EVALUATION OF MOISTURE CHARACTERISTICS AND AGGREGATE STABILITY OF SOILS UNDER DIFFERENT LAND USE SYSTEMS IN AHIAZU MBAISE IMO STATE

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ABSTRACT
Land use is a complex process shaped by human activity affected by ecological, economic, and social drivers, and capable of influencing a wide range of environmental and economic conditions. The study evaluates the soil moisture characteristics and aggregate stability of soils under different land use systems in Ahiazu mbaise. The purpose of this work is to determine the effects of land use systems on soil aggregate stability and to evaluate the effects of land use systems on the soil moisture characteristics. The soil samples for the study were collected from two depths 0-20cm and 20-40cm from soils under different land use systems in Ahiazu Mbaise which include Arable land, Fallow, and palm plantation. The experiment was randomized complete Block Design replicated three times. The factors include the three land uses (arable, fallow and palm plantation), two depths (0-20 and 20-40cm) given a total of 18 sampling units (3x2x3). The auger samples were divided into two portions. The first portion was air dried and sieved through 2mm mesh for determination of particle size distribution, organic carbon and other chemical analysis. The other portion was air dried and passed through a 4mm mesh for the determination of water stable aggregates and mean weight diameter. Results of the findings revealed that At both depths of 0 – 20 and 20 – 40 cm, OP was observed to have the most stable aggregates with the highest mean weight diameter (MWD) which ranged from 5.41 to 5.81 mm. Arable land (AR) was the least aggregated and also showed the greatest tendency to disperse at both depths with the lowest MWD and highest dispersion ratio (DR). Oil palm plantation showed the lowest tendency to disperse with the lowest dispersion ratio at both depths. Generally, the bulk density of the soils increased significantly ($p \leq 0.05$) with depth, whereas total porosity and saturated hydraulic conductivity decreased significantly ($p \leq 0.05$) with depth. The moisture content of the soils at different land use systems studied shows that the arable land (AR) had the lowest field capacity. The highest field capacity was observed in fallow land (FL) at the two depths. The study therefore recommended that management practices such as organic matter application to stabilize soils under arable land against erosion and other mechanical manipulations should be encouraged.

INTRODUCTION
Land uses is a complex process shaped by human activity. It is affected by ecological, economic, and social drivers, and capable of influencing a wide range of environmental and economic conditions (Agarwal *et al.*, 2005; MacDonald *et al.*, 2000). Due to intensified agricultural production, natural resources encounter increasing anthropogenic pressure. Consequently, the effects of land use and land cover change on soil properties have drawn much attention over the past several decades. Water and nutrients are essential for plant production and soil functioning; accordingly, it is important to know the impact of various land use types and soil management systems on water and nutrient transport within the soil matrix. In agricultural systems, the plant available water in soils can affect cultivation methods and economic considerations such as use of an irrigation system. Therefore, understanding the soil hydraulic properties and their changes overtime may influence future decision making in both agricultural and environmental sectors. So many researches have been carried out on the fertility, physical and chemical properties of soils of Mbaise and Imo state at large but no research has been tailored towards the evaluation of the moisture characteristics and aggregate stability of soils under different land use systems in Ahiazu Mbaise. This research will help us understand the effect of different land uses, practiced over time on the soil moisture characteristics and the soil structure of Ahiazu Mbaise. It will also help us to make informed recommendations toward soil improvement and sustainable crop production. The main objectives of this study will be to evaluate the soil moisture characteristics and aggregate stability of soils under different land use systems in Ahiazu mbaise. The specific objectives of this study are to:

i. Determine the effects of land use systems on soil aggregate stability.
ii. Evaluate the effects of land use systems on the soil moisture characteristics.

MATERIALS AND METHODS
Study Area
The study was carried out in Ahiazu, Mbaise, in Imo State. Which lies between latitude $5^{0}30^{0}$ N and 20.79^{0}N and Longitude $7^{0}13^{0}$ and 23.59^{0} of the equator. It lies at an altitude of 122m above sea level

(Nwosu *et al*., 2016). It is a semi urban settlement about 11km. Majority of the people are farmers. The climate of the study area is typically of humid tropics with fairly even and uniform temperature throughout the two seasons (dry and rainy) of the year (Chukwu and Ajuamaiwe, 2013).

