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Variation in Soil Physicochemical Properties of Different Land Use Types in Abakaliki, South Eastern Nigeria

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Abstract

The effect of land use on soil physicochemical properties was evaluated in soils of Abakaliki, south eastern Nigeria. The four land use types selected are managed Gmelina plantation (MP), fallow land (FL), grass land (GL) and continuously cultivated soil (CCS). Soil samples (undisturbed and auger) were collected from three soil depths of 0 – 20 cm, 20 - 40 cm and 40 – 60 _ cm for physicochemical properties analysis. Bulk density was significantly ($P < 0.05$) lower (1.33 – 1.50 gcm^{-3}) in FL across the depths than other land use types. The pH of the soils was moderately to slightly acidic. Soil organic carbon, total nitrogen and available phosphorus were significantly higher ($P < 0.05$) in FL than others and followed the trend FL>MP>GL>CCS. The exchangeable acidity was significantly different among the land use type but was the highest in MF (2.20) and the lowest in (GL). Across the soil depths, 0-20 _cm recorded higher values for bulk density, saturated hydraulic conductivity, soil organic carbon, total nitrogen and available phosphorus compared to other soil depths. In all, FL, MF and GL recorded higher values for most soil properties studied, while CCS recorded lower values. There was a decline in most of the properties studied due to continuous cultivation.

Keywords: Land use types; Soil depth; Physical and chemical properties.

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1. Introduction

Generally, land is utilized for a variety of various activities, both agricultural and non-agricultural. For instance, in the rural areas of our nation, Nigeria, agriculture and simple residential structures are the common uses of land, whereas, in the urban areas, ultra-modern residential structures, commercial buildings, recreation facilities, road networks, and a very limited amount of agricultural activities are the major uses of land [1]. The definition of a land use type according to two different sources is "the arrangements, actions, and inputs that people make in a specific land cover with the intention of producing, altering, and managing it" [2, 3]. Land use is one major driver of different processes of environmental changes as it directly influences basic natural resources within the earth's surface, including the soil resources determines to a large extent the productivity of any given soil [4]. The chemical and physical characteristics of the soil, such as its bulk density, hydraulic conductivity, and ability to retain moisture, determine in large part how productive a soil can be. When these characteristics are fully utilized, the soil's essential components can be fully utilized for optimum productivity, which can lead to long-term economic benefits based on in-depth knowledge of soil fertility and real-world experience [5]. Agricultural output is now seriously threatened in both industrialized and emerging nations due to the rapid degradation of fertile areas that can result from improper soil management. Regrettably, land use planning, particularly in urban areas, and land use policies intended to maintain the sustainability of land resources are noted to be critically lacking in Nigeria [6]. This has greatly affected the soil which is an integral part of the land. Depending on the land use type, land use could be useful in conditioning the soil physically for improved crop environment such as structure of soil, reduced bulk density, increase porosity and water and nutrients retention [7]. This is to say that soil quality is influenced by the type of management practices the land is subjected to. Many researchers [8, 9] observed that land use affects all the chemical, physical and biological properties of the soil that tend to affect the quality attributes and fertility status of the soil. Soil physical properties like bulk density, hydraulic conductivity, total porosity, infiltration, aggregate stability and overall health of the soil have been reported to be influenced by land use change by several studies [10]. Soil physical properties like bulk density, hydraulic conductivity, total porosity, infiltration, aggregate stability and overall health of the soil have been reported to be influenced by land use change by several studies [11]. Soil is said to be fertile and productive when it is capable in its normal environment to support plant growth. Several land use types used in soil management are similarly important since soil is a habitat for over 80% of the terrestrial biodiversity which includes plants, animals and micro-organisms [12]. Soil properties deteriorate with changes in land use, especially from forest to arable land. According to Anyadike [12] land use types affect surface runoff and change in resilience of soil to environmental impacts. According to Josiah, *et al.* [13], the magnitude of these changes varies depending on the type of land use, the management strategy, and the vegetation cover. Due to changes in the physical and chemical qualities of the soil, certain land use types have a propensity to promote soil compaction and erosion [14]. Natural degradation of the physical and chemical characteristics of soils due to ongoing farming results in loss of organic matter, erosion, leaching of nutrients from the soil, and ultimately diminished productivity [15]. On the other hand, according to Gee and Bauder [16] mixed planting or intercropping of trees results in improved soil.

