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EFFECTS OF LAND USE AND DEPTH ON CARBON SEQUESTRATION AND AGGREGATE STABILITY IN SOILS OF COASTAL PLAIN SANDS PARENT MATERIAL IN OKWUTA-ISIEKE, SOUTHEASTERN, NIGERIA

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ABSTRACT
Effect of land use and depth on carbon sequestration and aggregate stability in soils formed under coastal plain sands in Okwuta-Isieke, Southeastern Nigerian were studied. The experimental design used for the study was 3 x 3 factorial in randomized completely block design (RCBD), comprising of two factors- soil depth (at 3 levels: 0-19, 20-39, 40-100cm) and land use [at 3 levels: planted pine forest of Pinus carribeae plantation (PPF-PCP), Managed Tree Cropland of Irvingia wombulu plantation (MTC-IWP) and continuously cultivated cropland of cassava/maize/telferia intercrop (CCC-CMI). Results showed that higher (P<0.05) mean weight diameter was observed under PPF-PCP and MTC-IWP relative to CCC-CMT. Planted pine forest and Irvingia plantation improved (p<0.05) soil aggregate stability more than arable cropland. Land use significantly (p<0.05) influenced soil organic carbon (SOC) , total nitrogen, cation exchange capacity, available P and SOC pool. Soils under PPF-PCP sequestered higher (p<0.05) amount of C, followed by MTC-IWP soil; across the soil depths. The trend showed that pine forest >Irvingiawombulu> Cassava/maize/telferiaintercrop in the amount of C sequestered. Soil conservation practices associated with CCC-CMT should be re-evaluated as this is inadequate to improve the qualities of soil with emphasis on organic matter content and aggregate stability.

Key word: Coastal plain sand, land use, aggregate stability, carbon sequestration

INTRODUCTION
Coastal plain sands is a dominant parent material in southeastern Nigeria due to the nearness of the region to the Atlantic coastal marshes (Ibe, 2014). These coarse textured soils are usually not environmentally friendly due to excessive soil nutrient leaching and low soil organic matter (SOM) (Anikwe, 2010). According to Ojanuga (1977), soils of southeastern Nigeria are highly weathered with low cation exchange capacity resulting in very low agronomic value. Uguru et al. (2011) recorded that coastal plain sands retain low amount of SOM because of its coarse nature and rapid mineralization of SOM in the tropics.

Food and Agricultural Organization (FAO, 2017) recognized reduction of agricultural related carbon emission as a main option in the mitigation of climatic change and global warming. Lal (2004) agreed that improved agricultural practices could help in mitigating climate change by reducing emissions from agriculture and storing carbon in plant biomass and soils. All ecosystems such as forests, grasslands, croplands, plantations swamp areas and fallow lands take up atmospheric carbondioxide (CO2) in the photosynthetic process and transform it into organic products (AN et al., 2010; Awelewa and Ogban, 2017). Soil carbon sequestration potential of a given ecosystem is dependent on use, crop plant species composition, age of component species, parent material, slope, various environmental factors and management practices (Ibe, 2020 and Salako, 2013). It was also reported by early researchers that soil carbon sequestration is a function of texture, elevation, drainage and degree of tillage operation carried out on arable cropland (IUSS Working Group, WRB, 2015; Salako, 2015; Abah and Petja, 2017).

According to Hamed et al. (2019), land use and continuous cultivation can change the total amount of soil organic matter (SOM) that is stabilized through physical and chemical processes. Long-term continuous cultivation and vegetation removal deplete SOC stock leading to aggregate instability due to low biomass input. Application of fertilizer, manure and other soil amendments have been found to increase SOC. This is because these cultural and management practices increase biomass and residue productivity (Baishya, 2015). Soils under long-term forage plants and crop rotation have higher ($p<0.05$) SOC in a similar tropical environment. Odurukwe et al. (1995) observed that forage plants leave more residues and biomass in the soil compared to arable cropland. Yadav and Arora (2018) reported that long-term vegetation cover on soils may be the best strategy for the improvement of the accumulation of carbon.

