African Journal of Agriculture and Food Science
ISSN: 2689-5331
Volume 7, Issue 1, 2024 (pp. 21-35)
www.abjournals.org

ORGANIC CARBON STORAGE AND STRUCTURAL-HYDRAULIC PROPERTIES OF ULTISOL UNDER AGRICULTURAL LAND USE SYSTEMS AT UMUAHIA

Amanze C. T.[1*], Eluagu K. F.[2], Nwosu O. C.[3]

Ukabiala M. E.[1], Okoror P. I.[4], and Okoroafor C. K.[1]

[1]University of Agriculture and Environmental Sciences, Umuagwo, Imo State

[2]Federal college of Agriculture Isiagu, Ebonyi State

[3]Michael Okpara University of Agriculture, Umudike, Abia State

[4]Benson Idahosa University, Benin City, Edo State

[*]Corresponding Author's Email: chikamneleamanze@gmail.com, Tel.: +234 7037921460

Cite this article:

Amanze C. T., Eluagu K. F., Nwosu O. C., Ukabiala M. E., Okoror P. I., Okoroafor C. K. (2024), Organic Carbon Storage and Structural-Hydraulic Properties of Ultisol under Agricultural Land Use Systems at Umuahia . African Journal of Agriculture and Food Science 7(1), 21-35. DOI: 10.52589/AJAFS-HCEKB6WI

Manuscript History

Received: 8 Nov 2023

Accepted: 17 Jan 2024

Published: 11 Feb 2024

ABSTRACT: *The extent and pattern of interaction among organic carbon, structural and hydraulic properties of soils under varying land use systems are of great concern in the overall management of soil fertility and productivity. This study was conducted to examine the relationship among soil organic carbon storage, structural and hydraulic properties of soils under different agricultural land use systems at Umuahia, Abia State. The treatments were the four (4) land use systems (continuously cultivated arable farmland, 3 – year fallow land, oil palm plantation, and forest land) in which nine (9) replicates each of disturbed and undisturbed soil samples were randomly collected to give thirty six observational units laid out in a randomized complete block design. The soil samples were prepared and analysed in the laboratory. Analyses of variance, regression and correlation analyses were conducted on the data collected using Genstat version 14 and SPSS version 20. Results show that organic carbon had significant positive relationship with saturated hydraulic conductivity, macro porosity and total porosity but significant negative relationship with bulk density at all the land use systems. However, the influence of organic carbon on the other parameters was greatest at continuously cultivated arable land followed by the 3 – year fallow land. There is need to increase organic matter input at the continuously cultivated arable land and 3 – year fallow land through increased organic manuring and extension of the fallow period, respectively.*

KEYWORDS: Bulk density, hydraulic conductivity, land use systems, organic carbon, porosity

Article DOI: 10.52589/AJAFS-HCEKB6WI
DOI URL: https://doi.org/10.52589/AJAFS-HCEKB6WI

INTRODUCTION

The arrangement of soil primary particles greatly influences soil physical properties such as bulk density, total porosity, and hydraulic conductivity thereby affecting soil tillage, tilt and crop production (Nathalie, 2014). These properties are greatly influenced by human activities through land use and management such that they vary across soil bodies (Amusan *et al*., 2006; Mbagwu and Auerswald, 1999). Inappropriate land use can aggravate the rate of soil degradation thereby affecting soil biological, physical and chemical qualities (Saikl *et al*., 1998). Reports have shown that the practice of bush burning, continuous cultivation (Senjobi *et al*., 2007), conventional tillage operations (Khurshid *et al*., 2006), reduced residue turnover and human induced erosion are chiefly responsible for damages in soil structure.

Soil structural and hydraulic properties are continuously faced with undue damages with changes in land use especially from forest to arable. Continuous cropping usually results in losses of soil organic matter, destruction of soil aggregates, and increase in bulk density resulting from compaction (Amanze *et al*., 2022).. Oguike and Mbagwu (2009) reported that changes in land use, such as conversion of natural forest to cropland, contributed to land degradation that manifested in losses of soil organic matter, increased bulk density and decreased porosity. Kutilek (2005) reported that intensive cropping leads to disaggregation in surface soils because of decline in organic matter content due to repeated machinery movement. He further stated that long use of machinery during tillage operation causes an irreversible soil compaction (increased bulk density) to a depth of about 60 – 70 cm.

Continuous cultivation results in increase in sand fraction and bulk density, reduced aggregation and water retention capacity as a result of reduced organic matter compared to bush fallow land use (Malgwi and Abu, 2011). Therefore, land use affects organic matter, structural and hydraulic parameters of soils. Holland (2004) showed how effective land restoration through bush fallow and conservation tillage could be in sequestering carbon (iv) oxide (CO_2) and in turn improve the organic matter content of soils. Intensive soil tillage increases soil aeration and changes the climate (temperature and moisture) of topsoil and thus, often accelerates soil organic matter decomposition rates (Balesdent *et al*., 2000). Conservation tillage is therefore considered as a measure to sequester carbon in soils as it has proven to be effective in conserving soil organic matter at the top soil (Holland, 2004). Blaire *et al*. (2006) revealed that in a comparative study on grassland and cropland, there was a significant difference in the amount of carbon stored in grassland than in cropland under similar agro-ecological conditions. It could therefore be established that there is considerable information on the influence of land use systems on organic matter content, structural and hydraulic properties of soils but there is dearth of information on how organic carbon, structural and hydraulic properties of soils relate at differing land use systems. Therefore, this study aims at examining the relationship between soil organic carbon storage, structural and hydraulic properties at varying agricultural land use systems.