2. Materials and Methods

2.1. Site Description

The study was carried out at four locations with a particular land use type situated in Abakaliki Ebonyi State, South Eastern Nigeria in 2019 cropping season. Abakaliki in Ebonyi State lies between Latitude 06^o 25^1N and longitude $08^0 3^1$ E and altitude of 170 m. The rainfall ranges from 1700 to 2000 mm, with mean a annual rainfall of 1800_mm. The mean annual temperature ranges from 27^oC to 31^oC throughout the year. The relative humidity is high 80% during the rainy season but declines to 65% in the dry season. The area's relief is generally undulating and no location exceeds 200_m above sea level [17]. Geologically, the area's soil is underlain by sedimentary rocks derived from successive marine deposits. According to Liu, *et al.* [17], Abakaliki agricultural zone lies within the Asu River and is associated with brown olive shales, fine grained sandstone and mudstone. The soils of the area being basically clayey loam underlain with laterite are particularly suitable for the cultivation of rice, yam, cassava, maize, etc. The soil is shallow with unconsolidated parent materials up to 1_m depth belonging to the order Ultisol classified as Typic Haplustult. The major vegetation of the area is derived savanna characterized by the growth of shrubs, herbs, dispersed large trees and common tropical grasses.

The four locations and their land use history are described below as follows;

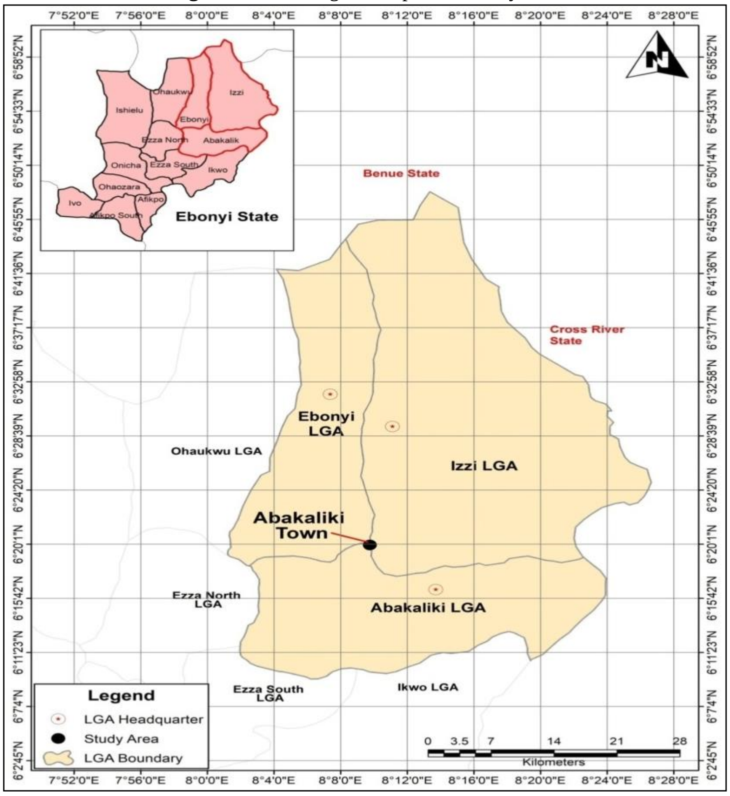
2.2. Managed Gmelina Plantation (MP)

In order to preserve the forestry resources for 50 years, an artificial gmelinaarborea was created at Azugwu Abakaliki during the colonial era. The plantation is home to a variety of other tree and shrub species. The region is located between latitude $06^o 19^1$N and longitude $08^o 74^1$E, with an elevation of 175m [18]. Hunting and farming are not permitted, yet poaching has decreased somewhat because people continue to encroach on forests for agricultural purposes. The study's land area was calculated as 100 m × 100 m, or 1 hectare.

2.3. Fallow Land (FL)

The fallow is located behind All Saints Cathedral, Abakaliki near Ogoja road. It lies between latitude 06°19[1]N and longitude 08°06[1]E. The fallow has lasted for more than 10 years. There are different types of vegetation covering the land, but among major ones are scattered trees, herbs, shrubs and grasses likeguinea grass (*Panicum maximum),* wire grass_*(Sporobulus pyramidalis*), goat weed (*Ageratum conyzoides*),_stubborn weed *(Sida acuta)*. The land area of 100 m x 100 m, equivalent to 1ha, was measured for the study (Figure 1).

Figure-1. Showing the map of the study area



Grass Land (GL): At Bishop Otubelu College Abakaliki, Grass Land (GL) is situated. A portion of the grassland is used to graze animals, and it is periodically trimmed down, particularly in the area that is used as a field for games. For nearly 20 years, there has been grassland there. Herbs are planted there, but grasses like Tridax (Tridax procumbens), huge star grass (Imperata cylindrical), guinea grass (Panicum maximum), wire grass (Sporobulus pyramidalis), and persistent weed (Ageratum conyzoides) predominate (Sida acuta). 06o191N and 08o611E are the coordinates of the region. For the study's purposes, a land area of one hectare (ha) is defined as 100_ m by 100_m.