Eibasiceuny et al. (2014) noted that even though the SOC pool forms the largest sink apart from sedimentary rocks and fossil deposit, it has remained the most vulnerable to anthropogenic disturbances. The net losses of SOC due to land use changes may occur as a result of decreased organic matter inputs and changes in litter composition, high rate of SOM decomposition and erosion (Khera and Singh, 2008; Ullasa and kumar, 2017). Substrate quality has been reported as one of the main factors affectingdecomposition (Ogunwole et al., 2014). It has also been linked to the relative abundance of specific compounds such as nitrogen, lignin and phenolic acids (Lal, 2004). Lack of nutrients, especially N could explain the low C conversion efficiency (Lal, 2005). According to Ogunwole et al. (2014), the rate of carbon accumulation in agricultural abandoned fields was controlled by the rate of nitrogen accumulation which in turn depend on atmospheric nitrogen deposition and symbiotic nitrogen fixation by legumes.

Surface soils in the tropics have low SOC and high erosion risk because of disturbances resulting from deforestation and tillage operations (Lal, 2017, 2006 and Li et al., 2010). When agricultural land is no longer used for cultivation and allowed to revert to natural vegetation or re-planted to perennial vegetation, soil organic carbon can accumulate by processes that essentially reverse some of the effects responsible for soil organic carbon depletion (Nnaji, 2018 and Ahaiwe et al., 2010). Soil organic matter enhances soil carbon sequestration with the adoption of appropriate land use and soil management.Bhuni et al. (2016) observed high amount of variation in rates and the length of time that carbon may accumulate in the soil. This is related to vegetation, physical and biological conditions in the soil and the past history of soil organic carbon inputs and physical disturbance (Uguru et al., 2011; Lal and Okigbo, 1990).

Soil aggregate stability may be used as an

control the dynamics of SOM and nutrient cycling The soil type of the area are dominantly Utisols (Acrisols) (Lekwa and White side, 1986; Igwe et al., 1995; Okpamen et al., 2013; Nuga, 2009 and Ahaiwe et al., 2010).

(Salako, 2015). It is an attribute that is contingent on the shear strength of a soil, on the amounts and forms of organic matter prevalent in a soil, on the biochemical composition of plant residues and on soils functional properties like soil permeability, on vegetation cover, on root length density, on susceptibility to surface run off during heavy precipitation events, on soils structure, on soil erosion (Govers et al., 2013; FAO, 2017 and Hamed et al., 2019). Tillage practices appear to be one major activity that breaks down soil aggregation and aggregate stability. It was found out that the aggregate stability decreased due to tillage (IUSS Working Group, WRB, 2015).

The conversion of land use often results in the destruction of soil structure (Sulieman et al., 2019; Yadav and Arora, 2018). Soil organic carbon (SOC) is known to have a strong relationship with aggregate formation and stabilization (Lal and Okigbo, 1990). Macro-aggregates are sensitive to changes in land use and cultivation practices whereas microaggregate re less sensitive (Ahaiwe et al., 2010; Igwe et al., 1995 and Lal, 2017).

Quantification of the impacts of land use and soil depth on carbon stocks and aggregate stability in the study area is challenging because of the heterogeneity of soil, climate, cultural/management conditions and due to the lack of data on soil carbon pools of most common ecosystems. There are limited knowledge about SOC pool dynamics in soils under specific ecosystems in the tropical humid agro ecosystem of southeastern Nigeria. It is important to generate reliable information which is essential for developing techniques of land management systems and for recommendation of agricultural practices that promote C sequestration for sustainable agricultural and erosion control. The broad aim of this study is to assess the effect of land use and depth on carbon sequestration and aggregate stability in coastal plain sands of Okwuta-Isieke, Southeastern Nigeria. The specific objectives are to:

i) Determine the effect of land use and depth on soil organic carbon sequestration and aggregate stability.

ii) Quantify SOC pool and assess their distribution across three depths (0-19, 20-39 and 40-100cm) under different land uses.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted at the Forestry Research Institute of Nigeria (FRIN), Okwuta-Isieke, Abia State. The FRIN lies within latitude 05^{o}30^{I}N to 05^{o}33N and longitude 07^{o}31E to 07^{o}35E (Fig.1). And is in the Southeastern Nigeria. The study area is shown in Figure 1.

