



## SOIL FERTILITY EVALUATION UNDER DIFFERENT LAND USE TYPE IN IKORODU, LAGOS STATE, NIGERIA

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### ABSTRACT

The study was conducted to assess the fertility status and nutrient index of the soils under two land use types (oil palm plantation and cassava farmland) in Ikorodu, Lagos State in 2024. Reconnaissance Survey of two land use types was carried out and samples were collected using systematic random sampling from each slope position at 0-20 and 20-40 cm depths. The samples were analysed to determine selected physical and chemical properties. Results indicated that the fertility status of soils under two land use types were medium to high, with high organic carbon contents and slightly acidic pH. The available phosphorus and potassium content were also high within both soils. The soils generally possessed high sand content with sandy loam and loamy sand texture. The results also shows that there is potential for improvement in soil fertility condition. As a result, manure application, balanced fertiliser usage, suitable cultivation techniques, and nutrient management are necessary to improve soil fertility and achieve optimal crop production levels.

**Keywords:** Fertility status, Nutrient index, Land use types

### INTRODUCTION

Soil fertility is a relatively complex concept that can be defined as the potential of a soil to generate or produce a substantial yield. (Akintola *et al.*, 2020). Soil fertility is associated with physical, biological, chemical, climatic, and geological properties of site sites, as well as anthropogenic activities such as building, farming, erosion, deforestation, overexploitation, and so on. Soil is a non-renewable resource, and it is commonly understood that it must be preserved, maintained, or enhanced in order to perform a wide range of tasks. If not handled properly, it can quickly deteriorate and have limited regeneration ability (Chandrakala *et al.*, 2018). The tropics have two-dimensional problems: falling per capita productivity and rising environmental degradation. Also important is the great regional heterogeneity in the physicochemical and morphological features of soils, indicating that different soils respond differently to land use types and management options (Chikere-Njoku, 2019). Land uses affect soil fertility and productivity. These manifests as change in soil properties such as nutrient content (N, P, K Ca Mg, and S etc.), pH, organic matter, CEC, structure etc. (Ayodele *et al.*, 2019). Hence, soil testing to know the status of soil fertility is a necessary step towards sustainable soil management. Soil test status based recommendation of nutrients, manures



results in better crop production and productivity apart from maintaining soil health (Chandrakala *et al.*, 2018). Nutrient index methods and fertility markers can be used to assess soil fertility. This study was therefore conducted to assess the fertility status and nutrient index of the soils under two land use types (oil palm plantation and cultivated cassava farmland) in Ikorodu, Lagos State.

## MATERIALS AND METHODS

### Description of the study area

The study was conducted at the Lagos State University of Science and Technology, Ikorodu, Lagos State. This lies between Longitude: 3°16' E, Latitude: 5°10' N. The study area is located in the humid tropical rainforest agro-ecological zone. The mean average temperature is 25°C - 29°C with December and February being the hottest. The annual rainfall ranges between 1000mm – 1500mm and relative humidity between 65 – 68%. The wet season normally starts from the month of March and ends in October while the dry season comes up between November and February.

### Soil Sampling

Reconnaissance Survey of two land use types (Oil palm plantation and Cassava farm land) was carried out, it was delineated into Upper, Middle and Lower slope positions for sampling. Soil samples were collected using Systematic random sampling at each slope position at 0-20 and 20-40 cm depths in triplicates. Composited soil samples were sub-sampled, well labelled and bagged for laboratory analysis. The soil samples were air dried and gently crushed in a mortar. It was passed through a 2mm sieve for the determination of particle size analysis, soil pH, Exchangeable acidity, available phosphorus, cation exchange capacity, exchangeable bases and micro-nutrients of the soil. The soil samples were also passed through a 0.5mm sieve for organic carbon and total nitrogen determination.

### Laboratory Analysis

Particle size analysis was determined using the Bouyoucos hydrometer method. The soil reaction (pH) of a 1:2.5 soil-to water suspension was measured using a digital pH meter (Rayment and Higginson, 1992). The total nitrogen content of the soil was determined by the Kjeldahl method (Bremner and Mulvaney, 1982), and Soil organic carbon was determined by a modified Walkley-Black method (Nelson and Sommers, 1996). The available phosphorus (P) was determined by the Bray P1 method (Olsen and Sommers, 1982). The exchangeable bases (Ca, Mg, K, & Na) were extracted from the soil using the ammonium acetate method, the extract was then analyzed for Ca and Mg by the use of atomic absorption spectrophotometer and the K<sup>+</sup> and Na<sup>+</sup> were determined by the use of flame photometer (Sparks, 1996).