Article DOI: 10.52589/AJAFS-HCEKB6WI
DOI URL: https://doi.org/10.52589/AJAFS-HCEKB6WI

MATERIALS AND METHODS

Location and description of study area

The study was conducted at Ndume Ibeku in Umuahia North LGA, Abia State. The area lies within latitude $5^{0}29^{l}$N to $5^{0}31^{l}$N and longitude $7^{0}30^{l}$E to $7^{0}32^{l}$E with mean annual rainfall distribution of 2200 mm (Amanze *et al.*, 2017). The area is characterized by rainy and dry seasons. The rainy season starts from March and extends to October with bimodal peaks in July and September, and a short break in August. The dry season starts in November and lasts till February. The mean annual temperature is about 28^{0}C (NiMeT, 2019; Amanze *et al.*, 2022). The landscape is flat to gently undulating. The parent material is predominantly the Coastal Plain with pockets of alluvial deposits, and the soil was classified as “Hapludult” according to the United State Department of Agriculture (USDA) soil Taxonomy (Amanze *et al.*, 2016) and vegetation type is Tropical rainforest.

Land use systems

Four land use systems were selected for the study. They are; arable farmland under continuous cultivation (CC), 20 – year oil palm plantation (OP), forest land (FL) and 3 – year fallow land (3-FL). The forest land was secondary vegetation regenerated for over 20 years. The common tree species found in that forest include oil bean plant (*Pentaclethra macrophyllum*), African bread fruit (*Treculia Africana*), and bush mango (*Irvingia gabonensis*). Other plant species were shrubs and herbs like “Siam weed” (*Eupatorium odoratum*), etc. The 3 – year fallow land was previously cultivated to cassava and potato three years ago and soil fertility managed by application of NPK fertilizer. The previous soil tillage was with heavy machineries and the land was set on fire on yearly basis during the dry season and allowed to regenerate during the rainy season. The common grass species was elephant grass (*Panicum maximum*).The oil palm plantation was established for over 20 years. There were also weeds (such as “Siam weed” (*Chromoleana odorata*), mimosa plant (*Mimosa pudica*), etc, found in the plantation. However, the weeds were periodically cleared especially during the dry season. The continuously cultivated arable farmland was planted to cassava (*Manihot esculentus*), yam (*Dioscorea spp.*) and pumpkin (*Telferia occidentalis*). The soil fertility was managed by the application of both mineral (NPK) and organic fertilizers (poultry droppings and swine waste). Weed control was done manually.

Soil sampling and sample preparation

Soils were sampled in a simple random sampling method such that nine (9) representative disturbed and undisturbed soil samples were collected from each land use system at a depth of 0 – 20 cm. The auger (disturbed) soil samples were air – dried and passed through 0.5 mm sieve before sending to the laboratory for organic carbon determination. The undisturbed (core) soil samples were saturated in water before determination of saturated hydraulic conductivity (K_{sat}) and bulk density (BD).

Laboratory analysis

Saturated hydraulic conductivity (K_{sat}): This was determined by the constant head method explained by Klute (1986). Saturated hydraulic conductivity (K_{sat}) of the soil was calculated using Darcy’s equation as explained by Youngs (2001) shown below.

$$\text{Ksat} = \frac{QL}{AT\Delta H} \quad \text{…………………………………………………………………………...} \quad \textbf{Eq. 1}$$

Where Q is quantity of water discharged (cm^3), L is length of soil column (cm), A is the interior cross – sectional area of the soil column (cm^2), ΔH is head pressure difference causing the flow or hydraulic gradient and T is time of water flow (s).

Bulk density (BD): This was determined using the core method as described by Anderson and Ingram (1993), and the bulk density (BD) of the soil was computed as shown in the equation below;

$$BD = \frac{\text{Mass of oven dried soil}}{\text{Bulk volume of the soil}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots . Eq. 2$$

Bulk volume of the soil is equal to the volume of cylindrical core sampler given as $\pi r^2 h$ where $\pi = 22/7$, r is the inner radius of the base of the cylindrical core sampler and h is its height.

Total porosity (Pt): This was calculated from the bulk density (BD) assuming a particle density (PD) of 2.65 mg/m^3 as shown below.

$$\text{Pt} = \left\{1 - \frac{BD}{PD}\right\} X\ 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots . . Eq. 3$$

Macro porosity (PM): This was computed from volumetric moisture content at field capacity (FC) as described by Mbagwu (1991) using the equation shown below:

$$\text{PM} = \text{Pt} - \text{FC} \quad \text{……………………………………………………………………..} \quad \text{Eq. 4}$$

Volumetric water content at field capacity (FC) is given as $\Theta_{vf} = \rho_b \Theta_{mf}$ Where Θ_{vf} is volumetric water content at field capacity, Θ_{mf} is gravimetric water content at field capacity and ρ_b is the soil bulk density.