Abia State generally have tropic rainforest with bimodal rainfall distribution pattern but with less intensity and clear distribution between wet and dry seasons. The tropical rainforest have average rainfall of 2500mm (NIMET, 2018 and NDBDA, 2019). The mean maximum temperature of the area is 32°C while the mean minimum is 21°C. February and March are usually the hottest months while July and September record the lowest temperature. The area has average daily sunshine of 6.25 hours with minimum and maximum hours of 0.1 and 9.9 respectively (Uguru et al., 2011; NIMET, 2008 and Odurukwe et al., 1995). Similarly, it has annual daily solar radiation of about 2.25kwh/m^2/day varying between 3.5kwh/m^2/day at the northern boundary (NIMET, 2008 and AbiaState Official Gazette). The relative humidity was 82% (NIMET, 2008 and 2017). Evaporation is generally high in southeastern Nigeria because of the relatively high value of insolation and temperature (NIMET, 2008 and 2017).

The vegetation of the experimental area is typical rainforest vegetation. The secondary bush which dominates the area are the remnant of the typical rainforests which are fast disappearing, some of the forest species found in the area include, oil beans (*Pentaclethra macrophyllum*), Oil palm (*Elaesis guinensis*), plantain/Banana (*Musa* spp), Raffia palm (*Raphia spp*). Grasses and brown leaf weeds that dominate the entire area include *Panicum maximum*, *Pennisetum purperium*, *Aspilla africana*. The major tuber and root crops mostly grown on ridges and mounds in the area include Cassava (*Manihot esculenta*), Yam (*Discorea* spp), Sweet potato (*Ipomoea batatas*) and Cocoyam (*Xanthomonas sagottofulium*), Maize (*Zeamays* L), Melon (*Citrusvulgris*) and vegetables such as Okra (*Hibiscus esculentus*) and Fluted pumpkin (*Telferia*spp).

Field studies, experimental design and sample collection

Reconnaissance study was carried out to assess the land use practices and soils at Okwuta- Isieke, Abia State, Nigeria. Through the collaboration of the staff of the Forest Research Institute of Nigeria, Okwuta-Isieke sub-station, local farmers and community leaders in the study area, soils under three land uses within the same area were selected for the study. The land uses were (i) planted pine forest of Pinus carribeae plantation (PPF-PCP) (ii) managed Tree Cropland of Irvingia wombulu plantation (MTC-IWP) and (iii) continuously cultivated cropland of cassava/maize/telferia intercrop (CCC-CMI).

The experimental design used for the study was a 3 x 3 factorial in randomized completely block design (RCBD), comprising of two factors- soil depth (at 3 levels: 0-19, 20-39, 40-100cm) and land use [at 3 levels: planted pine forest of Pinus carribeae plantation (PPF-PCP), Managed Tree Cropland of Irvingia wombulu plantation (MTC-IWP) and continuously cultivated cropland of cassava/maize/telferia intercrop (CCC-CMI).

Stratified random sampling as modified by Smith (1976) was used in the field. Three mini-pits (0.5m x 0.5m x 1m) were dug in the study area under each of the land use types (planted pine forest of Pinus carribeae plantation land use type (PPF-PCP), Managed Tree Cropland of Irvingia wombulu plantation land use type (MTC-IWP) and continuously cultivated cropland of cassava/maize/telferia intercrop land use type (CCC-CMI). Soil samples were collected from 0-19, 20-39 and 40-100cm sampling depths from each of the mini-pits. A total of 27 disturbed and 27 undisturbed soil samples were collected and used in the laboratory for the determination of soil physical and chemical properties.

