Effect of Vegetation Types on the Physicochemical Properties of Soils under Different Land Use

Amonum. J. I. [1,2]*, ISSA, S. [1], Amusa, T. O. [1]

[1]*Department of Forest Resources Management, Faculty of Agriculture, University of Ilorin, Nigeria.*

[2]*Department of Forest Production and products, College of Forestry and Fisheries, Federal University of Agriculture Makurdi, Nigeria.*

*Corresponding Author: *Amonum. J. I., Department of Forest Resources Management, Faculty of Agriculture, University of Ilorin, Nigeria.*

Abstract: *Proper utilization of land is essential to soil quality maintenance and sustainable land development. This study was conducted to evaluate effects of different vegetation types under land use management on physicochemical characteristics of soils in the University of Ilorin, Nigeria. Composite soils samples under different vegetation types used were collected at the depth of 0-30 cm from sampling plots of 25m x 25 m; using random sampling design. The vegetation types used in the study area include: Tectona grandis (teak) plantation, Forestreserve, Jatropha curcas plantation and Farmland. The soil samples were analyzed in the laboratory to determine the soil physicochemical properties. Soil properties were analyzed using One way Analysis of Variance, and the relationship among the soil physicochemical properties were determined using correlation analysis. Results showed that natural forest on the overall accumulated more nutrients than teak plantation, Jatropha plantation and farmland. Farmland has the least concentration of chemical properties, for soil organic carbon (0.37%), total nitrogen (0.35%), available phosphorus (0.34%), calcium (0.57 cmol(+)/kg), potassium (0.2757cmol(+)/kg) and sodium (0.0657cmol(+)/kg), when compared to Forestland, Jatropha and Teak plantations. This indicated that there is an overall change towards the direction of loss of soil fertility under farmland than the other vegetation types. The study further revealed that there was significant (p<0.05) difference in available phosphorus and total nitrogen between and among the different vegetation types. However, there was no significant difference (p>0.05) in silt fraction between and among the vegetation types. The results obtained from the present study indicated that the different vegetation types have affected the soils at a various rate. It could be concluded that the soil quality and health were maintained relatively under the forestland, whereas, the influence on most parameters were very low on the soil of farmland indicating the need for employing integrated soil fertility management. It is recommended that appropriate and integrated land management options for different vegetation types under land uses are required to sustain agricultural productivity while protecting the environment.*

Keywords: *Chemical, Forest, Physical, Plantation, Property, Soil, Vegetation.*

1. INTRODUCTION

Lands have been utilized intensively for all purposes at the expense of their suitability, which have resulted in massive land degradation (Senjobi and Ogunkunle, 2011; Ahukaemere *et al.,* 2012). Land degradation has serious impact on soil physical and chemical properties especially the infiltration, bulk density, organic matter, porosity and aggregate stability causing their compaction and erosion (Tukahirwa, 2003). It has been reported that unsystematic changes in land use predisposes it to several environmental problems such as desertification, acidification, eutrophication, greenhouse effect that cause climate change and biodiversity loss (Reichstein, 2008).

Over the years, soil biodiversity and its physical properties that control water movement and retention in the soils are largely affected due to human, animal activities as well as use of machine(s) for soil tillage purposes (Tilahun, 2007). The anthropogenic changes in land use have altered the characteristics of the Earth's surface, leading to changes in soil physicochemical properties such as soil fertility, soil erosion sensitivity and content of soil moisture (Abad *et al.,* 2014). These changes may be caused by soil compaction that reduces soil volume and consequently lowers soil productivity and environmental quality (Abad *et al.,* 2014). As the fertility of soil declines, soil structure weakens and the soil becomes susceptible to erosion (Adetunji, 2004).

Soil physical and chemical properties play a vital role in transport and reaction of water, solutes and gases in soils. Their knowledge is very important in understanding soil behavior to applied stresses, transport phenomena in soils; however, little is known on the soil physicochemical properties in the different vegetation types of the study area. Baseline information on effect of vegetation on soil in the study area, which form essential component of any sustainable land use systems, are yet unavailable in the study area.