Vegetation

The identifiable vegetation type is the tropical rainforest vegetation. Grasses and broad leaf. It has an annual rainfall of 2238mm with maximum temperature of 32^0C and 23^0C respectively and relative humidity of 63-80^0C (Nigerian Meteorological Agency, 2015). The dominant plants include; Panicum maximum, Elusineindica, Axonopuscompressus, Pennisetum purpureum, Broad leaf weeds like, Chromolenaodorata, Calapogoniummucunoides. Major roots and tuber crops grown are; cassava, sweet potato, maize, pepper and vegetables such as fluted pumpkin, okra are also grown.

Field study

The soil samples for the study were collected from two depths 0-20cm and 20-40cm from soils under different land use systems in Ahiazu Mbaise. The land use types include Arable land, Fallow, and palm plantation. Arable land has been used continuously over the years to cultivate crops like, cassava, yam, maize and vegetables. The Fallow land has been uncultivated for about 3 years. The palm plantations are well developed with shrubs and grasses as undergrowth. Auger samples were collected from the different sampling points at two depths for some chemical and physical analysis. Undisturbed soil samples were collected from the locations at the two depths with core samplers for the determination of bulk density and hydraulic conductivity.

Experimental Design

The experiment was randomized complete Block Design (RCBD) replicated three times. The factors include the three land uses (arable, fallow and palm plantation), two depths (0-20 and 20-40cm) given a total of 18 sampling units (3x2x3).

Sample Preparation

The auger samples were divided into two portions. The first portion was air dried and sieved through 2mm mesh for determination of particle size distribution, organic carbon and other chemical analysis. The other portion was air dried and passed through a 4mm mesh for the determination of water stable aggregates and mean weight diameter.

Laboratory Analysis

Moisture content (MC)

Moisture content (MC) was calculated using the gravimetric method where soil samples were placed into ceramic crucibles and weighed to get the fresh weight and then oven-dried at 105 °C to constant weight for about 48hrs and the dry weight recorded. These values were then used to calculate the moisture contents of the soils using the formula:

MC (%) = (fw − dw)/dw x 100

where *MC* soil moisture content (%), *fw* fresh weight (g) of soil sample, *dw* dry weight (g) of soil sample.

Volumetric Moisture Content (VMC)was calculated by multiplying MC values with BD values

Bulk density

Anderson and Ingram (1993) method was used. Core samples of known volume were used to collect soil samples. Saturated samples weight was taken before oven drying at 105^0C until constant weight was obtained. Thereafter, bulk density was calculated as shown below.

$$Bulk\ density\ (g/cm^3) = \frac{mass\ of\ soil}{volume\ of\ soil}$$

$$\therefore \frac{mass\ of\ wet\ soil - oven\ dried\ soil}{volume\ of\ dry\ soil}$$

Total porosity

Total porosity was calculated from bulk density data assuming a particle density is 2.65kg/m^3, using the formula.

$$Total\ porosity = P_t(\%) = 1 - \frac{bulk\ density}{particle\ density} \times 100$$

Water retention characteristics

Field capacity (FC) and permanent wilting point (PWP) were estimated by the method describe by Mbagwu (1991). Core samples were saturated and allowed to drain freely for 2 days. The weight after 2 days was recorded. The, it was allowed to continue draining freely up to the 10th day. Weight after drainage for 10days was recorded. Thereafter, the core sample was oven dried to constant weight.

(a) $$field\ capacity\ \% = \frac{weight\ after\ two\ days\ (g) - weight\ of\ oven\ dried\ (g)}{weight\ of\ oven\ dried\ (g)} \times 100$$

(b) $$Permanent\ wilting\ point = \frac{weight\ after\ 10\ days\ (g) - weight\ of\ oven\ dried\ (g)}{weight\ of\ oven\ dried\ (g)} \times 100$$

(c) Available water content (AWC) was deduced as:

AWC % field capacity – permanent wilting point

Saturated Hydraulic Conductivity (K_{sat})

The constant head method proposed by Stolte (1997) was used. The base of the core sample of known volume was fastened with cheese cloth using a rubber band, before placement in a basin of water to saturate. An empty core sampler was joined to the core sample and held in place with masking tape so that there was no water leakage. These were set up on a retort stand. Another cheesecloth was place in contact with the top of the soil sample to ensure no disturbance when water was added through the empty core. Ensuring that water was always at a marked position in the empty core, the rate of passage of water through the column was noted as the quantity of water (Q) and was measured. The saturated hydraulic conductivity (K_{sat}) was calculated using Darcy's equationfor vertical flow of liquids, as explained by Young (2001).

