79
Mean	5.11	0.91
SD	1.68	0.26
C V	46.22	14.10
LG 4		
Range	3.32	0.58-0.79
Mean	6.59	0.61
SD	3.21	0.36
C V	37.15	21.74

CEC= Cation exchange Capacity; EA = Exchangeable acid

Table 3: pH of the four selected local government areas.

Location	pH(Water)	pH(KCl)	EC
LG 1			
Range	3.06-5.06	0.31-0.64	0.02-0.08
Mean	4.22	0.60	0.03
SD	2.32	0.14	0.01
C V	34.86	26.36	64.88
LG 2			
Range	1.50-7.71	0.45-0.77	0.02-0.08
Mean	4.54	0.54	0.04
SD	1.12	0.25	0.02
C V	46.88	19.31	0.01
LG 3			
Range	4.21-7.47	0.62-0.89	0.02-0.08
Mean	7.11	0.94	0.03
SD	1.68	0.23	0.01
C V	46.21	17.10	0.02
LG 4			
Range	4.32-6.11	0.58-0.79	0.02-0.08
Mean	6.59	0.61	0.01
SD	3.23	0.36	0.02
C V	47.18	31.71	0.01

EC= Electrical Conductivity

DISCUSSION

Observing the Soil Particle Size, **g**enerally all the soil were identified as been dominantly sandy loam with some variations in the content of silt and clay from Table 1. While, soils from LG2 were observed to be lower silt than the clay content, when compared to the Alfisols of Northern Guinea Savanna. According to Akpa *et al.* (2014), reiterate the influence of harmattan dust as a contributor of silt deposition on a surface soils. The results obtained is contrary to the findings of (Sharu *et al.,* 2013).

High sand content has been reported by Akpa *et al.* (2014) to be a common phenomenon for Savanna soils has it reflects the granitic origin of the parent materials of the soils and may be attributed to the removal of the fraction by surface run-off and by alluviation. Odunze, (2003) opined that the soils in the Northern Guinea Savanna have dominantly Kaolinite clays and are sandy to sandy-loam in texture. They have low available soil moisture retention capacity and encourage nutrient loss away from the rooting depth, this may be due to high rate of mineralization brought about by high temperature and moderate rainfall of the area.

The low pH across the locations from each soil order may be attributed to the use of chemical fertilizer and other amendments (most especially of Ammonium Nitrate origin) by most of the farmers across the region to supply nutrients for field crops (Tanko, 2018). Similarly, Mustapha *et al.* (2017) and Tanko (2018) obtained similar results on their work on the soils of Savanna soils, thus, implying salinization is not a significant pedogenic process in the soils this region and the soils does not contain a concentration of soluble salt that may hamper the growth of plant.

Moderate organic matter content of the region has been attributed to factors such as continuous cultivation, frequent burning of farm residues commonly carried out by farmers which tends to destroy much of the organic materials that could have been added to the soil (Sharu *et al.,* 2013). Lawal, (2013) pointed out that low organic carbon content of the soils is characteristics of the savanna due to partly to rapid decomposition and mineralization of organic matter and to poor management sometimes by burning of crop residues by farmers. Moderate levels of organic carbon are usually expected at the top layers as explained by Fagwalawa *et al.* (2014) due to accumulation and decomposition of organic debris accumulates at the top of the soil.

The low contents of available P obtained on average across most of the locations might be related to parent materials made up of low weatherable mineral reserve necessary for nutrient recharge and partly to the complete crop residue removal by the farmers in the Guinea Savanna region. (Ibrahim *et al.,* 2016; Tanko, 2018). Voncir *et al*. (2006) further proposed that the reason for the observed low phosphorus in the Savanna region could be due to the prevalent soil management practices which encourage the export of nutrients in harvested crops without adequate replacement.

Low exchange acidity is an indication of little or no acidity problems and therefore Al^{3+} is not part of the dominance cation in the soil of this region (Ibrahim *et al.,* 2016) with similar results obtained by Raji and Mohammed, (2000). It was proposed that the contribution of exchange acidity to potential acidity is very low in soils of Nigerian savannas.

The CEC results obtained is in line with the findings of Oyinlola and Chude, (2010) in Northern Nigeria Savanna. Lawal, (2013) also reported high level of CEC in the surface soils of Southern Guinea Savanna zone of Nigeria, which could be attributed to the nature of clay minerals (kaolinite) dominant in the savanna zone of Nigeria. It may also be a reflection of the intensity of weathering that produced the soils or as a result of continuous mining through cultivation (Shehu *et al*., 2015).

Conclusion

The evaluation of soil properties in selected areas of agrarian communities of Akwa Ibom state, Nigeria, were the principal objective of this research. Soil analysis to determine the levels of plant nutrients in the soils was carried out. However, the results from this research revealed that the soils were majorly sandy loam, acidic and low organic carbon content. Total nitrogen was rated moderate to low while cation exchange capacity was rated from very low to high. Relevant information that can affect decisions on use and management of these soils has been highlighted by this research.

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