It woul be difficult to evolve a sound sustainable use of soil resources strategy, especially to enhance land productivity for the study area without adequate knowledge of soil physical and chemical properties. Hitherto, there is dearth of information about soil quality in the different vegetation types. Thus, there is need to determine the soil physicochemical properties in order to provides a suitable land management practices, and present appropriate recommendations for optimal and sustainable utilizations of land resources.

The effects of land uses on the environment ranges from minor land cover changes and soil modification to severe desertification, deforestation, erosion, and river encroachment problems. Therefore, there is increasing concern about the land use land cover changes and its negative impacts on soil quality and the environment in many parts of the world due to the current global population growth and economic development. Thus, it is important to have knowledge on the soil physicochemical properties as this may facilitate the formulation of sustainable soil management strategies and effective soil conservation practices in the study area. This study, therefore, provides baseline information on physicochemical properties of soil, which will help to ascertain the status of the soil in the area to ensure an effective management planning.

2. METHODOLOGY

2.1. The Study Area

The study was carried out at the University of Ilorin, situated in Ilorin South, Ilorin. It is located on Latitude 8º30' and 8º50'N, and Longitude 4º20' and 4º35'E of the equator, occupying an area of about 468 sq.km. It is situated in the transitional zone within the forest and the guinea savannah regions of Nigeria. The University of Ilorin is located at about 500 km apart from Abuja, the Nigeria national capital, and 300 km away from Lagos, Nation's economic capital. Geographically, the study area lies at latitude 8.47oN and longitude 4.54oE, covering an approximate land mass of 5,000 hectare.

The annual rainfall of the area is between 600 and 1500 mm with distinct wet and dry seasons of almost six months each. The average relative humidity is 77.50% and daily sunshine of 7.1 hours. The mean monthly temperatures are very high, varying from 25˚C to 38˚C (Olanrewaju, 2009).

The soil of the area is loamy-sand with mean composition of 4%, 7% and 89% for clay, silt and sand respectively. Sand, which is predominantly large particles, tend to drain quickly and have lower fertility. The pH ranges between 7.10 and 7.81, Water holding capacity ranges between 0.28 ml/g and 0.53 ml/g, and the Moisture content ranges from 2.10% to 5.23% (Oyeyiola and Agbaje, 2013).

2.2. Soil Sampling Procedure and Collection

Soil samplings were collected from four vegetation types under different land use in the study area, to determine their physicochemical properties. The vegetation types used in the study area include: *Tectona grandis* (teak) plantation, Forestland (forest reserve), *Jatropha curcas* plantation and Farmland. In each vegetation type (treatment), sampling plots were demarcated into 25m x 25 m from which soil samples were randomly selected in six different areas. The soil samples were collected from 0-30 cm depth using soil auger. The 30 cm depth for soil were considered during sampling in order to accommodate mobile nutrients such as nitrogen, where large volumes of soil might be disturbed. For each treatment, one composite soil sample was then prepared from the six different areas with three replicates. The collected soil samples were properly labeled for identification and packed in polythene bags. Samples were air-dried, grounded (using mortar and pestle) and passed through 2 mm size sieve before laboratory analysis.

2.3. Laboratory Analysis of Soil Physicochemical Properties

The soil physical and chemical analysis was carried out at the Soil Analytical Laboratory of the Department of Agronomy, university of Ilorin, Nigeria. Standard laboratory procedures were followed in the analysis of the physicochemical properties considered in the study.

Particle size distribution of different particle size fractions for soil texture evaluation was determined using Boyoucos hydrometric method as described by (Bouyoucos, 1962; Day, 1965; Gee and Bauder, 1986; Van Reeuwijk, 1992). Soil pH determination was carried out in water (H2O) and potassium chloride (1M KCl) suspension in 1:1 (soil solution ratio) was determined using a glass electrode (Van Reeuwijk, 1992). Soil Organic Carbon was determined based on wet-oxidation method as described by Walkley and Black (1934). Total Nitrogen was analyzed using the Kjeldahl digestion, distillation and titration method as described by Black (1965). Available Phosphorus was analyzed by Bray (P-1) acid Fluoride method as outlined by Olsen et al. (1954). Exchangeable bases [Calcium (Ca), Magnesium (Mg), Potassium (K) and Sodium (Na)] were determined after extracting the soil samples by ammonium acetate (1N NH4OAc) at pH 7.0 (Chapman, 1965; Rowell, 1994; Reeuwijk, 2002).