$$K_{sat} = \frac{QL}{(AT \times \Delta H)}$$

Where

K_{sat}= Saturated hydraulic conductivity

A= Cross sectional area of inner diameter of core sampler (cm^2)

Q=Volume of water flowing through the core sampler per unit time (cm^3)

T = Time of flow (sec)

ΔH =Hydraulic Head difference

L = Length of soil column (cm)

Mean Weight Diameter

Mean weight diameter was determined by the wet-sieving method of Kemper and Rosenua (1993). Soil sample (25g) was weighed into the top most of nest of four sieves of diameter 4mm, 2mm, 1mm, 0.5mm and 0.25mm and soak in water for about ten minutes. The nest of sieves with the contents were oscillated in water for 20 times at the rate of one oscillation per second. Care was taken to ensure that the soil in the top most sieve was under water throughout the period of oscillation.

The stable aggregates retained in the sieves were transferred into different container and oven dried at 105^0C. The oven dried weights were taken.

Mean Weight Diameter was calculated thus:

MWD (mm) = $\Sigma X_i W_i$

Where

X_i = Arithmetic mean diameter of the i^{th}size

W_i= Proportion of total aggregates in the i^{th} fraction.

Particle size

Particle size distribution was determined by the hydrometer method of Bouyoucus, as described by Udo *et al*.,(2009).

Calgon was used as the dispersing agent; a soil sample weighing 50g was subjected to dispersion over night with the dispersing agent in a dispersing cup. The hydrometer readings were taken the next day after stirring the content in the dispersing cup and transfer the content to the sedimentation cylinder and subsequent vigorous agitation of the cylinder from end to end while covering the open end of the cylinder with the palm. Hydrometer readings were taken after 40 seconds and 2hours after agitation. Textural class was determined with textural triangle

Organic carbon and organic matter

Organic carbon was determined by dichromate-oxidation method of Walkley and Black wet oxidation method as outlined by Udo *et al*., (2009). Soil sample was ground using aggregate mortar and passed through a 0.5mm sieve., 0.5g of the ground sample was weighed out into a 250ml conical flask and 5ml of 1N $K_2Cr_20_7$ (potassium dichromate) solution was added accurately into each flask and swirled gently to disperse the soil. 10ml of concentrated sulphuric acid (H_2S0_4) was added using an automatic pipette directing the stream into the suspension and swirling in other to mix the soil and the reagents. After standing for 30minute in sheets of asbestos, 50ml of distilled water was added and 2-4 drops of (barium solution) indicator was added before titration with 0.5N ferrous ammonium sulphate solution. The blank was prepared using the same method without soil sample.

The organic carbon was calculated

Organic carbon in soil =

$$\frac{(\text{Me } K_2Cr_20_7 - \text{MeFS}0_4) \times 0.003 \times 100\ (F)}{\text{Mass of air dried soil to be used}}$$

Where F = correction factor

Me = Normality of solution x volume used.

While organic matter was calculated by multiplying organic carbon with Van Bemmelen factor (1.724).

Micro Aggregation

For micro aggregate indices, particle size analysis was done twice using Calgon in the first instance and water in the second instance.

(a) Dispersion ratio (DR)

This was computed as

$$\%\ DR = \frac{\%\ silt + \%\ clay\ in\ H_2O}{\%\ silt + \%\ clay\ in\ calgon}$$

(b) Clay Dispersion index (CDI)

$$\%\ CDI = \frac{\%\ clay\ in\ H_2O}{\%\ clay\ in\ calgon}$$

(c) **Clay flocculation index (CFI)**

$$\%\ (CFI) = \frac{\%\ clay\ in\ calgon - \%\ \%\ clay\ in\ H_2O}{\%\ clay\ in\ calgon} \times 100$$

(d) **Aggregated silt + clay (ASC)**

ASC (% clay + silt in Calgon) – (%clay + silt in water).