Continuously Cultivated Soil (CCS) Behind the law school of Ebonyi State University Abakaliki lies a large area known as arable land. The area is the experimental farm of the Faculty of Agriculture, Ebonyi State University, Abakaliki's Department of Soil Science and Environmental Management. Since more than 18 years ago, the area has been maintained yearly by Department employees and students. It has undergone traditional tillage procedures, chemical applications (such as fertilizers, herbicides, and pesticides), organic amendments, and other cultural activities. Vegetables, cucumbers, leguminous crops, yam (Dioscorea spp.), cassava (Manihot spp.), and maize (Zea mays L) are typical crops produced in rotation. The area lies between latitude 06o191N and Longitude 08o741E. Between latitude 06o191N and longitude 08o741E is where the area is located [19]. The measurement of the land area for the research is 100 m × 100 m, or 1 hectare. The four land use types mentioned above were chosen to provide a more accurate depiction of the varied land use methods used in Abakaliki, South Eastern Nigeria.

2.4. Soil Sampling Procedure

Soil samples were collected from the four (4) selected land use types. Undisturbed samples were randomly collected from all four land use types at three different depths (0 – 20 cm, 20 – 40 cm and 40 – 60 cm) using open-faced coring tubes of 6 cm height and 5_cm diameter from the research laboratory of the Department of Soil Science, University of Nigeria, Nsukka for determination of physical properties of the soil. Within each land use type, two (2) core and auger samples of the soils were collected from each of the three depths and replicated five times. Disturbed (auger) samples were randomly collected from the four land use types at the same three depths (0 – 20 cm, 20 – 40 cm and 40 – 60 cm). The five auger samples from each depth per land use type were bulked together to obtain three composite samples for each land use type for physicochemical properties determination of soils of the land use types. The experiment was laid out in a Randomized Complete Block Design (RCBD) with four treatments (the four land use types viz: Continuously cultivated soil, Fallow land, Grass land and Managed Gmelina plantation), three-sub-treatment was the soil depths (0 – 20 cm, 20 – 40 cm and 40 – 60 cm) and replicated five times.

2.5. Laboratory Methods

The disturbed soil samples were air-dried and sieved through 2_mm mesh. The undisturbed core samples were used for bulk density, total porosity and hydraulic conductivity determinations only. The samples < 2mm were used for the determination of particles size distribution (in water and calgon), soil pH, soil organic carbon, total Nitrogen, available phosphorus, and exchangeable acidity according to the standard analytical procedures. _Particle size distribution was determined using Bouyoucous hydrometer method as described by [20]. The textural class of the soil was determined using the textural triangle. Bulk density was determined using the core sampling method after oven drying the soil samples to a constant weight at a temperature of 105oC for 24 hrs. Total porosity was calculated from soil bulk density using as assumed particle density of 2.70_gcm3. Saturated Hydraulic Conductivity (Ksat) was determined by the core method as described by Udo, *et al.* [20]. Soil pH was determined both in water and 0.1N potassium chloride solution at the ratio 1:2.5 soil/water suspension using standardized glass electrode pH meter [21]. Soil organic carbon content of the soil and aggregate –associated carbon was quantified by Walkley and Black wet oxidation method as described by Bremner and Mulvanney [22]. Total Nitrogen content of the soil (< 2.00mm) was determined by the Micro Kjeldahl digestion method using CuSO4 (Copper sulphate) and Na2SO4 (Sodium sulphate) catalyst mixture. Available Phosphorus was determined using the Bray II bicarbonate extraction method using 0.03N ammonium fluoride with 0.1NHCl. The phosphorus in the extract was determined with a photo-electric colorimeter. Exchangeable acidity (EA) was calculated by summing the values of exchangeable aluminum and hydrogen; EA = Al3+ + H+.

3. Results and Discussion

3.1. Data Analysis (Analysis of Variation Processes Mechanism)

An analysis of variance (ANOVA) of each soil properties within each depth and land use type was performed on the soil data generated from the laboratory using the Genstat Discovery Software, edition 4. Mean separation was done using Fisher's Least Significant Difference (F-LSD) at a 5% level of probability. Descriptive statistics (mean, range and coefficient of variation) were used to assess the variability in soil physicochemical properties across the land use types. Coefficients of variation were ranked according to Bray and Kurtz [23] as follows: CV <20% Low variation, CV = 20 - 50% Moderate variation and CV = 50% and above High variation.