2.4. Data Analysis

The Laboratory analytical results on different soil physicochemical properties were computed into Excel spreadsheet (2013), and were then subjected to One way Analysis of Variance using MINITAB 14 to determine the mean, standard deviation and to test for significance among the treatment. Soil properties were compared using Pearson correlation coefficient, and the existence of inter-relationships between data set was tested by linear correlation.

3. RESULTS

3.1. Soil Particle Size Distribution to Vegetation Types

The result of particle size distribution analysis showed there was no significant difference in silt content among the vegetation types. The highest average silt content was recorded under Forestland (12.67 %) and the lowest in Jatropha plantation (8.67 %). Silt content showed a significant and positive correlation with Organic carbon (r = 0.66), Total Nitrogen (r = 0.61), Phosphorus (r = 0.65), Calcium (r = 0.60) and available Potassium (r = 0.64) as shown in Table 4. The textural class for all the four vegetation types was loamy sand, indicating the similarity in parent material.

Sampled soils did not show significant differences in the sand and clay percentages among Teak plantation, Jatropha plantation and Farmland at 0.05 levels (Table 1). However, there were little variations in the particle size composition of the sampled soil at the different vegetation type. Numerically, Jatropha plantation and Farmland have the highest average mean of sand contents (86.76%), and Teak plantation and Farmland have the least average mean of clay contents (3.91 %) respectively. Likewise, Forestland has the highest average clay content (7.91 %) and the least average sand content (79.43 %) respectively as shown in Table 1. Clay content were positively correlated with Magnesium (r = 0.60) and 53 total Nitrogen (r = 0.59) while sand content was positively and negatively correlated with pH (H2O) and Mg2+ having values of r = 0.68 and r = -0.62 respectively (Table 4).

Table1. *Soil particle size distribution in the study area*

Soil composition	Location				F-values	p- values
	Teak Plantation	**Forestland**	**Jatropha Plantation**	**Farmland**		
% Silt	10.00 ± 0.00^a	12.67 ± 3.06^a	8.67 ± 1.16^a	9.33 ± 1.16^a	3.07	0.091
% Sand	86.09 ± 1.16^a	79.43 ± 2.31^b	86.76 ± 0.00^a	86.76 ± 0.00^a	22.93	0.000
% Clay	3.91 ± 1.16^a	7.91 ± 1.16^b	4.57 ± 1.16^a	3.91 ± 1.16^a	8.25	0.008
Textural Class	**LS**	**LS**	**LS**	**LS**		

Means with the same letters are not significantly different from each other.

3.2. Soil (pH), Organic Carbon, Total Nitrogen and Available Phosphorus on Vegetation Types

The Analysis of Variance as shown in Table 2 revealed that, the soil pH (H20) and pH (KCl) were significantly affected by vegetation types. Numerically, Jatropha plantation has the highest mean soil pH in water (7.17) and soil pH in KCl (6.47) while Forestland has the least soil pH in both water (6.30) and KCl (5.30). pH (H2O) was negatively correlated with organic carbon (r = -0.70), available phosphorus (r = -0.64) and K+ (r = -0.69) as shown in Table 4.

Soil Organic Carbon (OC) content in the study area was lower in Farmland with mean composition of (0.37 %) compared to Teak plantation (0.49 %), Jatropha plantation (0.52 %) and Forestland (1.00 %). There was no significant difference between the plantations, but among the four vegetation types, there was a signicant difference. From Table 4, OC showed a positive and significant relationship with silt (r = 0.66).

Total Nitrogen (TN) and Available Phosphorus (AP) contents showed significant differences (p<0.05) under soils of different vegetation types with the highest mean (0.76 %; 1.32 mg/kg) and lowest mean (0.35 %; 0.34 mg/kg) contents of both recorded under Forestland and Farmland respectively as shown in Table 2. The result of correlation analysis in Table 4 showed that total nitrogen has a significant and positive relationship with K+ (r = 0.65), Silt (r = 0.61) and Clay (r = 0.59) while Available Phosphorus has a positive relationship with silt (r = 0.65).