Soil water retention characteristics

Water retained at field capacity was determined following the procedure outlined by Mbagwu (1991) and the percentage moisture at field capacity (FC) on dry mass basis was calculated as follows:

$$\%\text{FC} = \frac{mass\ of\ water}{mass\ of oven\ dry\ soil} X\ 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Eq\ 5$$

Organic carbon was determined by the dichromate oxidation procedure of Walkley and Black as modified by Nelson and Sommers (1982), and the organic carbon storage in the soil was calculated using the formula provided in Amanze *et a*l. (2022).

$C_T = C_F \times q \times D \times 1$ ha …………………………………………………………………. Eq. 6

Where C_T is total organic carbon for the layer (metric ton), C_F is the fraction of carbon (percentage carbon divided by 100), q is density of the soil, D is the depth of the soil layer (m)

Experimental design and data analyses

The experiment was laid out in a randomized complete block design (RCBD) involving four land use systems replicated nine (9) times to obtain thirty six (36) observational units. Data obtained were subjected to analysis of variance (ANOVA) and means were separated using Fisher's least significant difference at 5% probability level ($LSD_{0.05}$) using Genstat analytical software version 14. Regression and correlation analyses were also performed using SPSS version 20.

RESULTS AND DISCUSSION

Bulk density, hydraulic conductivity, total and macro porosities

There was a significant variation in BD among the land use systems although CC (1.51 mg/m^3) and FL (1.49 mg/m^3) were statistically ($P \le 0.05$) similar. The lowest value of BD was observed under OP (1.42 mg/m^3) while the highest was observed under 3-FL (1.64 mg/m^3). The reason for the high BD under GL may be due to the compaction of the soil by compressive and overburden forces impacted by the movement of heavy machineries during previous tillage operation (Kutilek, 2005). The relatively low bulk density (BD) observed under OP was probably as a result of its high OC content. This confirmed the report of Mbagwu (1992) who stated that treatment of soils with organic amendments significantly reduced BD.

The most rapid K_{sat} (1.94 cm/min) was observed under CC. This was statistically similar to FL (1.84 cm/min) but significantly ($P \le 0.05$) different from OP and 3-FL. The slowest (1.15 cm/min) was observed under 3-FL. The rapid K_{sat} under CC was probably the result of the pulverization of the soil during tillage which loosened the soil thereby increasing the pore volume and as well enhanced the water permeability of the soil. Conversely, the slow K_{sat} under 3-FL was perhaps due to its high BD and small pore volume possibly due to compaction of the soil particles (Kutilek, 2005).

The highest total porosity (PT) (46.18 %) was observed under OP and this was significantly ($P \le 0.05$) different from the other land use systems. The lowest (38.21 %) was observed under 3-FL which also differed significantly from the other land use systems. There was no significant difference between CC (42.93 %) and FL (43.79 %). There was also a significant variation in macro porosity (PM) among the land use systems with the highest value (20.61 %) observed under CC while the lowest (8.22 %) was observed under FL. The highest total porosity under OP was probably due to its good aggregation at micro and macro levels than the other land use systems. This aggregation may have been encouraged by the relatively highest clay and OC contents under OP at micro and macro levels, respectively. Also, the biopores created by the decayed roots of the oil palm trees contributed to this effect. The relatively high PT observed under FL may be as a result of the relatively high OM content.

Article DOI: 10.52589/AJAFS-HCEKB6WI
DOI URL: https://doi.org/10.52589/AJAFS-HCEKB6WI

Organic matter helps in the aggregation of soil mineral particles into definite aggregates which enhanced the creation of macro pores thereby improves the total porosity of the soil (Schaetzi *et al*., 2005). Under CC, the high PM may be due to the loosening of the soil by tillage which may have increased the pore volume per unit mass of soil. On the contrary, the low porosity under 3-FL was probably due to the very small soil pore volume induced by the compaction of the soil particles during tillage operations (Kutilek, 2005).

The OC of the soils under the different land use systems varied significantly ($P \leq 0.05$). However, the OC contents under OP (25.73 t ha^{-1}) and FL (24.69 t ha^{-1}) were statistically similar. The highest content (25.73 t ha^{-1}) was observed under OP while CC had the lowest value (14.22 t ha^{-1}). The reason for the relatively high OC under OP and FL may be related to their high biomass production which returned litter to the soil. Also, OM loss by oxidation was reduced due to adequate soil cover by the plant canopies as well as little or no disturbance to the soil (Holland, 2004; Amanze *et al*., 2022). On the contrary, the low OC content under CC was perhaps a result of continuous loss of SOM by oxidation via continuous turning of the soil during frequent tillage. The regular removal of plant biomass from the land at harvest coupled with low rate of residue return to the soil may have contributed to the low OC content under CC (Balesdent *et al*., 2000).