### Nutrient Index Evaluation

Nutrient index was calculated using the equation proposed by Ravikumar and Somashekar (2013).

$$\text{Nutrient Index (NI)} = \frac{NL * 1 + NM * 2 + NH + 3}{NT} \quad (1)$$

Where, NL, NM and NH are number of samples falling in low, medium and high classes of nutrient status, respectively and NT is total number of samples analyzed for a given area. Interpretation of this nutrient index values was conducted using the Nutrient Index category I, II and III as shown in Table 1.

**Table 1:** Nutrient Index Rating for Soils

Nutrient Index	Range of Soil nutrient	Fertility Level
I	Below 1.67	Low
II	1.67-2.33	Medium
III	Above 2.33	High

The soil data was subjected to descriptive statistics such as mean, standard deviation and coefficient of variation (CV). The variability analysis utilised the coefficient of variation (CV), with CV <15% indicating low variability, CV 15-35% indicating moderate variability, and CV >35% indicating high variability (Wilding and Drees, 1985).

## RESULT AND DISCUSSION

The results for the particle size distribution of the oil palm plantation and cassava farm are shown in Table 1 and 2. The soils were dominated by sand fractions with both depths ranging 75.8 % – 84.08 % and 70.08 % - 77.8 % for the oil palm plantation and cassava farm respectively. For the oil palm plantation, the sand fraction and clay fraction of the soils at both depths had low variability with ranges of 2 % - 3% and 1 % - 7 % respectively. However, the silt fraction of the soils showed medium variability with values of 34 % for 0 – 20 cm depth and 17 % for 20 – 40 cm depth. The cassava plantation had similar low variability fraction (2% - 5 %) for its sand fraction, with low variability (3 % - 8 %) within both depths for silt contents of the soil. However, at depth 20 -40 cm the clay fraction of the soil showed medium variability (21%). The texture of the soils at both depths were sandy loam, with loamy sand texture in the middle slope position at 0-20cm depth for oil palm plantation and sandy clay loam in the in the lower slope portion at 20 – 40 cm depth for cassava farm. The high sand fraction in the soils can be attributed to the nature parent material from which the study sites soil have been derived, with Ikorodu soils been formed from coastal plain sands. Epuh *et al.* (2020) reported that the two geology types found in Ikorodu are the alluvial and coastal plain sands. Similar results of high sand fractions in Ikorodu soils was reported by Orimoloye and Okpitari (2020).

**Table 2:** Selected Soil Physical Properties of the Oil palm plantation

Sample point	Sand	Clay	Silt	Texture
	%	%	%	
<b>0 - 20 cm depth</b>				
Oil palm 1	81.08	11.2	7.72	Sandy Loam
Oil palm 2	84.8	10.92	4.28	Loamy Sand
Oil palm 3	80.08	11.2	8.72	Sandy Loam
Mean	81.98667	11.10667	6.906667	
STD	2.487194	0.161658	2.329063	
CV (%)	3%	1%	34%	
<b>20-40 cm depth</b>				
Oil palm 1	75.8	13.92	10.28	Sandy Loam
Oil palm 2	78.8	12.92	8.28	Sandy Loam
Oil palm 3	76.8	14.92	8.28	Sandy Loam
Mean	77.13333	13.92	8.946667	
STD	1.527525	1	1.154701	
CV (%)	2%	7%	13%	

CV = Coefficient of variation; STD = Standard Deviation

**Table 3:** Selected Soil Physical Properties of the Study Site

Sample point	Sand %	Clay %	Silt %	Texture
<b>0 - 20 cm depth</b>				
Cassava 1	77.08	13.2	9.72	Sandy Loam
Cassava 2	76.8	14.92	8.28	Sandy Loam
Cassava 3	74.8	15.92	9.28	Sandy Loam
Mean	76.22667	14.68	9.093333	
STD	1.243436	1.375791	0.737925	
CV (%)	2%	9%	8%	
<b>20-40 cm depth</b>				
Cassava 1	76.8	14.92	8.28	Sandy Loam
Cassava 2	76.18	14.92	8.9	Sandy Loam
Cassava 3	70.08	21.2	8.72	Sandy Clay Loam
Mean	74.35333	17.01333	8.593333	
STD	3.713776	3.62576	0.273008	
CV (%)	5%	21%	3%	

CV = Coefficient of variation; STD = Standard Deviation

The results of the soil chemical properties of the study sites (Table 4 and 5) showed that the soils were slightly acidic to neutral in nature with a mean value of 6.59 and 6.6 at 0 – 20 cm and 20 – 40 cm depth respectively. Low variation was observed across the pH of the oil palm plantation and cassava farm land. This could be attributed to the parent material from which the soils originate. Kharal *et al.* (2018) noted that the fundamental cause for more acidic soils on forest land may be related to parent materials high in elements such as silica, significant leaching of basic cations during monsoon season, and the atmospheric nature of aluminium in these soils. Chukwu *et al.* (2023) noted that soils derived from coastal plain sands are predominantly deep, sandy with low pH.