Table2. *Soil pH, Organic Carbon, Total Nitrogen and Available Phosphorus of the study area*

Parameters	Locations	Mean	Std. Deviation	F-value	p-value
pH (H2O)	Teak Plantation	7.00a	± 0.10	9.63	0.005
	Forestland	6.30b		± 0.17	
	Jatropha Plantation	7.17a		± 0.21	
	Farmland	6.77ab		± 0.31	
pH(KCl)	Teak Plantation	5.87ab	± 0.06	3.32	0.078
	Forestland	5.30a		± 0.00	
	Jatropha Plantation	6.47b		± 0.40	
	Farmland	5.87ab		± 0.81	
% OC	Teak Plantation	0.49a	± 0.00	838.58	0.000
	Forestland	1.00b		± 0.02	
	Jatropha Plantation	0.52a		± 0.03	
	Farmland	0.37c		± 0.01	
% TN	Teak Plantation	0.65a	± 0.03	226.79	0.000
	Forestland	0.76b		± 0.03	
	Jatropha Plantation	0.49c		± 0.01	
	Farmland	0.35d		± 0.01	
AP (mg/kg)	Teak Plantation	0.70a	± 0.04	515.06	0.000
	Forestland	1.32b		± 0.02	
	Jatropha Plantation	0.61c		± 0.34	
	Farmland	0.34d		± 0.02	

Means with the same letters are not significantly different from each other.

3.3. Exchangeable Bases to Vegetation Types

Table 3 shows the exchangeable bases of the study area. Contents of Calcium (Ca2+) and Magnesium (Mg2+) have no significant difference under soils of Teak and Jatropha plantation but among the different vegetation types, there was significant difference. There was a positive and significant correlation between Ca2+ and Silt (r = 0.60), and between Mg2+ and Clay (r = 0.60). Numerically, Forestland has the highest average Ca2+ and Mg2+ contents with mean composition of 1.09 (cmol(+)/kg) and 0.36 (cmol(+)/kg) respectively, while Farmland has the least average Ca2+ content with mean composition of 0.57%, and both plantations have the least average Mg2+ content with mean composition of 0.18 (cmol(+)/kg).

Both Teak plantation and Farmland showed no significant differences in Potassium (K+) and sodium (Na+). Likewise, Forestland and Jatropha plantation showed no significant differences in sodium. However, there was significant difference among the four vegetation types in both K+ and Na+ contents. Numerically, the highest average K+ and Na+ contents were recorded under Forestland (0.43 (cmol(+)/kg)) and Jatropha plantation (0.15 (cmol(+)/kg)) respectively, while the least average K+ and Na+ contents were recorded under Teak plantation and Farmland with mean composition of 0.27 (cmol(+)/kg) for K+ and 0.06 (cmol(+)/kg) for Na+ as showed in Table 3. From Table 4, Na+ and K+ were negatively correlated (r = -0.64) with each other.

Table3. *Exchangeable bases (cmol(+)/kg) as influenced by the vegetation types in the study area*

Parameters	Locations	Mean	Std. Deviation	F-value	p-value
Ca	Teak Plantation	0.85a	± 0.02	367.17	0.000
	Forestland	1.09b		± 0.02	
	Jatropha Plantation	0.80a		± 0.02	
	Farmland	0.57c		± 0.01	
Mg	Teak Plantation	0.18a	± 0.01	160.17	0.000
	Forestland	0.36b		± 0.02	
	Jatropha Plantation	0.18a		± 0.01	
	Farmland	0.32c		± 0.01	
K	Teak Plantation	0.27a	± 0.01	136.98	0.000
	Forestland	0.43b		± 0.01	
	Jatropha Plantation	0.32c		± 0.01	
	Farmland	0.27a		± 0.01	
Na	Teak Plantation	0.06a	± 0.01	73.20	0.000
	Forestland	0.13b		± 0.01	
	Jatropha Plantation	0.15b		± 0.01	
	Farmland	0.06a		± 0.01	

Means with the same letters are not significantly different from each other.