Table 1: Variability in bulk density, hydraulic conductivity, total and macro porosities across the various land use systems

Land use systems	BD (mg/m^3)	K_{sat} (cm/min)	PT (%)	PM (%)	OC (t ha^{-1})
CC	1.51	1.94	42.93	20.61	14.22
FL	1.49	1.84	43.79	8.22	24.69
3-FL	1.64	1.15	38.21	8.71	19.68
OP	1.42	1.41	46.18	12.55	25.73
LSD (0.05)	0.04	0.25	1.45	1.93	1.71

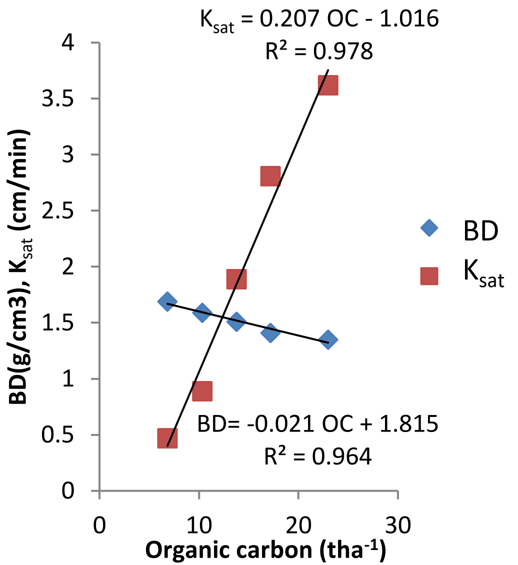
CC – continuous cultivated land, FL – forest land, 3-FL – 3-year Fallow land, OP – oil palm plantation, BD – bulk density, Ksat – saturated hydraulic conductivity, PT – total porosity, PM – macro porosity, OC – Organic carbon

Relationship of organic carbon storage with bulk density and hydraulic conductivity

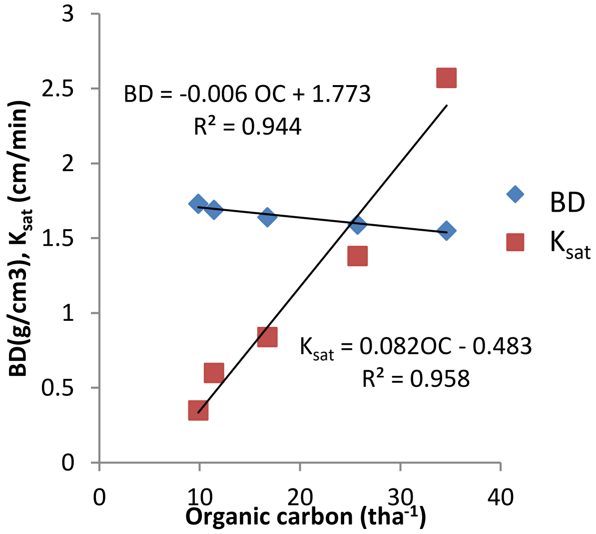
Figure 1 showed that there was positive linear relationship between OC and K_{sat}, and this varied considerably across the land use systems such that under CC, 3-FL, OP and FL, for any unit increase in OC, K_{sat} increased by 0.207, 0.082, 0.062 and 0.09 cms^{-1}, respectively. The values of coefficient of determination (R^2) revealed that at CC, 3-FL, OP and FL, the total variability in K_{sat} contributed by OC were 97.8, 95.8, 95.3 and 97.0 %, respectively. These values implied that OC had great influence in determining K_{sat} of the soils and such influence was highest at CC. There was a negative linear relationship between OC and BD such that for any unit increase in OC, BD decreased by 0.021, 0.006, 0.007 and 0.005 mgm^{-3} under CC, 3-FL, OP and FL, respectively. The values of coefficient of determination (R^2) for the various land use systems showed that the total variability in BD contributed by OC were 96.4, 94.4, 87.3 and 81.5 % under CC, 3-FL, OP and FL, respectively. These illustrated that OC exerted much influence in reducing BD and this influence was greatest at CC and least at FL.

Article DOI: 10.52589/AJAFS-HCEKB6WI
DOI URL: https://doi.org/10.52589/AJAFS-HCEKB6WI