Laboratory analysis

Particle size distribution was determined by the hydrometer method as described by Gee and Or (2002), using sodium hydroxide as the dispersing agent.

Bulk Density Measurements was obtained by the cylindrical core method as described by Blake and Hartage (1986):

$$\text{Bulk Density} = \frac{\text{Mass of Oven Dry Soil (g)}}{\text{Volume of Bulk soil (cm}^3\text{)}} \quad (1)$$

Aggregate size separation was performed on 100g of 4.75mm sieved soil by wet sieving air-dried soil through a series of sieves (Elliot, 1986), after submerging the soil samples in water at room temperature for 5minutes. A series of four sieve were used to obtain five different water stable aggregate (WSA) fractions as follows: >2.00mm, 1.00–2.00mm, 0.50–2.00mm, 0.25 – 0.50mm, and < 0.25mm. Materials retained on each sieve (WSA) were oven dried at 40°C to constant weight.

The mass of aggregates >0.25mm was calculated by subtracting the sum of the oven dried weights of materials retained on each sieve from the air-dried weight of the original sample. The proportion of each class to the total sample weight is computed, thus:

$$W_i = \frac{M_i}{M_t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Land use and depth on carbon sequestration and aggregate stability i material

occurring in the corresponding size fraction.

M_i=weight of the oven dried aggregates (uncorrected for sand) in the size class fractions after sieving.

M_t = total weight of the initial material (100g) before sieving

The mean weight diameter (MWD) was calculated from the equation:

$$MWD = \Sigma x_i W_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where; x_i = mean diameter of each size fraction (mm) W_i = proportion of the total sample weight occurring in the corresponding size fraction Soil pH was determined in distilled water and potassium chloride solution at ratio 1:1 and 1:2:5 soil/water suspension using pH meter (Mclean, 1982). Soil organic carbon content was determined by Walkey and Black wet oxidation method as described by Nelson and Sommers (1982). And the SOC pool content was calculated using the following equation (Lal et al., 1998)

$$MgCha\text{-}1=\frac{\%\ C \times Pb \times d \times 104M2ha^{-1}}{100} \quad (4)$$

Where:

MgCha-1=Mega-gram carbon per hectare (1Mg= 106g), % C=Percentage of C given by laboratory results, Pb (MgM^{-3})=Soil bulk density (Mega-gram per cubic meter) d=Depth in metres Total nitrogen content was determined by the macro kjeldahl digestion method using $CuSO_4$ and Na_2SO4 catalyst mixture (Bremmer and Mulvaney, 1982). Cation exchange capacity (CEC) was determined by the NH_4OAC (Ammonium acetate) at pH 7 methods (Thomas, 1982).

Statistical analysis

Data collected from the study were subjected to the analyses of variance. Separation of means for significant difference was performed using the F-LSD procedure as stated by Obi (1986).

RESULTS AND DISCUSSION

Effect of Land Use and Depth on Soil Properties

Physical properties

The effect of land use and depth on some soil physical properties in the study area are presented in Table 1. Sand dominated other particle sizes with values >52% at all depths. Land use did not significantly (P>0.05) influence particle size distribution and bulk density. Sand particle significantly (P<0.05) decreased with depth under MTC-IWP. This shows that eluviations of clay to the subsoil is more under this land use type. Generally, soil texture is more or less permanent property of the soil and do not change easily over time (Nnaji et al. 2009), hence the non-significant influence of land use on particle size distribution. MTC-IWP land use type reduced bulk density across soil depths. This could be related to the fact that vegetations associated with land uses could affect soil structure through their secretions into the soil, dead parts, micro and macro-organisms they attract to the soil, etc. This is shown by the differences in soil bulk density values under the different land uses. This result is in agreement with the observation of Igwe et al. (1995). They noted that bulk density is a function of land use.