3.4. Responses of Correlation Matrix among Soil Parameters

Table 4 shows the result of correlation among the soil parameters. There was significant and positive correlation between silt particles and organic carbon, total nitrogen, available phosphorus, calcium as well as potassium with correlation coefficients (r-values) of 0.66, 0.61, 0.65, 0.60 and 0.64 respectively. However, correlation between silt particles and pH(H2O) was negatively significant with a correlation coefficient of r = -0.59.

Clay content had significant and positive correlation with total nitrogen (r = 0.59) and magnesium (r = 0.64), while sand particles was significantly positive with pH(H2O) (r = 0.68) and negative with magnesium (r = -0.62). Of all the soil parameters, the correlation between available phosphorus and organic carbon (r = 0.98) was the strongest. However, sand particles and pH(H2O) had the strongest, positive and significant correlation (r = 0.68). This was followed by that between silt and organic carbon (r = 0.66), and the resulting correlations were also significant. The weakest and insignificant correlation was between sodium and pH(H2O) with correlation coefficient of r = -0.01 as shown in Table 4.

Table4. *Pearson's correlation matrix among the various soil physicochemical parameters*

	Silt	Clay	Sand	pH (H2O)	OC	TN	AP	Ca	Mg	Na	K
SILT	1.00										
CLAY	0.34	1.00									
SAND	-0.84	-0.80	1.00								
pH (H2O)	-0.59*	-0.52	0.68*	1.00							
OC	0.66*	0.85	-0.92	-0.70*	1.00						
TN	0.61*	0.59*	-0.73	-0.41	0.81	1.00					
AP	0.65*	0.81	-0.88	-0.64*	0.98	0.91	1.00				
Ca	0.60*	0.73	-0.81	-0.46	0.92	0.95	0.97	1.00			
Mg	0.44	0.60*	-0.62*	-0.81	0.52	0.08	0.40	0.18	1.00		
Na	0.06	0.52	-0.38	-0.01	0.54	0.30	0.50	0.55	-0.03	1.00	
K	0.64*	0.82	-0.89	-0.69*	0.96	0.65*	0.90	0.82	0.58*	0.64*	1.00

* Correlation is significant at 0.05 level

4. DISCUSSION

4.1. Soil Physical Properties

The results of the study revealed that the textural class of all the vegetation types was loamy sand (Table 1), indicating the similarity in parent material under the same climate. Irrespective of vegetation type, the particle sizes in the four land uses were dominated by sand fraction. The result of

this study is in accordance with Oguike and Mbagwa (2009), who reported that high sand fraction, could be attributed to the parent material (coastal plain sand) since the texture of the soil is highly influenced by the parent material and topography over time. Similar case was reported by Fagbami and Udoh, (1982) and Senjobi (2007), who noted that the high percentage of sand fraction is a good indication of the observable high infiltration rate and low water holding capacity of the soils, thereby resulting into moisture stress. In addition to the above, this scenario encourages rapid leaching of nutrients from the soils beyond the rooting zones of the planted crops – a situation that threatens increase in food productivity and food security.

The mean percent of silt particle in all the vegetation types had no significant different when compared to the particles of clay and sand mean percent (Table 1). This may be as a result of little leaching and runoff water encounter which has no significant impact on the silt particles. This report is in accordance with Miles, (1985) and Sharma and Yogender, (2004). They reported that vegetation has a pronounced effect on many soil properties in which when a population of one species is replaced by plant of another species, significant change in dynamic properties of surface and subsurface soils can be expected, and with time, changes in soil structure, thickness, horizon and colour.

Clay soil content was lower in farmland and teak plantation as compared to the forestland and Jatropha plantation. The reason could be attributed either to selective removal of clay from the surface by erosion, or intensive and continuous cultivation which might cause compaction on the surface that reduces translocation of clay particles within the different layers in agreement with the findings reported by Wakene (2001) and Jaiyeoba (2001). Similarly, Eyayu *et al.,* (2009) and Mojiri *et al.,* (2012) reported lower clay content in cultivated land than the adjacent soils under natural forest.

4.2. Soil Chemical Properties

The soil Organic Carbon content varied among the vegetation types with higher amount of Organic Carbon in Forestland compared to others. This could be attributed to improved aeration that promoted mineralization of OC or owing to the little or no return of plant residues and manures into the soils. Also, high temperature and high relative humidity, which favour rapid mineralization, might be responsible for decreasing order of magnitude of Organic Carbon (FO > TP > JP > FL) in conformation with the finding of Senjobi and Ogunkunle (2011).