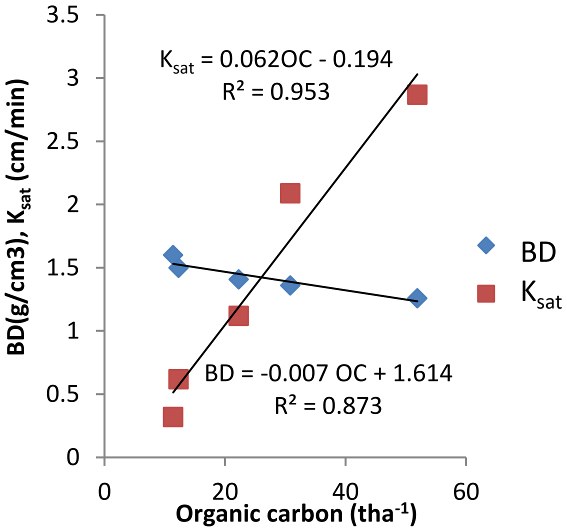
The reason for the increased influence of OC on K_{sat} and BD at CC compared to the other land use systems could be associated with its characteristic reduced OC storage compared to the other land use systems; hence, any unit increase in its OC storage caused a tremendous increase in soil aggregation which enhanced the water transmission characteristic of the soil (K_{sat}) while significantly decreasing the bulk density (Amanze *et al*, 2017). Similarly, the great influence of OC on BD at 3-FL is attributable to the increased BD at 3-FL compared to the other land use systems such that any slight increase in OC significantly impacted the soil at 3-FL by reducing the BD. This corroborates the reports of Oguike and Mbagwu (2009) and Amanze et al. (2022) that OC has the ability to weaken the strong forces that kept the soils compacted thereby reducing the BD while improving K_{sat}.



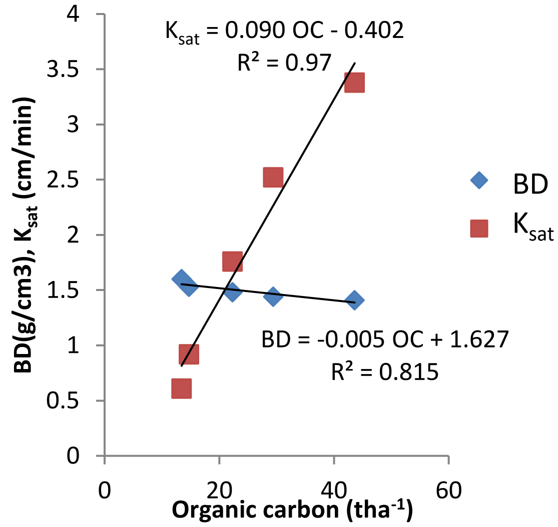
a. CC



b. 3-FL



c. OP

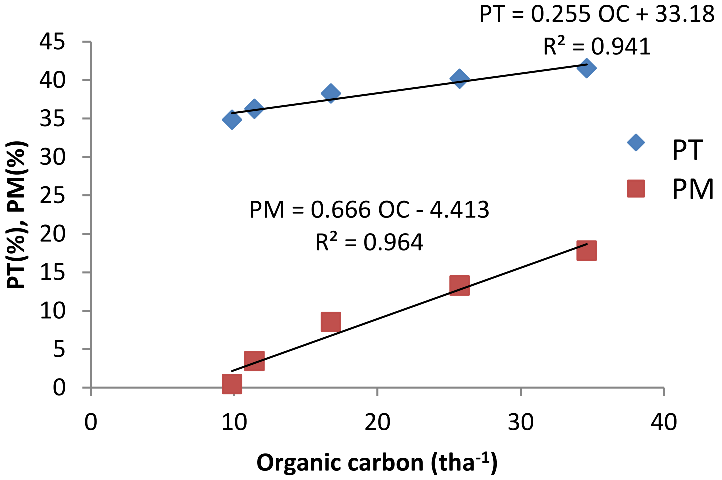


d. FL

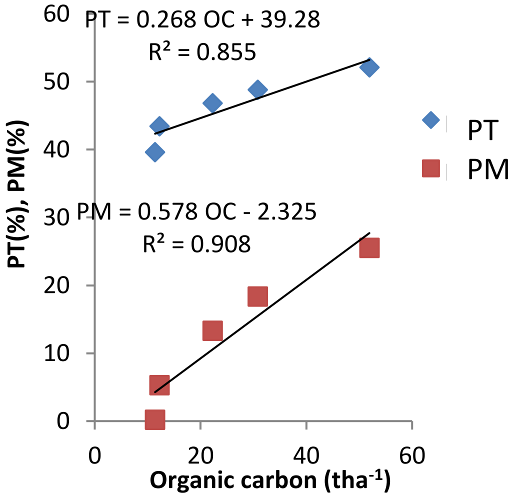
Figure 1a-d: Relationship between independent variable (OC) and dependent variables (BD and K_{sat}) in each land use system