Clay ratio (CR)

$$CR = \frac{\%\ silt + \%\ clay\ in\ calgon}{\%\ clay\ in\ calgon}$$

(d) Silt -Clay ratio (SCR)

$$\%\ SCR = \frac{\%\ silt\ in\ calgon}{\%\ clay\ in\ calgon}$$

Statistical Analysis

The data generated under moisture characteristics, aggregate stability and organic matter of the soil was subjected to analysis of variance and means separated using least significant difference (LSD) to determine the effects of land use systems on the soil measured properties. Correlation was used to determine the relationship between moisture characteristics, aggregate stability and organic matter.

RESULTS AND DISCUSSION

Particle Size Distribution

The particle size distribution of the soils studied is shown in Table 4.1. At the two depths of 0 – 20 and 20 – 40 cm, the texture of soil under arable land (AR) was loamy sand and sandy loam, respectively. Sandy loam was observed at oil palm plantation (OP) and fallow land (FL) at 0 – 20 cm depth. However, for the

20 – 40 cm depth, oil palm plantation (OP) and fallow land (FL) recorded a sandy clay loam texture

At both depths of 0 – 20 and 20 – 40 cm, respectively, the highest sand contents of 806.00 and 750.00 g kg^{-1} were observed under the arable land (AR) while oil palm plantation (OP) had the lowest with values 756.00 and 721.30 g kg^{-1}. With regard to the silt contents, arable land (AR) recorded the highest at the two depths (94.00 and 104.0 g kg^{-1}) while fallow land (64.00 g kg^{-1}) and oil palm plantation (92.00 g kg^{-1}) recorded the lowest at 0 – 20 and 20 – 40 cm depths, respectively. The highest clay contents were observed under the oil palm plantation (OP) at both depths (170.00 and 186.70 g kg^{-1}). The lowest clay contents at both depths were observed in arable land (100.00 and 146.00 g kg^{-1}).

Generally, the sand content decreased with depth except oil palm plantation, while the silt and clay contents increased. As shown in Table 4.1, and with regards to depth, the particle sizes were significantly ($p \leq 0.05$) different. With regards to the land use systems and depths, the sand, silt and clay particles of arable land (AR) were significantly ($p \leq 0.05$) different from OP and FL. Generally, the sand, silt and clay particles of oil palm plantation (OP) were significantly ($p \leq 0.05$) different from AR and FL in both depths.

Table 4.1: **Particle size distribution of soils studied**

Land use	Soil Properties			
	Sand	Silt	Clay	TC
	→	(g kg^{-1})	←	
		0 – 20 cm		
AR	806.00	94.00	100.00	LS
OP	756.00	74.00	170.00	SL
FL	776.00	64.00	160.00	SL
Mean	776.33	77.33	143.33	
		20 – 40 cm		
AR	750.00	104.00	146.00	SL
OP	721.30	92.00	186.70	SCL
FL	739.50	109.30	151.20	SCL
Mean	736.93	101.76	161.30	
$LSD_{0.05}$				
Land use	1.02	0.97	1.57	
Depth	1.56	1.78	1.09	
L × D	0.86	0.65	0.04	

AR = arable land, OP = oil palm plantation, FL = fallow land,
L × D = Interaction of land use × depth.

The high sand contents of the soils could be attributed to the geology of the area. The geology of the area is unconsolidated sand deposits formed over coastal plain sand which are characterized by sandy soils over a wide land area (Ogban and Obi, 2010). The continuous destruction of soil structure as well as the deposition of silt-sized particles by runoff water must have led to the decrease in silt content of AR (Ufot *et al.*, 2016)

The increase in clay with soil depth may be due to translocation (Agoume and Birang, 2009), dissolution and leaching of clay materials as a result of intense torrential rainfall, argillation of clay, lessivage and sorting of soil materials (Ojanuga, 2013). Jaiyeoba (2003) observed that increased clay contents at lower depths were due to increase in cultivation. This may be as a result of either increase of clay translocation from the surface to subsurface horizons or removal of clay from the surface by runoff.

4.2 Bulk density, Total porosity and saturated hydraulic conductivity

The bulk density, total porosity and saturated hydraulic conductivity of the soils studied are shown in Table 4.2. At the two depths of 0 – 20 and 20 – 40 cm, arable land had the highest bulk density with a value of 1.54 and 1.57 Mg m^{-3}, respectively. The lowest bulk density was observed in oil palm plantation (OP) at the two depths with values ranging from 1.30 to 1.31 Mg m^{-3}. With regard to porosity, OP had the highest at both depths (50.94 % and 50.56 %). Arable land (AR) was observed to have the lowest total porosity (41.88 % and 40.75 %) at both depths. Fallow land had the fastest saturated hydraulic conductivity ranging from 16.80 to 18.20 cm hr^{-1} at both depths while arable land had the slowest of 11.40 to 12.60 cm hr^{-1}.