Much of farmland loss in soil Organic Carbon can be attributed to reduced inputs of organic matter, decreased decomposability of crop residues, and tillage effects that decrease the amount of physical protection to decomposition as reported by Post and Kwon, (2000). Offiong and Iwara, (2012) also reported that the conversion of forest ecosystem to other forms of land cover may decrease the stock of OC due to changes in soil moisture and temperature regimes, and succession of plant species with differences in quantity and quality of biomass returned to the soil. Shukla *et al.,* (2006) reported that Organic Carbon is a powerful indicator for assessing soil potential productivity, and a great number of studies have reported similar observations. Paustian *et al.,* (1996) observed that a greater frequency of cropping with associated increases in SOC is due to greater return of crop residues.

The significant differences (p = 0.00) in soil Organic Carbon among the different vegetation types indicate a drastic reduction in the organic Carbon content, structural stability and nutrients content of the soils in the study area. With respect to global climate change as reported by Barrow (2006) and Khresat *et al.,* (2008), who noted that the destruction of forests due to anthropogenic activities and enforced processes of Organic Carbon decomposition contribute to increased emissions of CO_2 into the atmosphere.

Total Nitrogen richness under Forestland in the study area could be attributed to the land use and management system, as roughly 95% of soil total Nitrogen is found in soil organic material in undisturbed, natural soils. This is in accordance to the report stated by Price *et al.,* (2010) and Walworth, (2013). The TN content of the soils ranged from 0.35 to 0.76 % (Table 2); this range of value was rated as medium when compared to the medium range of 0.10 to 0.45% recommended by Holland *et al.,* (1989) and Deekor (2012). This range is however, consistent with the works of Ukaegbu and Akamigbo (2005) who reported average TN percentage of 0.08 in soils of the Cross River Coastal plain sands. Ayoubi *et al.,* (2011) reported that natural forest soils had more TN as compared to the cultivated lands. Likewise, Heluf and Wakene (2006) recorded the highest TN on surface soil layers of virgin lands compared to research and farmers' fields.

The least total Nitrogen value recorded in farmland may be attributed to the intense cultivation of the soils which normally decrease the rate of mineralization of the organic matter. Franzluebbers *et al.,* (1999) reported that increase in the intensity and frequency of tillage operations which produces more soil disturbance decreased total Nitrogen content. The increase in the contents of OC and TN under forestland is attributable to the increase in plant density and cover which provides large amount of biomass that decomposes to form nutrient in the soil.

The significant difference in available Phosphorus of the soil under the different vegetation type could be attributed to organic material deposit, the rate of mineralization and leaching. Content of AP in all the vegetation types ranged from 0.34 – 1.32 mg/kg revealing that all soils of the study area were deficient in AP as in accordance to Thomas (2000). Bubba *et al.,* (2003) reported that the causes of available phosphorus deficiencies have been attributed to high weather ability of the soils, clay type, leaching by intense rainfall and adsorption reaction by soil constituents.

Yeshaneh (2015) reported that the availability of phosphorus under most soils decline by the impacts of fixation, abundant crop harvest and erosion. Among the vegetation types, forestland contained relatively higher concentration of AP as a result of high organic matter which released phosphorus during its mineralization.

Soil reactions (pH) values measured in a suspension of soil to water ratio are greater than that of soil to KCl solution ratio. Soil pH of the study area are moderately acidic to neutral (6.30-7.17) for soil pH (H2O), and slightly acidic to moderately acidic (5.30-6.47) for soil pH (KCl). The sequence of increase in soil reactions among the vegetation types is JP > TP > FL > FO. Lower soil pH (H2O) in the forestland could be attributed to increased nutrient uptake resulting from soil acidification, and organic acids released by litter decomposition. This is in conformity with the findings of Brady and Weil (2007) in USA. Similar case has been reported by Yoshinori *et al., c*omparison of physicochemical properties of soils under contrasting land use systems in Southwestern Nigeria. Mohammed *et al.,* (2005) also reported that the relative decline in soil pH under natural forest land could be due to oblong shaped canopy leading the rain to form big drops consequently enhancing leaching of basic cations as well as releasing organic acids associated with mineralization of organic matter.