Table 1: Effect of land use and depth on soil physical properties in the study area

			%		
Depth (cm)	Land use	Sand	Silt	Clay	BD (g/cm^3)
0-19	PPF-PCP	70.30	6.70	23.00	1.46
	MTC-IWP	79.33	8.67	12.00	1.40
	CCC-CMT	80.00	6.64	13.36	1.55
Sub mean		76.54	7.33	16.10	1.47
20-39	PPF-PCP	75.70	9.00	15.30	1.56
	MTC-IWP	63.00	6.00	31.00	1.37
	CCC-CMT	76.70	5.87	17.43	1.54
Sub mean		71.80	6.89	21.24	1.49
40-100	PPF-PCP	66.30	3.33	30.37	1.79
	MTC-IWP	54.33	6.67	39.00	1.67
	CCC-CMT	66.70	3.54	30.30	1.82
Sub mean		62.44	4.54	33.22	1.76
Total mean		70.26	6.24	23.53	1.57
LSD(0.05) for land use		5.77^{NS}	1.99^{NS}	6.39^{NS}	0.09^{NS}
LSD(0.05) for depth		7.07*	2.45*	7.83*	0.11**
LSD(0.05) for interaction		10.00^{NS}	3.46^{NS}	11.07^{NS}	0.16^{NS}

*, **, = Significant at 0.01 and 0.05 alpha levels, respectively, NS= Non-signficiant BD = Bulk density, CEC = Cation Exchange Capacity, TN = Total Nitrogen, SOC = Soil Organic Carbon, P = Phosphorus, K = Potassium, PPF-PCP = Planted Pinus forest of *Pinuscarribeae* plantation, MTC-IWP = Managed tree cropland of *Irvingiawombulu* plantation, CCC_ CMT = Continuosly cultivated Cropland of Cassava/Maize/Telferia mixed cropping

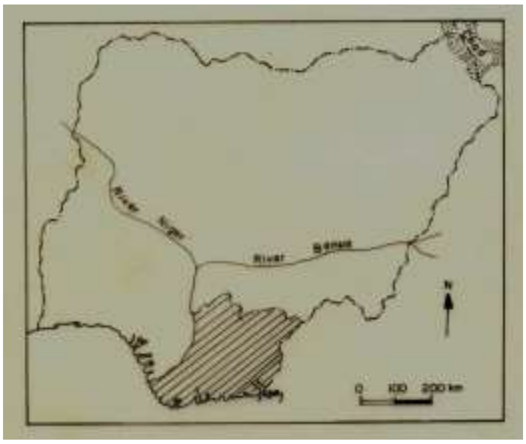

Fig. 1: Southeastern Nigeria: Study Area (Shaded)
Source: (Cartographic Unit, Department of Geography, Abia State University, 2015)

Aggregate stability

Effect of land use and depth on selected aggregated stability indices in the study area are presented in Table 2. Significant ($P<0.05$) influence of land use on mean weight diameter (MWD) was observed at the various soil depth, with PPF-PCP having highest MWD, followed by MTC-IWP. The results revealed that soil aggregate stability was high in PPF-PCP and MTC-IWP. This implies higher stability and resistance to erosion by these soils. Soil under CCC-CMTare unstable and could be termed, erosion risk area. The most affected areas in the soil are the subsoil (20-100cm) of the arable land. The decrease in aggregate stability status of the subsoils could be due to the decrease in SOM content down the profile. This aligns with the findings of An et al. (2010), who reported that SOM serves as a biding agent for soil aggregates and primary soil particles. Lal (2006) recorded that reduced SOM in soils due to continuous cropping and vegetation removal results in pore collapse which reduces infiltration and increases runoff and erosion and consequently may cause further soil degradation.