3.2. Physical Properties of Soils of the Different Land Use Types

The results in Table 1 show the physical properties of the soils of the four land use types studied. The results revealed that the sand fraction was significantly different (P< 0.05) among the land use types and varied from 620 to 740 gkg-1 with coefficient of variation (CV) of 5.0% at 0-20 cm depth, 580 to 640 gkg-1 with CV of 6.0% at 20 – 40 cm depth and, 580 to 680_gkg-1 (CV: 7.0%) at 40-60cm.The sand fraction generally decreased with depth in all land use types except at 40-60cm depth in FL which could be attributed to the selective removal of soil particles from one horizon to another by an agent of erosion and variations in weathering intensity [24]. The sand fractions are similar in variation irrespective of different land use types as evidenced by their CV values (CV ≤ 7.0%). The general decrease in sand fraction with depth was reported by Kolo [25]. The silt fraction was found to be significantly different (P< 0.05) among the four land use types. Silt fraction varied from 90 to 190 gkg-1 with CV of 11.0%, 70 to 170 gkg-1 with CV of 39.0% and 70 to 150 gkg-1 with CV of 39.0% for 0-20_cm, 20-40¬_cm and 40-60_cm depths, respectively (Table 2). The distribution of silt fraction was irregular with depth across the land use types. Although in CCS, FL and GL land use types, silt fractions decreased with increase in depths but the reverse was the case with MP which could be as a result of loessial deposit on soils of managed Gmelina plantation. According to Thomas and Oke [26] the development of soils in-situ is responsible for the irregular distribution of silt down the soil depths.

The clay fraction varied from 130 to 230 gkg-1 (CV: 30.0%) at 0-20cm depth, 250 to 270 gkg-1 (CV: 4.0%) at 20-40cm depth, and 230 to 310_gkg-1 with CV of 13% at 40- 60cm depth. The clay fraction was found to be significantly different (P< 0.05) among the four land use types. According to the result, clay fraction increased with depth at 0-20_cm and 40_cm but varied at 40-60cm depth. Continuously cultivated soil (CCS), fallow land (FL) and Grass land (GL) land use types recorded higher values of clay fractions at the sub-soil (20-40 cm and 40-60cm) depths compared to the top soils (0-20cm) (Table 1). This might be attributed to the selective transport of finer soil particles into lower soil depths by eluviation/illuviation processes [27]. The higher clay on the upper depth (20-40cm) of MF land use type might be attributed to clay accumulation from the selective dissolution of more soluble minerals. The particle size distribution result is in tandem with the general trend in particle size distribution sand >clay>silt, this was also observed by Maniyunda, *et al.* [27] in most soils of southeastern, Nigeria. The dominance of sand fraction in the soils may be attributed to high content of quartz mineral in the parent material. Reported that sand dominated the mineral fraction due to quartz-rich parent material, clay migration, surface erosion and geological sorting of soil materials by biological activities in their field of study. Low silt fraction observed in the soils could be attributed to leaching and the nature of the parent material [28]. The textural class of the soils of the different land use types varied from sandy loam to sand clay loam (Table 1). The textural variation across the land use types might be attributed to the selective removal of soil particles from one location to another by agents of soil erosion and variation in weathering intensity.