The slightly lower average value of soil pH under farmland may be attributed to continuous cultivation which increase losses associated with lowering of organic matter and organic Carbon contents in the soil. Chimdi *et al.,* (2014) reported that slightly lower pH value in farmland may be due to the depletion of basic cations in crop harvest, and due to its highest microbial oxidation that produces organic acids, which provide H+ to the soil solution lowers its soil pH value. As reported by Wasihun and Muktar (2015), that continuous cultivation practices, excessive precipitation, and application of inorganic fertilizers could be some of the factors which are responsible for the variation in pH in the soil profiles.

There were significant differences in the concentration of exchangeable Ca2+, Mg2+, K+ and Na+ among the different vegetation types. This may be attributed to leaching losses, low content in the parent rock and the proportion of clay minerals as well as the conversion of forestland into the other land use types. This study is in agreement with the findings of Wakene and Heluf (2003), who reported that continuous cultivation and use of acid forming inorganic fertilizers deplete exchangeable Ca2+ and Mg2+.

The proportions of exchangeable bases Ca, Mg, and K were low across the studied soils. This finding agrees with the works of Akinrinde and Obigbesan, 2000; Uzoho *et al.,* 2007, who reported low values of Ca, Mg and K for most Nigerian soils, and are attributed to leaching losses by the high tropical rainfall as well as low content in the parent rock. The low exchangeable potassium contents observed under cultivated land could be due to continuous cultivations and inorganic farming practices in the study area. This is in line with Malo *et al.,* (2005), who indicated intensity of weathering, cultivation and use of acid forming inorganic fertilizers affect the distribution of potassium on farmland, thus, enhancing its depletion.

Concentration of sodium in all the vegetation types is below the critical limit (1.0(cmol(+)/kg)), thus, the soils have sodicity problem. This is in conformity with the work of Uquetan *et al.,* (2017) in Akampa, Cross River state. In general, deforestation, leaching, limited recycling of dung and crop

residue in the soil, very low use of chemical fertilizers, declining fallow periods or continuous cropping and soil erosion have contributed to depletion of exchangeable bases.

5. CONCLUSION

The result of this finding revealed that, the vegetation types under different land uses have influenced the soil physical and chemical properties at a different level. The results of this study are evidences of significant changes in the quality attributes of the soils in the study area, following the removal of vegetative cover and frequent tillage that lead to soil erosion, thereby declining soil fertility. The direct causes of land degradation, including decline in the use of fallow, limited recycling of dung and crop residues to the soil, limited application of external sources of plant nutrients, and deforestation are apparent. Most parameters of the soil under farmland vegetation showed overall changes towards the direction of fertility loss compared to the parameters of the other vegetation types. Soil under forest reserve (forestland) recorded high level of organic carbon, total nitrogen, available phosphorus, calcium, magnesium, potassium, silt and clay particles over soils under teak plantation, Jatropha plantation and farmland. This resulted from high content of organic materials, a dense vegetative cover which mitigates erosion effects, found in the forestland. Likewise, forestland soil was more acidic among the different land uses. Irrespective of vegetation type, it was observed that soil particle sizes did not vary among the studied soils. However, soils of Jatropha plantation and farmland are more sandy, while teak plantation and farmland had the lowest clay content. From the present study, it could be concluded that the soil quality and health were maintained relatively under the forest rserve, whereas, the influence on most parameters were very low on the soil farmland, suggesting the need for intervention so as to optimize and sustain the soil quality.

Thus, it is recommended that management practices such as planting leguminous crops, increased fallow period, organic manuring, planting of fast growing vegetative species and returning crop residues to the soil as a way of building up used carbon stocks on farmland. Also, Techniques complemented with strong land-use policy should be integrated into the strategy for sustainable agricultural development in the study area. The management should enlighten the land users, particularly the farmers, on soil conservation practices through detailed soil survey and land evaluation. When this is carefully done, the soil can then be put to appropriate land use by land users, having known its capability and constraints as well as use the land for the purpose it is best suited for, this will go a long way to improve the productivity of such lands, thus, directly or indirectly maintaining the quality of the soil.

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