Significant ($p=0.05$) influence of land use on clay dispersion index (CDI) was observed at all depths. The CCC-CMT soils had higher CDI than PPF-PCP and MTC-IWP soils. There were also significant ($p<0.05$) effect of land use on clay flocculation index (CFI) and soil structural index (SI) at the various soil depths with PPF-PCP and MTC-IWP having higher CFI and SI than CCC-CMT soil. Across the study location and the three depths, PPF-PCP showed the least tendency to disperse, followed by MTC-IWP. While CCC-CMT showed the greatest tendency to disperse. The ability of the soil to resist dispersion increased with depth and clay content of the soils (Igwe and Ejiofor, 2005). The results showed that soils under PPF-PCP and MTC-IWP were statistically similar compared to soils under CCC-CMT.

The SI followed the same trend with clay content, it can be deduced that SI is a function of clay content. Bhunia et al. (2016) reported that land use and depth were among the major environmental factors that control SOM and extent of soil structural degradation. This implies that whereas PPF-PCP and MTC-IWP indicated high structurally stabilized soils, CCC-CMT indicated high risk of structural degradation. Degradation showed a decreasing trend in this order; CCC-CMT > MTC-IWP> PPF-PCP. There were significant ($P<0.05$) effect of land use and depth on CDI, CFI and SI. There was also significant ($p<0.05$) influence of interaction of land use and depth on CDI andCFI. This is in line with Lal and Okigbo (1990), who reported that soil microaggregate stability indices are dependent on depth and land use. However, Okpamen et al. (2013) also observed that most tropical soil microaggregate stability indices are dependent on parent material and mineraology.

Chemical properties and soil organic carbon pool

Effects of land use types and depth on soil chemical properties and soil organic carbon pool are presented in Table 3. Significant ($P<0.05$) effect of land use on SOC also was observed at the various soil depths with PPF-PCP having the highest SOC followed by MTC-IWP while CCC-CMT had lowest SOC. This suggests that planted pine forest and *Irvingia*plantation improved soil organic carbon across the soil depths. There was also significant effect of land use on total nitrogen (TN) at 0-19cm and 20-39cm soil depths with PPF- PCP having highest TN, followed by MTC-IWP while CCC-CMT had lowest TN. Significant ($P<0.05$) influence of land use on CEC was observed at the various depths with MTC-IWP having higher CEC, followed by PPF-PCP. There was significant ($P<0.05$) effect of land use on SOC pool at the various depths with PPF-PCP having highest SOC Pool, followed by MTC-IWP. The SOC pool in PPF-PCP and MTC-IWP were within the threshold level ($\geq$ 120 $MgCha^{-1}$) for surface (0-100cm) soil in relation to mitigating climate change and for better environmental quality control as postulated by FAO (2017). Whereas SOC pool in CCC-CMT was at the lower limit of the threshold level. This suggests that planted pine forest and Irvingia plantation improved SOC pool whereas continuous cultivation of cassava/maize/telferia intercrop depleted SOC pool.

Land use and depth significantly affected H (H_2O), SOC, TN, AV. P and SOC Pool. Significant interaction between land use and depth influenced TN, AV. P and SOC Pool. This supports Lal and Okigbo (1990) who reported that SOC pool depends on land use.

Table 2: Effect of Land Use and Depth on Selected Aggregate Stability Indices in the Study Area

Depth (cm)	Land use	MWD (mm)	CDI	CFI	SI%
0-19	PPF-PCP	5.57	29.08	38.75	23.47
	MTC-IWP	5.10	29.68	21.00	21.23
	CCC-CMT	4.28	81.85	19.88	9.47
Sub mean		4.98	46.87	26.54	18.06
20-39	PFP-PCP	5.60	25.25	56.80	24.73
	MTC-IWP	5.17	25.18	57.30	10.64
	CCC-CMT	4.12	56.63	43.50	7.32
Sub mean		4.96	35.69	52.53	14.23
40-100	PFP-PCP	5.62	17.50	63.53	14.33
	MTC-IWP	5.23	20.29	76.00	6.61
	CCC-CMT	4.16	30.28	62.82	2.68
Sub mean		**5.00**	**22.69**	**68.12**	**7.87**
Total mean		4.98	42.64	49.06	13.39
LSD (0.05) for land use		0.13**	0.73**	1.93**	4.29**
LSD (0.05) for depth		0.16^{NS}	0.89**	2.39**	5.25*
LSD (0.05) for interaction		0.22^{NS}	1.26**	3.38**	7.43^{NS}