Across the soil depths (0 – 60cm), the value of bulk density was significantly different (P< 0.05) among the land use types and ranged from 1.33 to 1.75 gcm-3. The highest (1.75gcm-3) and lowest (1.51gcm-3) bulk density values at 0 – 20 cm soil depth were recorded at continuously cultivated soil (CCS) and fallow land (FL) respectively. The values of bulk density ranged between 1.33 and 1.65gcm-3 with CV of 9.0% (mean = 1.63_gcm-3) at 0-20_cm depth, 1.35 and 1.68_ gcm-3 (CV 9.0%; mean = 1.59gcm-3) at 20-40cm depth, and 1.51 and 1.75gcm-3 with CV of 6.0% (mean = 1.56gcm-3) at 40-60cm depth (Table 1). Fallow land (FL) recorded the lowest bulk density among the land use types across the depths which ranged from 1.33 to 1.50_ gcm-3 which has an advantage of increased porosity [29]] with accompanied adequate aeration. The increase in bulk density with depth may be attributed to ompaction caused by the weight of the overlying horizons and a decrease in organic matter with depth. This agrees with the reports of Osujieke, *et al.* [30] as they reported increasing bulk density with depth due to changes in organic matter content, porosity and compaction. The higher values of bulk density in continuously cultivated soil at 0-20cm could result from compactive efforts of working implements and trafficking during tillage. The mean values of total porosity ranged from 40.00 to 41.54% for the different land use types and across the depths defying a particular trend. Total porosity values of the soils were significantly different (P< 0.05) among the land use types. At 0 – 20, 20 – 40 and 40 - 60 cm soil depths, fallow land had the highest values (46.50, 50.00 and 50.97%) for total porosity and the lowest (36.41%) was recorded at continuously cultivated at 0-20cm, grass land and fallow land (36.60 each) at 20-40_cm and grass land (38.30%) at 40 – 60_ cm. Total porosity varied from 38.30 to 50.90% with CV of 15% at 0-20_cm depth, 36.60 to 50.00% with CV of 17% at 20-40_cm depth and 36. 41 to 46.50% with CV of 12% at 40-60cm depth. The trend in enhancement of total porosity by the different land use types at 0-20_cm depth is FL >MP> GL> CCS. Increase in bulk density reduces pore spaces as well as continuous traffic and agricultural activities on land [31, 32]. The decrease in total porosities with depth might be attributed to the decrease in organic matter content with depth. The values of hydraulic conductivity of the soils were significantly different (P< 0.05) among the land use types The result showed that Ksat ranged from 15.52 to 25.75 cmhr-1 with CV of 39.0% at 0-20_cm, 13.05 to 28.41 cmhr-1 (CV: 39.0%) at 20-40_cm and 5.80 to 17.10 cmhr-1 (CV: 50.0%) at 40-60_cm. The wide variation (23.0, 39.0 and 50.0%) observed in Ksat might be due to variation in particle size distribution and moisture content [32]. Hydraulic conductivity increases with decrease in bulk density, increase in porosity and organic matter content. The values of K sat were found to be lower in sub soil when compared with the top soils suggesting a low rate of water transmission in the former due to accumulation of clay. At 0-20cm depth, fallow land recorded the highest value (25.75cmhr-1) compared with other land used types whereas managed forest recorded the highest value (28.41cmhr-1) at 20-40_cm depth. In all, 0-20__cm recorded the highest mean value when compared with the other depths and the trend of the decrease in the mean values was 0-20_cm> 20-40_cm < 40-60_cm (Table 2). Askari, *et al.* [31], reported high K sat on top soils due to higher water content and smaller pores.

Table-1. Physical properties of soils of the four land use types

Land use	Sand (gkg-^{1})	Silt (gkg-^{1})	Clay (gkg^{-1})	TC	Bd (gcm^{-3})	TP(%)	Ksat (cmhr^{-1})
0-20cm							
CCS	680	190	130	SL	1.75	36.41	15.52
FL	740	110	150	SL	1.51	46.50	25.75
GL	740	130	130	SL	1.69	36.60	1854
MF	680	90	230	SCL	1.58	43.49	2453
MEAN	710	130	160		1.63	40.75	21.09
CV(%)	5.0	11.0	30.0		6.0	12.0	23.0
FLSD(0.05)	6.29	58.35	6.29		0.15	2.26	8.73
20-40_cm							
CCS	580	170	250	SCL	1.65	36.79	13.05
FL	640	90	270	SCL	1.35	50.00	16.92
GL	660	70	270	SCL	1.68	36.60	13.74
MF	640	110	250	SCL	1.68	36.60	28.41
MEAN	630	110	260		1.59	40.00	18.04
CV(%)	6.0	39.0	4.0		9.0	17.0	39.0
FLSD(0.05)	25.94	34.09	50.71		0.89	15.73	1.89
40-60_cm							
CCS	580	150	270	SCL	1.62	38.52	5.80
FL	680	70	250	SCL	1.33	50.97	7.09
GL	620	70	310	SCL	1.64	38.30	17.10
MF	640	130	230	SCL	1.65	38.35	14.20
MEAN	630	105	265		1.56	41.54	11.05
CV(%)	7.0	39.0	13.0		9.0	15.0	50.0
FLSD(0.05)	15.41	62.90	3.15		0.99	5.03	4.40

Land use	Sand (gkg^{-1})	Silt (gkg^{-1})	Clay (gkg^{-1})	TC	Bd (gcm^{-3})	TP(%)	Ksat ($cmhr^{-1}$)
0-20cm							
CCS	680	190	130	SL	1.75	36.41	15.52
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CCS	580	170	250	SCL	1.65	36.79	13.05
FL	640	90	270	SCL	1.35	50.00	16.92
GL	660	70	270	SCL	1.68	36.60	13.74
MF	640	110	250	SCL	1.68	36.60	28.41
MEAN	630	110	260		1.59	40.00	18.04
CV(%)	6.0	39.0	4.0		9.0	17.0	39.0
FLSD(0.05)	25.94	34.09	50.71		0.89	15.73	1.89
40-60_cm							
CCS	580	150	270	SCL	1.62	38.52	5.80
FL	680	70	250	SCL	1.33	50.97	7.09
GL	620	70	310	SCL	1.64	38.30	17.10
MF	640	130	230	SCL	1.65	38.35	14.20
MEAN	630	105	265		1.56	41.54	11.05
CV(%)	7.0	39.0	13.0		9.0	15.0	50.0
FLSD(0.05)	15.41	62.90	3.15		0.99	5.03	4.40