Generally, the bulk density of the soils increased significantly ($p \leq 0.05$) with depth, whereas total porosity and saturated hydraulic conductivity decreased significantly ($p \leq 0.05$) with depth (Table 4.2). These observations reflected the influence of organic matter on the parameters Figure 4.1 With reduced organic matter content, bulk density increased while total porosity decreased resulting to a reduction in saturated hydraulic conductivity (Baunhardt and Lascano, 1996).

As shown in Table 4.2, and with reference to the two depths, the values indicated that bulk density, total porosity and saturated hydraulic conductivity were significantly ($p \leq 0.05$) different. With reference to land use systems in both depths, the bulk density of AR was significantly ($p \leq 0.05$) higher than OP and FL. The porosity under AR were significantly ($p \leq 0.05$) different from OP and FL at both depths. The saturated hydraulic conductivity under AR was significantly ($p \leq 0.05$) slower than OP and FL at both depths, whereas OP was significantly ($p \leq 0.05$) faster than AR and FL.

Table 4.2: **Bulk density, total porosity and saturated hydraulic conductivity of soils studied**

Land use	Soil Properties		
	Bd ($Mg\ m^{-3}$)	Pt (%)	Ksat ($cm\ hr^{-1}$)
		0 – 20 cm	
OP	1.30	50.94	15.40
FL	1.43	46.04	18.20
Mean	1.42	46.29	15.40
		20 – 40 cm	
AR	1.57	40.75	11.40
OP	1.31	50.56	13.20
FL	1.46	44.90	16.80
Mean	1.45	45.40	13.80
$LSD_{0.05}$			
Land use	0.20	3.54	0.03
Depth	0.12	6.41	0.11
L × D	0.15	2.91	0.01

AR = arable land, OP = oil palm plantation, FL = fallow land,
L × D = Interaction of land use × depth.

The variation in bulk density and total porosity may be attributed to the level of organic matter in the soil (Okolo *et al*., 2013). The high bulk density, low porosity, slow saturated hydraulic conductivity and infiltration rate observed under AR were similar to the findings of Ahukaemere *et al.* (2012). He observed consistently higher bulk density in continuously cultivated land than in oil palm plantation. The low bulk density and high porosity with a fast saturated hydraulic conductivity observed under OP may be as a result of the high organic matter content of the OP. This concurred with the findings of Onweremadu and Mbah (2009) who reported that the high level of organic matter in oil palm plantation led to low bulk density, high total volume and favoured transmission of water under saturated conditions. The slow saturated hydraulic conductivity observed under AR may be attributed to the low mean weight diameter, high bulk density and the mechanical disruption of the pore arrangements by tillage (Celik, 2005). As organic matter decreased from OP to AR, the total porosity reduced. This was consistent with the observations of Oguike *et al*. (2006)

4.3 Aggregate stability

The aggregate stability of soils studied are shown in Table 4.3. At both depths of 0 – 20 and 20 – 40 cm, OP was observed to have the most stable aggregates at both depths with the highest mean weight diameter (MWD) which ranged from 5.41 to 5.81 mm. Arable land (AR) was the least aggregated and also showed the greatest tendency to disperse at both depths with the lowest MWD and highest dispersion ratio (DR). The values ranged from 4.76 to 4.88 mm for MWD and 62.70 to 62.30 % for DR. Oil palm plantation showed the lowest tendency to disperse with the lowest dispersion ratio at both depths. The values ranged from 54.90 to 53.32 %. Aggregated silt + clay from the different land use systems were significantly different ($p \leq 0.05$) at 0 – 20cm depth whereas at the 20 – 40 cm depth, soils from AR and FL were statistically similar and less aggregated than soils from OP. The AR and FL soil showed the least resistance to dispersion as revealed by the high CDI and low ASC and CFI values. Also, at 20 – 40cm depth soils from AR and FL were statistically similar with respect to CDI. This may be due to the increase in clay content of soils under the land use systems with depth.