Relationship of organic carbon storage with macro and total porosities

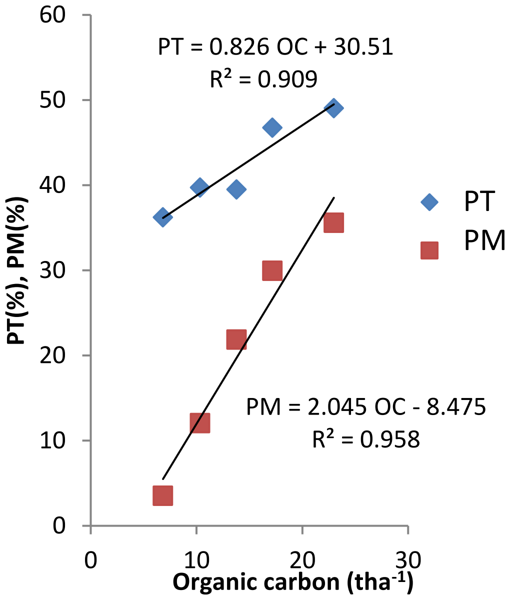
There was positive linear relationship between OC (independent variable), PT and PM (dependent variables) at all the land use systems as shown in figure 2. Hence, for every unit increase in OC, PT increased by 0.255, 0.268, 0.826 and 0.206 under 3-FL, OP, CC and FL, respectively. By this, the total variability in PT contributed by OC as shown by R^2 values was highest under 3-FL (94.1%) and lowest under FL (81.6 %). Similarly, the figure showed that for every unit increase in OC, PM increased by 0.666, 0.578, 2.045 and 0.581 under 3-FL, OP, CC and FL, respectively. Consequently, R^2 values revealed that the total variability in PM influenced by OC was greatest under 3-FL (96.4 %) and least under OP (90.8 %). This implies that increase in organic matter content of soil under 3-FL, resulted to a significant increase in PM and PT. This observation could be predicated on the ability of OC to weaken the compressive forces that caused the compaction of soil particles under 3-FL and therefore improved the aggregation of the soil particles which may have resulted in an increase in the number and volume of the soil pores. Nathalie (2014) reported that OC improved macro aggregation and stability which also improved the total volume of macro pores and by extension, enhanced PM and PT.



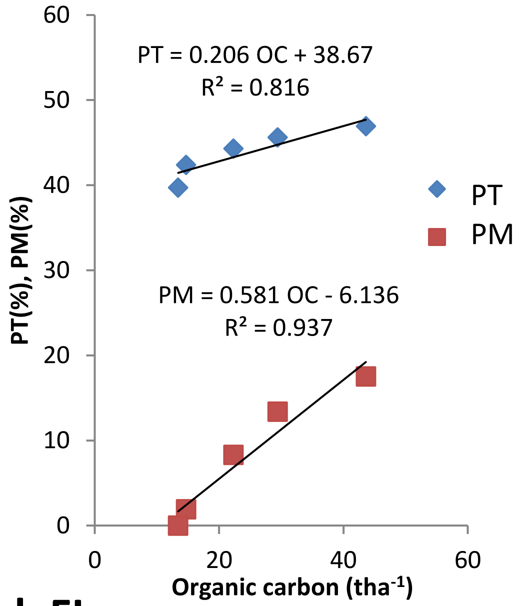
a. 3-FL



b. OP



c. CC



d. FL

Fig. 2a-d: Relationship between independent variable (OC) and dependent variables (PT and PM) in each land use system

Article DOI: 10.52589/AJAFS-HCEKB6WI
DOI URL: https://doi.org/10.52589/AJAFS-HCEKB6WI

Correlation of organic carbon storage, bulk density, saturated hydraulic conductivity, macro and total porosities at the land use systems

The correlation coefficients indicating the strength of the relationship among soil parameters (OC, BD, K_{sat}, PT, PM,) at continuously cultivated arable farmland (CC) were shown in Table 2. It showed that OC had a significant negative relationship with BD (-0.982**) but had significant positive relationship with K_{sat} (0.989**), PT (0.954*), PM (0.979**). Onweremadu *et al*. (2007) reported a significant improvement in macro aggregation and stability of macro aggregate which in turn enhanced the water transmission characteristics of the soil including soil porosity. Oguike and Mbagwu (2009) reported a significant reduction in BD of soils amended with organic materials which illuminates the finding of this research. Bulk density (BD) had a significant negative relationship with K_{sat} (-0.987*), PT (-0.959**), and PM (-0.998**). This signifies that increase in BD under CC significantly decreased the water transmission capacity of the soil, and this may have resulted from the significant decrease in PT and PM with increase in BD (Kutilek, 2005); this elucidates the reason for the positive relationship among $K_{sat,}$ PM and PT as reported in Oguike and Mbagwu (2009) .

Table 2: Simple linear correlation of some soil physical properties and organic carbon in continuously cultivated land (CC)

	OC	BD	K_{sat}	PT	PM
OC	1				
BD	-0.982**	1			
K_{sat}	0.989**	-0.987**	1		
PT	0.954*	-0.959*	0.955*	1	
PM	0.979**	-0.998**	0.988**	0.942*	1

** (significant at 0.01), * (significant at 0.05), n = 36, OC = organic carbon, BD = bulk density, Ksat = saturated hydraulic conductivity, PM = macro porosity, PT = total porosity

Table 3 shows the correlation coefficients indicating the strength of the relationship among OC and BD, K_{sat}, PT, PM at forest land (FL). Organic carbon had significant positive relationship with K_{sat} (0.985**), PT (0.904*), PM (0.968**), but negative with BD (-0.903*). The significant positive relationship among OC and the water transmission properties implied that increase in OC content of the soil under FL may have resulted in a significant improvement in the aggregation of the primary particles of the soil which invariably enhanced the soil porosity (Onweremadu *et al.*, 2007) and water transmission capacity of the soil (Nathalie, 2014). On the contrary, the significant negative relationship between OC and BD revealed that increase in OC content of the soil under FL resulted to a significant decrease in BD and this corroborated the report of Oguike and Mbagwu (2009).