TC – Textural class Bd – Bulk density, TP- Total porosity, Ksat.-Saturated hydraulic conductivity, CCS= Continuously cultivated soil, FL= Fallow land, GL= Grass land, MP= Managed Gmelina plantation. CV= Coefficient of variation

3.3. Chemical Properties of Soils of Various Land Use Type

The chemical properties of the soils of the various land use types are presented in Table 2. The soil pH in H_2O and KCl ranged from 5.60 to 6.90 and 4.20 to 5.20 with CV of 10.0% and 9.0% respectively, 5.50 – 6.40 and 4.30 – 5.20 with CV of 7% and 9% respectively at 20 – 40 cm. At 40-60cm depth, pH in H_2O and KCl ranged from 5.60 to 6.80 and 4.30 to 5.7 with CV of 10% and 14% respectively. The soil pH was significantly different (P < 0.05) among the land use types. Generally, the pH values both in H_2O and KCl were rated moderately acidic to slightly acidic according to the ratings of Ezema, *et al.* [33]. This status of soil reaction may be attributed to the influence of the parent materials, continuous cultivation, application of commercial fertilizers and loss of exchangeable bases through leaching.

Soil organic carbon (SOC) was significantly different (P<0.05) among land use types across the depths. The highest (11.37gkg^{-1}) and lowest (4.74 gkg^{-1}) values of SOC were recorded at fallow land (FL) and continuously cultivated soil (CCS) at 0 – 20 cm. Soil organic carbon varied from 4.74 to 11.37gkg^{-1} with CV of 38.0% (mean = 8.24gkg^{-1}) at 0-20_cm, for soils at 20-40_cm, SOC varied from 3.29 to 7.11 gkg^{-1} with CV of 29.0% (mean = 5.41 gkg^{-1}) and 2.37 to 6.72 gkg^{-1} with CV of 43.0% (mean = 4.21_gkg^{-1}) at 40-60cm depths. Generally, SOC contents in the soil under different land use types significantly decreased with depths giving the least values at 40-60_cm depths. The trend of soil organic carbon content under different land use types at 0-20_cm depths is FL > MP > GL > CCS and in the depth intervals the trend is as follows: 0 – 20_ cm > 20 – 40_ cm > 40 – 60_ cm (Table 2). Low values of SOC recorded in soils of the various land use types might be attributed to the low content of organic matter in the soils. Obalum, *et al.* [34], observed that organic manure like poultry manure has the capacity of improving the nutrient condition of soils. Soil organic carbon had the highest values at the depths of 0-20cm, in all the land use types studied compared to values obtained at the other depths with fallow land recording the highest value (11.37_ gkg^{-1}) while the lowest (4.74_ gkg^{-1}) was obtained in continuously cultivated soils. These variations might be due to a high level of humification of organic matter in the top soils as reported by Anikwe [35]. Vegetation cover was observed to encourage high organic carbon and organic matter contents of the soils as observed by Ezeaku, *et al.* [36]. The variability of SOC within land use types and soil depths was moderate with CV efficient coefficient of variation (CV) of 38 %, 29 % and 44 % for 0-20_ cm, 20-40_ cm and 40-60_ cm respectively. The studied soils had generally low content of carbon since the SOC of the soils were below the critical value (< 17.0_ gkg^{-1}) and this could be attributed to the leaching and washing effects of high erosivity in the region [37]. Total Nitrogen (TN) showed a significant difference (P < 0.05) among the land use types. Total N at continuously cultivated soil, CCS (0.98 gkg^{-1}); fallow land, FL (1.68gkg^{-1}); grass land, GL (1.40 _gkg^{-1}) and managed Gmelina plantation, MF (1.54_ gkg^{-1}) at 0 – 20 cm. On the other hand TN recorded 0.70, 1.12, 0.84 and 0.98 gkg^{-1}for CCS, FL, GL and MP, respectively at 20 – 40 cm soil depth. Similarly, at 40 – 60_ cm, the values of TN across the various LUTs are 0.70, 0.98, 0.70 and 0.84 gkg^{-1}for CCS, FL, GL and MP, respectively. Total N at 0-20_cm, 20-40_cm and 40-60_cm varied from 0.98 to 1.68_ gkg-^{1} with CV of 21.0 %, 0.70 to 1.12 _gkg^{-1} with CV of 19.0% and 0.70 to 0.98_gkg^{-1} with CV of 17.0% respectively. Total nitrogen was generally low, which according to Antonio, *et al.* [38] could be rated very low to low. The content of TN recorded low variation in its distribution across the land use types with CV ranged from 17 to 21 %. The highest TN value (1.68_ gkg^{-1}) and the lowest value (0.98_ gkg^{-1}) were obtained at 0-20cm in fallow land and continuously cultivated soil, respectively. The low values of total nitrogen obtained might be attributed to the low organic matter content of the soils as OM accounts for 93 to 97% of total nitrogen. Total nitrogen of the soils of various land use types decreased with an increase in depths with 0-20cm recording the highest values (CCS = 0.98_ gkg^{-1}, FL = 1.68 _gkg^{-1}, GL = 1.40_gkg^{-1} and MP = 1.54_gkg^{-1}). Enwezor, *et al.* [39], attributed low TN to losses through run off, low organic matter, high N mineralization and crop removal. The higher TN content values in surface soils when compared with the sub-surface soils of the different land use types might be due to nutrient recycling through litter fall.