Significant variations were also observed in the flocculation abilities of the soils. Clay flocculation at 0 – 20 cm depth was found to increase in the order AR<FL<OP. This may be as a result of the proportionate increase in clay and silt contents. However, at 20 – 40 cm depth, the flocculation ability of soils formed over AR and OP were statistically similar. The exhibition of good structural abilities observed in soils of OP and FL were due to their increased organic matter contents (Igwe, 2011) while the reduced aggregation noticed in soil from AR was a result of its reduced OM content (Onunkwo *et al.*, 2013; Myravarapu *et al.*, 2014).

Table 4.3: Aggregate stability of soils studied

Land use	Soil Properties				
	MWD (mm)	ASC (%)	CDI (%)	CFI (%)	DR (%)
		0 – 20 cm			
AR	4.88	9.40	41.00	59.20	62.70
OP	5.81	8.80	39.00	64.46	54.90
FL	5.66	9.20	40.00	60.00	61.09
Mean	5.45	9.10	40.00	61.22	59.56
		20 – 40 cm			
AR	4.76	9.10	41.00	60.14	62.30
OP	5.41	8.80	36.00	66.28	53.32
FL	5.12	9.00	39.00	61.32	58.22
Mean	5.10	8.97	38.67	62.58	57.95
$LSD_{0.05}$					
Land use	0.284	0.10	2.17	0.95	0.61
Depth	0.214	2.01	1.02	1.43	2.01
L × D	0.026	0.16	1.96	3.97	0.43

AR = arable land, OP = oil palm plantation FL = fallow land, L × D = Interaction of land use × depth. MWD = mean weight diameter, ASC = aggregated silt + clay CDI = clay dispersion index, CFI = clay flocculation index, DR = dispersion ratio.

The macro aggregation measured with MWD and the dispersion of soils (DR) increased significantly ($p \leq 0.05$) with depth. As shown in Table 4.3 and with regards to depth, the means indicated significant ($p \leq 0.05$) differences in both at the macro and micro levels. With reference to land use systems in both depths (Table 4.3.), the MWD of arable land (AR) was significantly ($p \leq 0.05$) lower than OP and RD. At both depths, mean weight diameter of OP was significantly higher than AR and FL. The MWD of AR was significantly ($p \leq 0.05$) different from the other land use systems at both depths. At the macro aggregation level, OP was better than the other land use systems. This observation supported the findings of Celik (2005), who reported that mean weight diameter of soil aggregates was significantly greater in oil palm plantation, than in arable land and fallow land. The low MWD observed in AR may be attributed to tillage with traditional implements and clean weeding, together with reduced organic matter (Oguike and Mbagwu, 2009). Cultivation breaks up soil aggregates and expose previously inaccessible organic matter to microbial attack and accelerates decomposition and mineralization of organic matter (Shepherd *et al*., 2001). The high value of MWD observed under OP may be attributed to the high organic matter contents of the soils (figure 4.1). This may be associated with increase in the percentage of binding materials (polysaccharides, humic and humin) contained in the organic materials which enable soil particles to aggregate with each other (Eneje and Lemoha, 2012; Turgut and Kose, 2015). The higher DR observed in AR may be attributed to the colloidal nature of clay which could promote the poor aggregation in the soils (Ghezzi, 2010).

4.4 Soil moisture content

The moisture content of the soils at different land use systems studied is shown in Table 4.4. At the two depths of 0 – 20 and 20 – 40 cm, arable land (AR) had the lowest field capacity with a value of 0.19 and $0.18 m^3 m^{-3}$, respectively. The highest field capacity was observed in fallow land (FL) at the two depths with values ranging from 0.21 and $0.24 m^3 m^{-3}$. With regard to permanent wilting point, FL had the highest at both depths ($0.15\ m^3 m^{-3}$ and $0.13 m^3 m^{-3}$). Arable land (AR) was observed to have the lowest permanent wilting point ($0.05\ m^3 m^{-3}$ and $0.06 m^3 m^{-3}$) at both depths. Arable land had the highest available moisture content of $0.13 m^3 m^{-3}$ at both depths while fallow land had the lowest. Fallow land had the highest gravimetric and volumetric moisture contents at both depths, whereas arable recorded the lowest.