The organic carbon content was rated high across the oil palm plantation soil with a mean value of 2.78 %; 1.58 % and 1.35 %; 1.32% at the 0 -20 and 20 – 40 cm depth respectively. The variability within both depths were medium. The high organic carbon content can be attributed to accumulation of organic carbon the soil over a long period of time. Yao *et al.* (2023) stated that every year, numerous extraneous compounds return to the surface soil, providing energy sources for microorganisms, accelerating the breakdown rate of humus, and increasing the input of soil organic carbon.

The soils were rated medium on the total nitrogen content of the soils, with mean values of 0.254 %; 0.232 % and 0.196 %; 0.178 % at the 0 – 20 cm and 20 -40 cm depth. The variability within the soils were low. The medium rating of the soils can be as a result of the high organic matter content present in the soil, with organic matter serving as a major source of nitrogen within soils. According to Suntoro *et al.* (2024) organic matter in soil impacts nutrient availability through mineralisation, especially nitrogen, and humification, which enhances cation exchange capacity of the soil. There is a clear correlation between soil organic carbon and total nitrogen content; an increase in the amount of organic carbon in the soil will result in an increase in total nitrogen content (Wibowo and Kasno, 2021).

The mean available phosphorus content from both depths rated high at 0 -20 cm depth (22.23 mg/kg) and medium at 20 -40 cm depth (18.83 mg/kg). Low variability was observed at the 0- 20 cm depth while medium variability was observed at the 20 – 40 cm depth. The high available phosphorus content might be due to the high organic matter within the soil and the

slightly acidic pH. Solangi *et al.* (2023) linked the relationship between pH and phosphorus availability, indicating availability of phosphorus in a soil being highest at close to neutral pH. Organic matter is the key organic carbon and energy provider for phoD-harboring bacteria. It can raise the C/P and C/N ratios, enabling Phosphorus mineralisation and release for plant uptake (Chen *et al.*, 2023)

The variability within the soil for exchangeable sodium, potassium, calcium and magnesium were low at both depths. The exchangeable potassium content of both depths were rated high with mean values of 0.527 cmol/kg; 0.492 cmol/kg and 0.498 cmol/kg; 0.507 cmol/kg. The exchangeable magnesium content was medium with mean values of 0.361 cmol/kg; 0.322 cmol/kg and 0.320 cmol/kg; 0.336 cmol/kg. The exchangeable sodium content of the soils had showed low variability at the 0-20 cm depth with medium variability at 20 - 40 cm depth. They had mean values 0.33 cmol/kg; 0.306 cmol/kg and 0.26 cmol/kg; 0.319 cmol/kg respectively, which were rated medium to high. This was similar to the findings of Negash and Mohammed (2014). Ugwa *et al.* (2022) reported similar findings of adequate exchangeable base contents in soils of different land uses, which included cassava cultivated farmland. The high exchangeable base content within the soils can be attributed high organic matter content, reduced leaching and parent material composition of the soils. The high clay and comparatively high organic matter content of the soils may be connected to the elevated divalent cation levels. Even though the soil's pH can be acidic, exchangeable Ca and Mg ions are adsorbed to the soil's surface due to its high organic matter content and remain in the soil with little likelihood of leaking since these cations have formed exchangeable bases (Aki and Esong, 2018).