The results of available phosphorus showed that the values ranged between 4.89 and 11.99 _$mgkg^{-1}$ with CV of 3.0% at 0-20_ cm; 3.86 to 10.93 _$mgkg^{-1}$ 32.0% at 20-40_ cm and 3.30 to 9.60_ $mgkg^{-1}$ with CV of 44.0% at 40-60 cm (Table 2). Available phosphorus values were rated low to high with content values between 4.89 and 11.99 _$mgkg^{-1}$ compared to the critical value of 10 – 16 $mgkg^{-1}$ as reported by Havlin, *et al.* [37]. The CV values of available phosphorus varied between 32 and 40% and are considered to be moderately high [40]. The value of available P at 0-20 cm depths of the soils of FL land use type was higher than 10 $mgkg^{-1}$ critical limit recommended for most commonly cultivated crops whereas others are below. This agrees with the observations of Igwe [41] that reported that the critical limit of available P recommended for most commonly cultivated crops is 10_$mgkg^{-1}$. Available P decreased with increasing soil depths in all the soils of the land use types with 40-60_ cm recording the lowest values. At 20-40_cm FL recorded the highest values (10.93$mgkg^{-1}$) above the critical limit for available P (10 _$mgkg^{-1}$) when compared with other land use types which recorded low values that fall below the critical limit of 10_$mgkg^{-1}$. The low values of available P recorded at the sub soils might partly be due to the nature of the parent material and as well due to the ease with which phosphorus undergoes fixation with iron and aluminum oxides under well drained acidic medium [42]. According to Meysner, *et al.* [43] tropical soils are generally low in available P due to low apatite content of the soil forming materials.

Exchangeable acidity (EA) was significantly different ($P < 0.05$) among the various land use types. The values of EA in CCS = 1.80 $cmolkg^{-1}$, FL = 2.00 $cmolkg^{-1}$, GL = 1.20 $cmolkg^{-1}$and 2.20 $cmolkg^{-1}$ at 0-20_cm depth. At 20 – 40_cm the values of EA include; 2.40, 2.60, 1.80 and 2.60$cmolkg^{-1}$ for CCS, FL, GL and MP, respectively. Similarly, at 40 – 60cm the values of EA include; 2.60, 2.60, 1.00 and 2.60$cmolkg^{-1}$ for CCS, FL, GL and MP, respectively. The exchangeable acidity ranged between 1.40 and 2.60 $cmolkg^{-1}$ with CV of 26.0% at 0-20_ cm, 2.20 and 2.60 $cmolkg^{-1}$ with CV of 9.0% at 20-40_cm and 2.20 and 2.80 _$cmolkg$-^{1} with CV of 12.0% at 40-60cm soil depths. Exchangeable hydrogen was significantly different ($P < 0.05$) among the land use types and ranged from 1.20 to 1.60 $cmolkg^{-1}$ with CV of 14.0%. At 20-40_cm H^+ varied from 1.00 to 1.60 $cmolkg^{-1}$ with CV of 20.0%. Exchangeable H^+ varied from 1.20 to 1.40_$cmolkg^{-1}$ with CV of 7.0% at 40-60_cm soil depth. Exchangeable aluminum ranged between 0.00 and 1.4 $cmolkg^{-1}$ with CV of 113.0% at 0-20_cm soil depth. At 20-40_cm Al^{3+} ranged between 0.80 and 1.20_ $cmolkg^{-1}$ with CV of 35.0%. Exchangeable Al^{3+} ranged from 0.20 to 1.20_$cmolkg^{-1}$ with CV of 35% at 40-60 cm soil depths. Exchangeable acidity values were rated low to relatively high according to the rating of [44, 45]. Higher values (2.60 $cmolkg^{-1}$ each) were observed in soils of the CCS and FL land use types at 40-60_cm. This might be attributed to the presence of iron and aluminum oxides in the sub soils. The high values of EA could be attributed to the application commercial fertilizer, uptake of basic cations and leaching. [46, 47] Higher values of EA on subsoil contributed to the solubility and movement of exchangeable acidity down to the soil from surface soils. The variation of EA across the soil depth is low with a CV range between 15.0 and 24.0% according to [48, 49].