The higher field capacities recorded under fallow land may be attributed to the high clay (in fallow land) which provided large surface area required for the absorption and retention of water molecules (Materechera and Mkhabela, 2001). The lower available water content of soils under arable land may be attributed to their low structural stability. Yihenew and Ayanna (2013) who made similar observation, reported that land under continuous cultivation deteriorated soil structure aggregates, reducing their available water contents. With regards to the lower available water content observed in fallow land, it is apparent, however that soils with clayed texture have high moisture retention at field capacity and permanent wilting point, making the available water for crops to be lower than those of loamy textured soils (Brady and Weil, 2002).

Table 4.4: Moisture contents of soils studied

Land use	FC (m^3m^{-3})	PWP (m^3m^{-3})	AWC (m^3m^{-3})	GMC(m^3m^{-3})	VMC (m^3m^{-3})
			0 – 20 cm		
AR	0.19	0.06	0.13	0.19	0.29
OP	0.20	0.08	0.12	0.22	0.30
FL	0.24	0.15	0.09	0.26	0.33
Mean	0.21	0.10	0.11		
			20 – 40 cm		
AR	0.18	0.05	0.13	0.17	0.28
OP	0.18	0.07	0.11	0.20	0.29
FL	0.21	0.13	0.08	0.24	0.32
Mean	0.19	0.08	0.11		
$LSD_{0.05}$					
Land use	0.03	0.01	0.01	0.02	0.01
Depth	0.01	0.02	NS	0.01	NS
L × D	0.02	0.01	0.01	0.01	0.02

AR = arable land, OP = oil palm plantation FL = fallow land, L × D = Interaction of land use × depth

4.5 Organic matter, available phosphorus, total nitrogen and pH of soils studied

The organic matter, available phosphorus, total nitrogen and pH of the soils studied are shown in Figure 4.1. At both depths of 0 – 20 and 20 – 40 cm, oil palm plantation (OP) was observed to have the highest organic matter at both depths with values 28.30 and 24.00 g kg^{-1}, respectively. The arable land (AR) was observed to have the lowest organic matter at both depths with values 25.90 and 23.40 g kg^{-1}. With respect to both depths, arable land(AR) was very low in organic matter whereas fallow land and oil palm were high in organic matter (Brady and Weil, 2002).

Figure 4.1: organic matter content of the soil studied

The decrease in organic matter content with soil depth may be attributed to the continuous accumulation of undecayed and partially decomposed plant and animal residues on the surface soil (Nega and Heluf, 2013). The high organic matter observed under OP and FL may be attributed to the presence of litter falls and roots (Alemayehu and Sheleme, 2013). The low organic matter observed in arable land may be attributed to the effects of continuous cultivation that aggravates organic matter oxidation (Alemayehu and Sheleme, 2013; Wakene, 2011; Malo *et al*., 2003).

CONCLUSION AND RECOMMENDATION

Soils of different land use systems; arable land (AR), oil palm plantation OP), and fallow land (FL) were studied at Ahiazu Mbaise in Imo State.The principal objective was to compare the impact of each land use system on the aggregate stability and moisture content of the soils of Ahiazu Mbaise at different depths (0-20 and 20-40cm).

At both depths of 0 – 20 and 20 – 40 cm, OP was observed to have the most stable aggregates with the highest mean weight diameter (MWD) which ranged from 5.41 to 5.81 mm. Arable land (AR) was the least aggregated and also showed the greatest tendency to disperse at both depths with the lowest MWD and highest dispersion ratio (DR). Oil palm plantation showed the lowest tendency to disperse with the lowest dispersion ratio at both depths. The arable land (AR) was observed to have the lowest organic matter at both depths. The high organic matter observed under OP and FL may be attributed to the presence of litter falls and roots. The low organic matter observed in arable land may be attributed to the effects of continuous cultivation that aggravates organic matter oxidation

The moisture content of the soils at different land use systems studied shows that the arable land (AR) had the lowest field capacity. The highest field capacity was observed in fallow land (FL) at the two depths The higher field capacities recorded under fallow land may be attributed to the high clay (in fallow land) which provided large surface area required for the absorption and retention of water molecules. The lower available water content of soils under arable land may be attributed to their low structural stability. Management practices such as organic matter application to stabilize soils under arable land against erosion and other mechanical manipulations should be encouraged. This will enhance sustainable utilization of such soils. There is also the need to evolve a long term conservation land use systems that will provide the solid base for agricultural production. These plans should be based on enhancing land use systems, for example; the continuously cultivated land should be replenished either by using the crop residues as mulching or applying such inputs as organic wastes/materials to enhance the organic matter status of the soil.

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