Table 3: Simple linear correlation of some soil physical properties and organic carbon in forest land (FL)

	OC	BD	K_{sat}	PT	PM
OC	1				
BD	-0.903*	1			
K_{sat}	0.985**	-0.957*	1		
PT	0.904*	-1.000**	0.956*	1	
PM	0.968**	-0.965**	0.996**	0.963**	1

** (significant at 0.01), * (significant at 0.05), n = 36, OC = organic carbon, BD = bulk density, Ksat = saturated hydraulic conductivity, PT = total porosity, PM = macro porosity

Table 4 shows the correlation coefficients indicating the strength of the relationship among BD, PT, PM, K_{sat}, and OC at 3 – year fallowed land (3 – FL). It revealed that OC also had a significant positive relationship with K_{sat} (0.979**), PT (0.970**), PM (0.982**) and CDI (0.919*) but related significantly negative with BD (-0.972**). This explains that at 3 - FL, an increase in OC induced a significant increase in the number, volume and continuity of soil pore spaces which in turn enhanced the water conductivity of the soil, hence justifies the positive relationship between PT, PM and K_{sat} (Nathalie, 2014; Amanze *et al*, 2022). Therefore, the significant negative relationship of OC with BD may have resulted from the significant increase in voids created in the soil by the possible aggregation of soil particles which lead to significant decrease in the mass of the soil per unit volume (Onweremadu *et al*., 2007). Conversely, BD had a significant negative relationship with K_{sat} (-0.938*), PT (-1.000**), and PM (-0.998**). This indicates that increase in BD at 3-FL significantly decreased the macro pores and the total pore volume of the soil; consequently, decrease the water transmission capacity of the soil (Kutilek, 2005).

Table 4: Simple linear correlation of some soil physical properties and organic carbon in 3 – Fallow (3 - FL)

	OC	BD	K_{sat}	PT	PM
OC	1				
BD	-0.972**	1			
K_{sat}	0.979**	-0.938*	1		
PT	0.970**	-1.000**	0.925*	1	
PM	0.982**	-0.998**	0.945*	0.998**	1

** (significant at 0.01), * (significant at 0.05), n = 36, OC = organic carbon, BD = bulk density, Ksat = saturated hydraulic conductivity, PM = macro porosity, PT = total porosity

Table 5 shows the correlation coefficients indicating the strength of the relationship among OC, BD, K_{sat}, PM, PT at oil palm plantation (OP). It showed that OC had a significant negative relationship with BD (-0.935*), but significantly positive with K_{sat} (0.977**), PT (0.925*), PM (0.953*). This signifies that, increase in OC at OP significantly reduced the BD (Oguike and Mbagwu, 2009) but significantly increased the total pore volume and size as well as the water transmission capacity of the soil. This was possibly as a result of

Article DOI: 10.52589/AJAFS-HCEKB6WI
DOI URL: https://doi.org/10.52589/AJAFS-HCEKB6WI

improvement in macro aggregation and stability of macro aggregates which according to Nathalie (2014) increased the number and continuity of macro pores as well as the total volume of the pore spaces; thus, enhanced water conductivity of the soil.. Meanwhile, Saturated hydraulic conductivity (K_{sat}), PM and PT related significantly positive with one another but negatively with BD and this is consistent with the report of Kutilek (2005); Oguike and Mbagwu (2009) who noted a significant increase in water transmission through a column of soil as the number, size and continuity of soil voids increase as a result of decrease in soil compaction and / or BD.

Table 5: Simple linear correlation of some soil physical properties and organic carbon in oil palm plantation (OP)

	OC	**BD**	**K_{sat}**	**PT**	**PM**
OC	1				
BD	-0.935*	1			
K_{sat}	0.977**	-0.961**	1		
PT	0.925*	-0.999**	0.958*	1	
PM	0.953*	-0.995**	0.978**	0.994**	1

** (significant at 0.01), * (significant at 0.05), n = 36, OC = organic carbon, BD = bulk density, Ksat = saturated hydraulic conductivity, PM = macro porosity, TP = total porosity

CONCLUSION

Organic carbon (OC) had significant relationship with bulk density (BD), total porosity (PT), macro porosity (PM) and hydraulic conductivity (K_{sat}) across the land use systems. The relationships among OC, PT, PM and K_{sat} was positive while the relationship of BD with the other parameters was negative. There was notable difference in the degree of influence of OC on the other parameters across the land use systems. The influence of OC on the other parameters was highest at the continuously cultivated arable farmland followed by the 3 – year fallow land. Therefore, there is need to increase organic matter input at the continuously cultivated arable land and 3 – year fallow land through increased organic manuring and extension of the fallow period, respectively.