Table-2. Chemical properties of soils of the land use types

Land use	pH (H_2O)	pH (KCl)	OC	TN	Av.P ($mgkg^{-1}$)	H^+	Al^{3+}	EA
			(g kg^{-1})				$cmolkg^{-1}$	
0-20_cm								
CCS	6.20	5.00	4.74	0.98	4.89	1.60	0.20	1.80
FL	6.40	5.20	11.37	1.68	11.99	1.40	0.60	2.00
GL	6.90	5.60	6.58	1.40	5.60	1.20	0.00	1.20
MP	5.60	4.20	10.27	1.54	9.40	1.20	1.00	2.20
Mean	5.38	5.00	8.24	1.40	7.97	1.45	0.55	1.90
CV(%)	10.0	12.0	38.0	21.0	38.0	14.0	113.0	26.0
FLSD(0.05)	0.06	0.37	0.07	0.26	0.72	0.37	0.27	0.39
20-40_cm								
CCS	5.60	4.30	3.29	0.70	3.86	1.60	0.80	2.40
FL	5.90	4.70	5.69	1.12	10.93	1.60	1.00	2.60
GL	6.40	5.20	5.53	0.84	4.20	1.00	0.80	1.80
MP	5.50	4.30	7.11	0.98	8.80	1.40	1.20	2.60
Mean	5.85	4.63	5.41	0.91	6.95	1.40	1.05	2.35
CV(%)	7.0	9.0	29.0	19.0	32.0	20.0	35.0	9.0

FLSD(0.05)	0.19	0.17	0.02	0.13	0.14	0.52	0.32	0.09
40-60_cm								
CCS	5.60	4.30	2.37	0.70	3.30	1.40	1.00	2.60
FL	6.00	5.00	4.19	0.98	9.60	1.40	1.20	2.60
GL	6.80	5.70	3.56	0.70	3.58	1.20	0.20	1.00
MP	5.60	4.30	6.72	0.84	7.18	1.60	0.20	1.80
Mean	6.00	4.83	4.21	0.81	5.92	1.35	1.10	2.45
CV(%)	9.0	14.0	47.0	17.0	40.0	7.0	35.0	12.0
FLSD(0.05)	0.41	0.43	0.06	0.09	0.25	0.17	0.14	0.34

OM: organic matter; TN: total nitrogen; Av. P available Phosphorus; H^+: exchangeable hydrogen; Al^{3+}: exchangeable aluminum; CV: coefficient of variation. CCS= Continuously cultivated soil, FL= Fallow land, GL= Grass land, MP= Managed Gmelina plantation

4. Conclusion

Land use types can bring about obvious variations in soil properties. This is to say that land use type directly affects the quality of any soil. The productivity of any given soil is determined by the physical, chemical and biological properties of such soil. The findings of the work showed that the soil bulk density was lowest(1.33_ gcm^{-3}) in fallow land and highest (1.75_ gcm^{-3}) in continuously cultivated soil at 0-20 cm soil depth and total porosity values showed a reverse condition at the same depth where fallow land recorded the highest value (46.50%) and continuously cultivated soil recorded the lowest value (36.41%). Soil organic carbon and total nitrogen at 0-20cm soil depth had the highest values in fallow land (11.37_gkg^{-1} and 1.68_ gkg^{-1}) and lowest (4.74_ gkg^{-1} and 0.98 _gkg^{-1}) and in continuously cultivated soil and the order of decrease across the land use types was FL > MP > GL > CCS. The results of the study revealed that land use affects the general condition of the soil. Based on the findings of the study, it can be concluded that the land use types practiced significantly affected the soil physical and chemical properties. The results further showed that land use such as managed Gmelina plantation, fallow land and grass land had better soil conditions and should be encouraged whereas continuously cultivated soil should be discouraged due to its poor conditions. Therefore, management practices like forest plantation, agro-forestry, fallow, crop rotation, etc, when encouraged would help to sustain good soil conditions. It is also recommended that further research be carried out from time to time to ascertain the level of variation in soil physicochemical as a result of different land use types in the area.

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