**Table 4:** Selected Soil Chemical Properties of the Oil palm plantation

Sample point	pH	N %	Org. C %	Av. P mg/kg	Na cmol/kg	K cmol/kg	Ca cmol/kg	Mg cmol/kg
<b>0 -20 cm depth</b>								
Oil Palm 1	6.85	0.261	2.77	21.41	0.334	0.523	0.316	0.363
Oil Palm 2	6.52	0.228	3.51	24.45	0.335	0.542	0.321	0.368
Oil Palm 3	6.4	0.275	2.05	20.82	0.328	0.518	0.32	0.354
Mean	6.59	0.254667	2.77939	22.22667	0.332333	0.527667	0.319	0.361667
STD	0.233024	0.024132	0.72827	1.947931	0.003786	0.012662	0.002646	0.007095
CV (%)	4%	9%	26%	9%	1%	2%	1%	2%
<b>20 - 40 cm depth</b>								
Oil Palm 1	6.53	0.179	1.14	16.89	0.302	0.488	0.291	0.316
Oil Palm 2	6.53	0.212	1.64	21.02	0.18	0.51	0.302	0.324
Oil Palm 3	6.74	0.199	1.28	18.56	0.309	0.496	0.291	0.322
Mean	6.6	0.196667	1.34977	18.82333	0.263667	0.498	0.294667	0.320667
STD	0.121244	0.016623	0.25733	2.077555	0.072542	0.011136	0.006351	0.004163
CV (%)	2%	8%	19%	11%	28%	2%	2%	1%

N= Total Nitrogen, Org.C= Organic Carbon, Av.P = Available Phosphorus, Na= sodium, K = Potassium, Ca= Calcium, Mg= Magnesium, STD = Standard Deviation, CV= Coefficient of Variation

**Table 5:** Selected Soil Chemical Properties of Cultivated Cassava Farmland

Sample point	pH	N %	Org. C %	Av. P mg/kg	Na cmol/kg	K cmol/kg	Ca cmol/kg	Mg cmol/kg
<b>0 -20 cm depth</b>								
Cassava 1	6.76	0.254	1.91	18.92	0.311	0.491	0.298	0.326
Cassava 2	6.6	0.207	1.40	20.1	0.305	0.498	0.294	0.321
Cassava 3	6.4	0.234	1.44	19.65	0.302	0.488	0.289	0.319
Mean	6.586667	0.231667	1.58237	19.55667	0.306	0.492333	0.293667	0.322
STD	0.18037	0.023587	0.28853	0.595511	0.004583	0.005132	0.004509	0.003606
CV (%)	3%	10%	18%	3%	1%	1%	2%	1%
<b>20 - 40 cm depth</b>								
Cassava 1	6.27	0.188	1.48	22.79	0.325	0.521	0.31	0.351
Cassava 2	6.72	0.184	1.44	19.85	0.328	0.519	0.311	0.345
Cassava 3	7.04	0.163	1.08	16.52	0.304	0.482	0.269	0.312
Mean	6.676667	0.178333	1.32985	19.72	0.319	0.507333	0.296667	0.336
STD	0.386825	0.013429	0.21976	3.137021	0.013077	0.021962	0.023965	0.021
CV (%)	6%	8%	17%	16%	4%	4%	8%	6%

N= Total Nitrogen, Org.C= Organic Carbon, Av.P = Available Phosphorus, Na= sodium, K = Potassium, Ca= Calcium, Mg= Magnesium, STD = Standard Deviation, CV= Coefficient of Variation

Results from the nutrient index of the soils presented in Table 6 indicate that the fertility status of the soils are medium to high. The pH status of the soils ranked between low and medium. The organic carbon content was categorised as medium to high, the total nitrogen was categorised as medium, the available phosphorus was categorised as high to medium, and the potassium content was high in both soils. Jangir *et al.* (2019) observed similar medium to high nutrient index levels of organic matter, phosphorus and potassium.

**Table 6:** Nutrient Index of the Oil Palm Plantation and Cassava Plantation

Parameter	Land use	Low (%)	Moderate (%)	High (%)	NIV	Remark
Soil pH	Oil palm	16.67	83.33	0	1.83	Medium
	Cassava	50	50	0	1.5	Low
Org. C	Oil palm	0	33.33	6.67	2.66	High
	Cassava	0	83.33	16.67	2.16	Medium
Total N.	Oil palm	0	83.33	16.67	2.16	Medium
	Cassava	0	83.33	16.67	2.16	Medium
Av. P.	Oil palm	0	33.33	66.67	2.66	High
	Cassava	0	66.67	33.33	1.83	Medium
Potassium	Oil palm	0	0	100	3	High
	Cassava	0	0	100	3	High

Org.C = Organic carbon, Av. P= Available phosphorus, NIV = Nutrient Index Value

## CONCLUSION AND RECOMMENDATION

The study on the fertility status of soils under the two land use types indicated medium to high fertility status, with high organic carbon contents and slightly acidic pH. The available phosphorus and potassium content were also high within both soils. The soils generally possessed high sand content with sandy loam and loamy sand texture. The results show that there is potential for improvement in soil fertility condition. As a result, manure application, balanced fertiliser usage, suitable cultivation techniques, and nutrient management are necessary to improve soil fertility and achieve optimal crop production levels.



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