*, **, *** = Significant at 0.01 and 0.05 alpha level (2 tailed), respectively, NS = Non-significant
MWD= Mean Weight Diameter, CDI = Clay Dispersion Index, CFI = Clay Flocculation Index, SI = Soil Structural Index

Table 3: Effect of land use and depth on some soil chemical properties and SOC pool in the study area

Depth (cm)	Land use	SOC	% TN	$CmolKg^{-1}$ K	CEC	AV. P (Mg/kg)	SOC Pool ($MgCha^{-1}$)
0-19	PPF-PCP	3.69	0.53	0.04	18.01	15.25	133.40
	MTC-IWP	2.62	0.17	0.04	21.42	19.72	70.30
	CCC-CMT	1.15	0.14	0.04	11.12	18.33	33.80
Sub mean		2.29	0.28	0.04	16.85	17.77	79.19
20-39	PPF-PCP	3.38	0.39	0.04	16.11	19.75	107.60
	MTC-IWP	2.27	0.11	0.03	21.39	22.68	42.20
	CCC-CMT	0.97	0.08	0.05	10.81	20.00	31.70
Sub mean		2.20	0.19	0.23	16.10	20.81	60.50
40-100	PPF-PCP	2.89	0.23	0.5	19.16	13.80	334.80
	MTC-IWP	1.75	0.10	0.03	20.43	23.39	147.30
	CCC-CMT	0.52	0.14	0.03	12.15	26.67	58.20
Sub mean		1.71	0.16	0.03	17.26	21.29	180.0
Total mean		1.50	0.16	0.10	16.74	19.96	106.59
LSD(0.05) for land use		0.20*	0.08*	0.02*	1.35**	1.68**	27.34**
LSD(0.05) for depth		0.25**	0.10*	0.02_{NS}	1.65_{NS}	2.06*	33.49**
LSD(0.05) for interaction		0.36^{NS}	0.15*	0.04^{NS}	2.34^{NS}	2.91**	47.36**

*, **, *** = Significant at 0.01 and 0.05 alpha level (2 tailed), respectively, NS= Non-signficiant
Key: CEC = Cation Exchange Capacity, TN = Total Nitrogen, SOC = Soil Organic Carbon, P = Phosphorus, K = Potassium, PPF-PCP = Planted Pinus forest of *Pinuscarribeae* plantation, MTC-IWP = Managed tree cropland of *Irvingia wombulu* plantation, CCC_ CMT = Continuosly cultivated Cropland of Cassava/Maize/Telferia mixedcropping

CONCLUSION

This study showed that planted pine forest of Pinus carribeae plantation (PPF-PCP) and managed Tree Cropland of Irvingia wombulu plantation (MTC-IWP) land uses improves soil SOC pool at 0-100cm soil depth relative to continuously cultivated cropland of cassava/maize/telferia intercrop (CCC-CMI) land use. The results revealed that soil carbon sequestration depends on land use and depth. The SOC pools of soils of PPF-PCP and MTC-IWP land uses were within the threshold level and therefore met the standards in relation to mitigating climate change and for better environmental quality control. Whereas SOC Pool in soil of CCC-CMT land use was at the lower limit of the threshold level. Soil aggregate stability was higher in PPF-PCP and MTC-IWP compared to CC-CMT. There were significant effect of land use and depth on CDI, CFI and SI. Macroaggregate stability was a function of land use. While microaggregate stability and soil structural stability were dependent on both land use and depth. The soil conservation practices associated with CCC-CMT under coastal plain sands in the area should be re-evaluated. This is because it is inadequate to maintain or improve the quality of the soil. Some practices such as no-till, use of cover crops, mulching, and application of organic and inorganic amendments and reduced application of agro-chemicals should be incorporated into the soil management and cultural practices.

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