REFERENCES

Amanze, C. T., Oguike, P. C., Eneje, R. C., Ukabiala, M.E., Omatule, L.A., Ozomata, A.S., Kolo J., Nwosu, O. C. (2022). Organic Carbon in relation to Water Retention Characteristics of a Typic Hapludult under four land use types at Ndume Ibeku in Southeastern Nigeria. *International Journal of Agric. and Rural Development.* Vol. 25(2): 6512–6517 2022

Chikamnele T. Amanze, Paul C. Oguike and Roseta C. Eneje (2017). Land use effect on some Physicochemical properties of Ultisol at Ndume Ibeku, Southeastern Nigeria. *International Journal of Scientific and Research Publication*. Vol. 7(9): 2250 – 3153

Amanze, C. T, Oguike, P. C and Lekwa, G. (2016). Characterization and Classification of Soils at Mbara Achara Ubowalla, Emekuku in Owerri North LGA, Imo State. *Nigeria Journal of Soil and Environmental Research*. Vol. 14: 245 – 255

Amusan, A. A., Shitu, A. K., Makinde, W. O. and Orewole, O. (2006). Assessment of changes in selected soil properties under different landuse in obafemi Awolowo University community, Ile – Ife, Nig. *Electron. Journal Environ. Agric. Food Cem.* 5 (1) : 1178 – 1184.

Anderson, J. M. and Ingram, J.S.I. (1993). Tropical Soil biology and fertility. A handbook of methods. 2nd Edn., CAB International, Wallingford UK., Pp. 221.

Balesdent, J., Chenu, C., and Balabane, M. (2000). Relationship of soil organic matter dynamics to physical protection and tillage. *Soil & Tillage Research* 53: 215-230.

Blaire, N., Faulkner, R.D., Till, A.R., Korschens,M., and Schulz, E. (2006). Long-term management impacts on soil C, N and physical fertility - Part II: Bad Lauchstädt Static and Extreme Fym Experiments. *Soil & Tillage Research* 91: 39-47.

Holland, J.M. (2004). The Environmental Consequences of Adopting Conservation Tillage in Europe: Reviewing the Evidence. *Agriculture Ecosystems & Environment* 103: 1-25.

Khurshid, K., Igbal, M. M., Arif, S. and Nawaz, A. (2006). Effect of Tillage and Mulch on Soil Physical Properties and Growth of Maize. *Int. Journal Agric. Biol.*, 5: 593 – 596.

Klute, A. (1986), Method of soil analysis. Physical and mineralogical analysis. *American society of agronomy*. 9: 23 - 41

Kutilek, M. (2005). Change of Soil Porous system due to Landuse. Unpublished lecture notes. College of soil Physics, International Centre for Theoritical Physics, trieste, Italy.

Malgwi, W. B. and Abu, S. T. (2011). Variation in some Physical properties of Soils formed on a hilly terrain under different landuse types in Nigeria savanna. *International Journal of Soil Science*, 6: 150 – 163.

Mbagwu, J.S.C. (1992). Improving the productivity of degraded Ultisols in Nig. Using organic and inorganic amendments, chemical properties and yield of maize. *Bioresources Tech*. 4: 149 – 154.

Mbagwu, J.S.C. and Auerswald, K. (1999). Relationship of percolation Stability of Soil Aggregates to Landuse, selected properties, Structural indices and simulated rainfall erosion. *Soil Tillage Resources,* 50: 197 – 206.

Nathalie S. (2014). What is soil structure and why is it important. deepRoot Blog.

Nelson, D.W.M. and Sommers, L.E. (1982). Total carbon, organic carbon and organic matter. In: Pg. A.L, Miller, R.H. and Keeny, D.R (eds.) Methods of soil Analysis, Part 2, *Amer. Soci. Of Agro*., Madison, WI,pp. 539 - 580

Nigeria Meteorological Agency (NiMeT) (2019). Seasonal rainfall prediction for 2015 Nigeria meteorological publication. Maitama, FCT Abuja. P. 18

Oguike, P.C. and Mbagwu, J.S.C. (2009). Variation in some physical Properties and Organic Matter content of Soils of Coastal Plain Sand under different Landuse types. *World Journal Of Agric. Sci.* 5(1): 63 – 69.

Onweremadu, E.U., Onyia, V.N. and Anikwe, M.A.N. (2007). Carbon and nitrogen distribution in water-stable aggregates under two tillage techniques in Fluvisols of Owerri area, southeastern Nigeria. *Soil & Tillage Research* 97, 195–206.

Schaetzi, R. J. and Anderson, S. (2005). *Soils: Genesis and geomorphology*. Cambridge university Press, Cambridge, UK. Pp. 353 – 365

Senjobi, B. A., Adeokun, O. A., Dada, O.A. and Ogunkunle, A. O. (2007). Influence of traditional farming practices on soil productive potentials in Ago – Iwoye enclave, Ogun State, *Nigeria. J. Environ. Extension*, 6: 64 – 70.

Soil survey staff (2010). *Keys to soil taxonomy (eleventh edition)*. United Department of Agriculture (USDA) and natural resources conservation service (NRCS)

Youngs, E. G. (2001). *Hydraulic conductivity of saturated soils*. In : Soil and environmental Analysis. Smith, K. A. and C. E. Mullins (Eds). Physical Methods. 2nd Ed. Marcel Decker Inc. NY., Pp. 637.